National Weather Service

California Nevada River Forecast Center

Spring/Summer 2012

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HIC's Corner

Rob Hartman - Hydrologist in Charge

The CNRFC has experienced a great deal of change over the last 18 months. We've implemented the Community Hydrologic Prediction System (CHPS) as the infrastructure for generating our hydrologic forecasts and dramatically ramped up our application of the ensemble streamflow prediction (ESP) process. Please take a look at Alan Haynes' article on this within this edition of our newsletter.

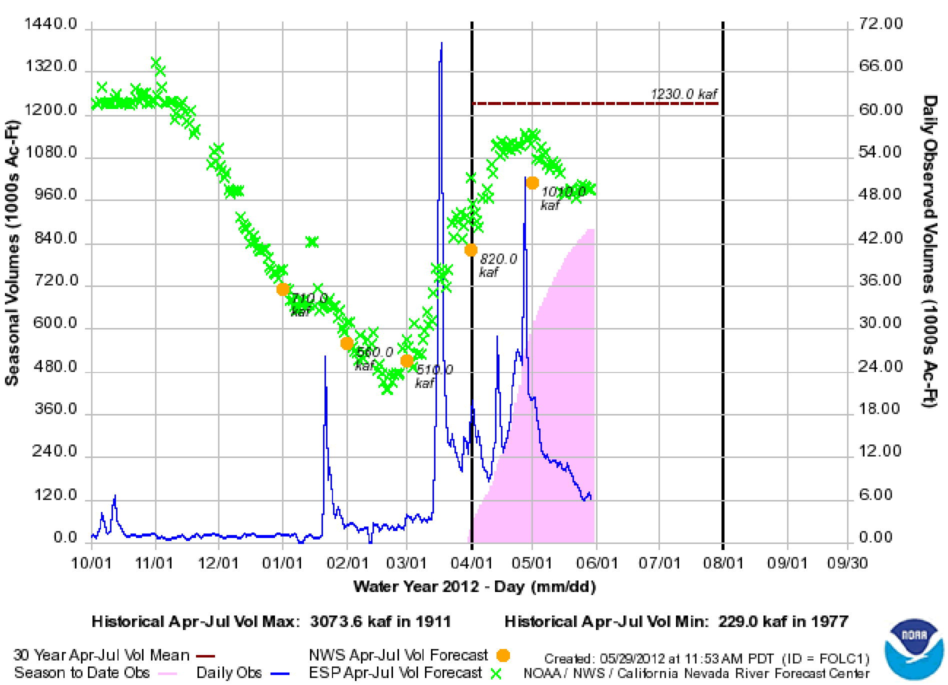
The rapid expansion and application of ESP is transforming the vision of our water supply and snowmelt forecasting services. Traditionally, water supply forecasts have been based on regression models that are driven with monthly data such as snow water equivalent and precipitation. Forecasts are updated monthly with mid-month updates in some basins. These forecasts are also rigorously coordinated with the NRCS outside of California and loosely coordinated with the California Department of Water Resources within California.

I believe it is always healthy to assess what you're doing and why, especially in government service where market forces are often absent. Anyone can calibrate and execute regression-based water supply forecast equations, and in fact, many organizations do. NOAA's niche in water resources services resides in our ability to integrate real-time hydrology with forecast weather and climate. Very few organizations can do this effectively and the CNRFC is one of them.

The key attributes of ESP-based water supply forecasts are (1) immediate integration of observed conditions, and (2) constant integration of the latest weather and climate forecast information. If it rained or snowed a lot yesterday, then today's ESP forecast will reflect it. If the weather forecast suddenly suggests that a big Pacific storm is headed our way, then today's ESP forecast will incorporate its impact. You don't have to wait for the next scheduled update. On a day-to-day basis, the ESP forecasts will appear a bit "noisy", especially compared to the monthly or mid-month forecasts that are intentionally dampened to avoid month-to-month oscillations. This is something we believe our customers can get used to and must if they really want the latest information.

AMERICAN RIVER - FOLSOM LAKE (FOLC1)

Water Year Trend Plot



Take a look at the graph on the left that shows how the ESP forecasts for the April-July period of 2012 have evolved since October 2011 (green x's). This sort of information really paints a clear picture of how the water supply season developed in the Sierra this year. Shortly after November 1st we started into a dry period that, with the exception of four days in January, extended to the third week of February. Wet conditions during March and early April allowed the volume

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forecasts to recover from 35% of normal to nearly 90% of normal. Daily updates keep customers aware of and in-tune with the latest observations and the current weather forecast.

Given this shift in direction, what then happens to the traditional "coordination" process? Great question. If your agency is dependent upon a specific "coordinated" volume, we will continue to support your requirement. Understand however, that our ESP forecasts may be slightly different than the value that is coordinated (as seen in the above figure with the orange dots). If there is no real requirement for a "coordinated" number, our current plan is to terminate coordination for that location and promote the use of the ESP information. Similar changes are taking place at the NWRFC and the CBRFC. I'm expecting that we'll need to make adjustments along the way, but this is clearly the direction we are heading.

Thank you for taking the time to review our newsletter. I hope you find it informative and helpful. If you have questions or would like to talk about how the CNRFC can better serve you, please give me a call at 916-979-3056 or email me any time at:

Robert.Hartman@noaa.gov

Recent Improvements to Hydrologic Ensemble Forecasts at the CNRFC

Alan Haynes - Service Coordination Hydrologist

The California Nevada River Forecast Center (CNRFC) has long recognized the value in being able to quantify uncertainty in its hydrologic forecasts. For many years, the CNRFC has accomplished this using Ensemble Streamflow Forecasts (ESP), where past climatology is run through its hydrologic model, starting with current model states such as those accounting for soil moisture and snowpack. In this way, the potential variability in the forecasts is described by superimposing the past meteorological forcings of precipitation and temperature for each year (e.g., from 1950 to 2007), starting with the current conditions. Each year is run through the hydrologic model and produces a "trace", or representation of the hydrologic response (see Fig. 1). The variability can then be processed statistically to determine various threshold exceedance probabilities as a function of lead time.

Recent improvements to this methodology account for the skill available in the shorter term, especially in the first three days of the forecast, but including skill derived from the atmospheric modeling which extends out to about two weeks. For example, although climatology may generally indicate wet conditions in the first few days, forecasts may reliably reflect dry conditions for that period, thus improving the predictability in the hydrologic response. Alternatively, reliable forecasts of a very large storm in the short term may produce enough precipitation to appreciably change the water supply picture, a scenario that wouldn't be well-represented by climatology either. Another recent improvement is the addition of 19 years worth of climatology, yielding 19 additional ensemble members and bringing the total to 57. This expansion of the climatological forcings set brings into the process the 1950s and the late 1990s through 2007. Thus, the December 1955 and December-January 2005/2006 events now factor into the picture, each being periods that produced high flows.

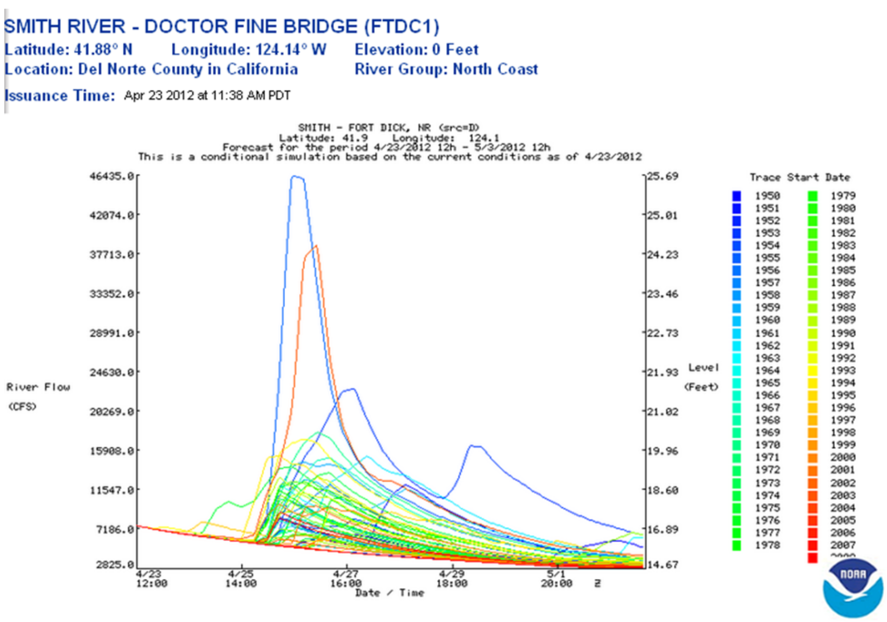

Figure 1. Ensemble Streamflow Forecast Trace Plot for the Smith River at Dr. Fine Bridge

Thus, more probabilistic information is now available from the CNRFC to help quantify uncertainty in its hydrologic forecasts. Additionally, the CNRFC has put the ensemble forecasts front and center on its web page (http://www.cnrfc.noaa.gov/index.php?type=ensemble).

So how can probabilistic forecast information be used? For example, suppose the CNRFC deterministic forecast at a particular location indicated a maximum stage nearing the flood threshold following an expected period of heavy rain over the next several days. The forecasts could then be used to determine the likelihood of exceeding flood stage (i.e., < 20 percent) at various lead times or over an accumulated period of time. In a similar manner, it could be used to assess the likelihood of various reservoir inflow volumes over a period of time. These forecasts are anticipated to better inform decision makers who deal with hydrological impacts, including public safety officials and water resource managers.

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They are also useful for assessing forecast probabilities internally at the CNRFC. Currently, ensemble-based forecasts are available for unregulated locations, but development efforts are underway to expand these forecasts to sites where flow is regulated. Accounting for uncertainty associated with regulation is a complicated matter and it will take some time to develop a reliable methodology to deal with these locations. For now, the CNRFC is engaged in expanding the use of its ensemble forecasts through jointly discovering applications with its user base.

Water Year 2012 - La Niña - Part II

Pete Fickenscher
CNRFC Sr. Hydrologist

After a bumper crop of precipitation during the La Niña of Water-Year (WY) 2011, some were hoping that this year's La Niña would produce in similar fashion. WY 2011 saw Northern California precipitation reach 72.7 inches (the ninth highest total in the history of the 8-Station Index) and Central California precipitation reach 65.0 inches (the seventh highest total in the 5-Station Index history). Most noteworthy was the snowpack which reached near record levels in many places in the Sierra Nevada. So with another La Niña on the way for WY 2012, hopes for a wet year abounded.

After a nice early storm the first week of October, WY 2012 turned extremely dry, with very little precipitation for three months. By the second half of January, rainfall accumulations were rivaling the record dry year of 1923-1924 throughout the state. One good storm in January helped to briefly alleviate fears of record drought, but the dry pattern persisted until almost mid-March. Then the rain dances finally started to work. With about half of the year's precipitation condensed into about 30 days, runoff during mid-March to mid-April was well above normal in many key locations. The timing could not have been better as well. With the end of the wet season in sight, reservoir operators were able to store much of the extra runoff. So heading into the dry summer months, many reservoir levels on April 1st were actually above normal.

As with many La Niña events, the rainfall of WY2012 has favored the northern third of California. The central and southern Sierra precipitation totals have continued to lag behind the north. The watersheds on the east side of the Sierra Nevada and into Nevada have also seen well below normal precipitation, which could correlate with the type of storms this year. A couple of our major storms featured strong orographic precipitation on the windward side of the mountains leaving Nevada in the rain shadow. Also, wintertime precipitation in California has continued to see average to below average snowlines, which seems to have been the trend since the recent switch to a negative phase of the Pacific-Decadal Oscillation in about 2007-2008.

Now, in late April, the La Niña pattern is rapidly fading. After two consecutive La Niña seasons, there is a good chance we may swing into an El Niño pattern next year. An interesting statistic is that historically, following two La Niñas in a row, the following year has never been neutral. After previous two-year La Nina events, 6 out of ten events turned into an El Niño the following year, while 4 came back for a third year of La Niña conditions. Looking at current conditions, the Southern Oscillation Index is already at the El Niño threshold, and the Madden-Julian Oscillation (MJO) has increased significantly. Oftentimes, the MJO activity helps to move warmer water into the equatorial Pacific, which then helps to intensify El Niños. Both of these are indications that an El Niño may well be in store for WY2013.

Whether we get an El Niño or La Niña next year, the past couple years have been a good reminder that either pattern can leave California wet or dry.

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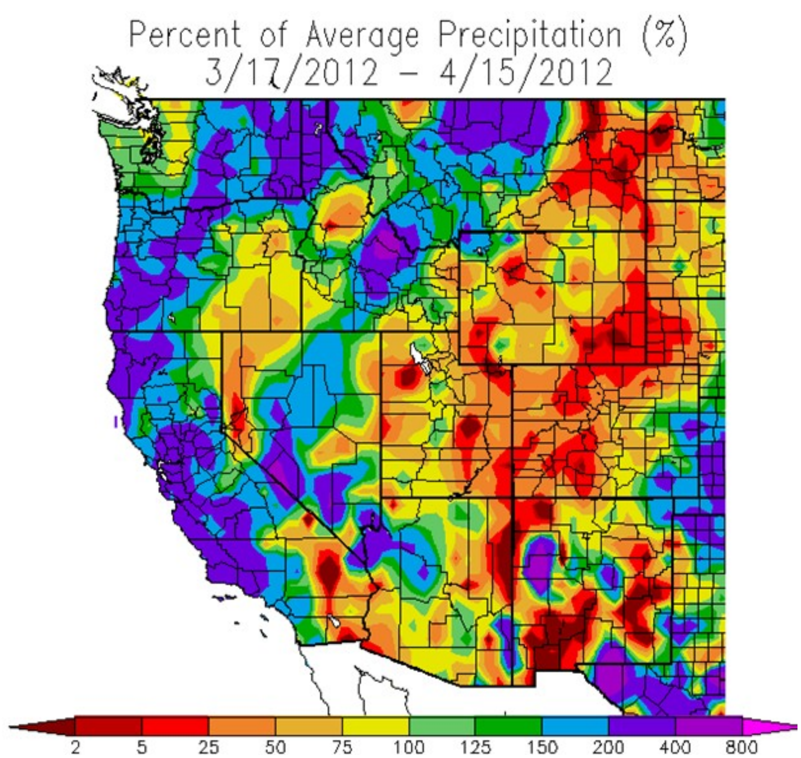
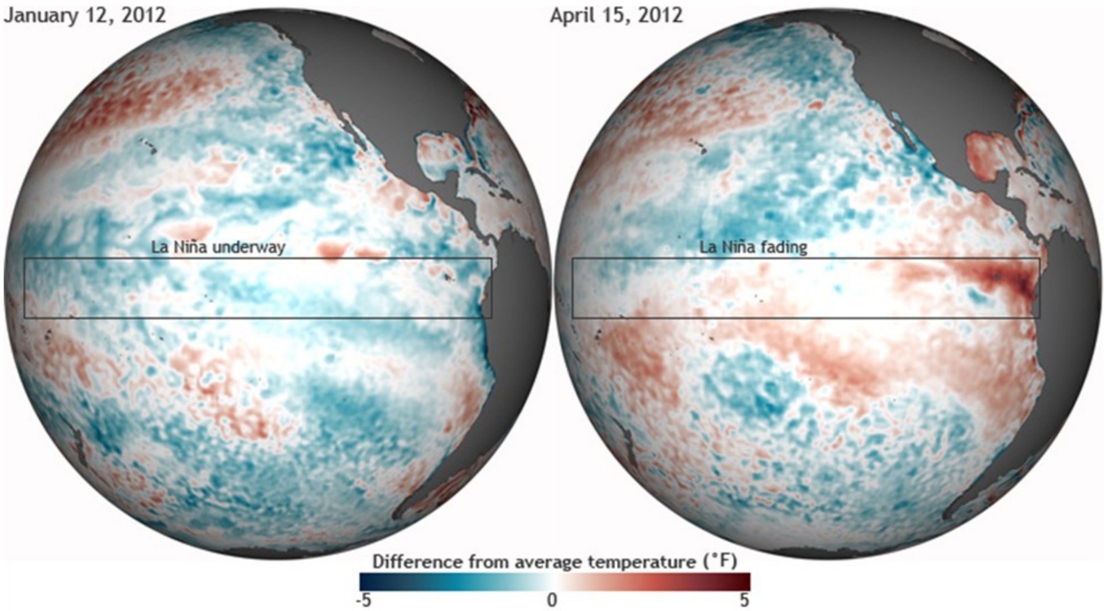


Generated 4/16/2012 at WRCC using provisional data
NOAA Regional Climate Centers



The images on the left show the ocean surface temperature anomalies along the equatorial region of the Pacific. The left image shows much of this region observing below-normal temperatures (La Niña conditions) in mid-January. The right image taken 3 months later in mid-April shows either neutral or slightly above normal temperatures (El Niño conditions), especially in the eastern Pacific near the coast of Ecuador.

New Tools for Forecasting Precipitation

Mike Ekern
Sr. HAS Forecaster

Quantitative Precipitation Forecasts (QPF) have come a long way from the days of simply writing a QPF on a piece of paper and handing it to the hydrologist, which is actually how it was done at the time of the 1997 floods of northern California and western Nevada. QPF and observed precipitation (QPE) for each river basin is used as a key input into the hydrologic models at the CNRFC, along with observed and forecast snow levels. By the late 1990s, CNRFC meteorologists, known as HAS (Hydrometeorological Analysis and Support) forecasters adopted a more modern gridded approach, using software originally designed and implemented at the Colorado Basin River Forecast Center in Salt Lake City. The program was called Specify and it was a member of a larger suite of software called Mountain Mapper. The Specify QPF forecast method used a gridded dataset of monthly precipitation climatology known as PRISM to distribute point QPF to a 4-km forecast grid. The PRISM method makes use of climatology grids to adjust point QPF to the surrounding terrain, which takes into account the dominating influence of terrain on the distribution of precipitation throughout the complex mountainous topography that lies within the CNRFC area of responsibility.

Using the original Specify interface, the job of the HAS forecaster was to forecast point QPF for approximately 70 fixed points scattered throughout California, Nevada, and southern Oregon for a total of twelve 6-hour periods (three days into the future). The software would then compute future mean areal precipitation estimates from the QPF grids for over 300 basin/sub-basin forecasts.

While Specify software successfully paved the way to the implementation of gridded QPF from the late 1990s through the next decade, its limitations due to such things as a lack of grid editing tools led to a search for software with more powerful features and flexible tools. Forecasters didn't have to look very far as National Weather Service Forecast Offices were already using nationally supported grid editing software appropriately known as GFE (Gridded Forecast Editor). Kyle Lerman, CNRFC HAS forecaster, took advantage of QPF-related software developments to GFE made at NWS Western Region Headquarters and at the Colorado Basin River Forecast Center in Salt Lake City to design and implement a customized GFE QPF-editing tool for the CNRFC. Coinciding with these software developments, another obstacle was overcome when hardware improvements to AWIPS workstations such as faster processors and additional memory made it possible to edit the large grid domain within the confines of the CNRFC area of responsibility. The PRISM method used in Specify still exists at the core of the internal workings of the new GFE tools.

The interface of the new GFE specify tool allows much more flexibility to customize the QPF patterns, especially for those times when the QPF is not

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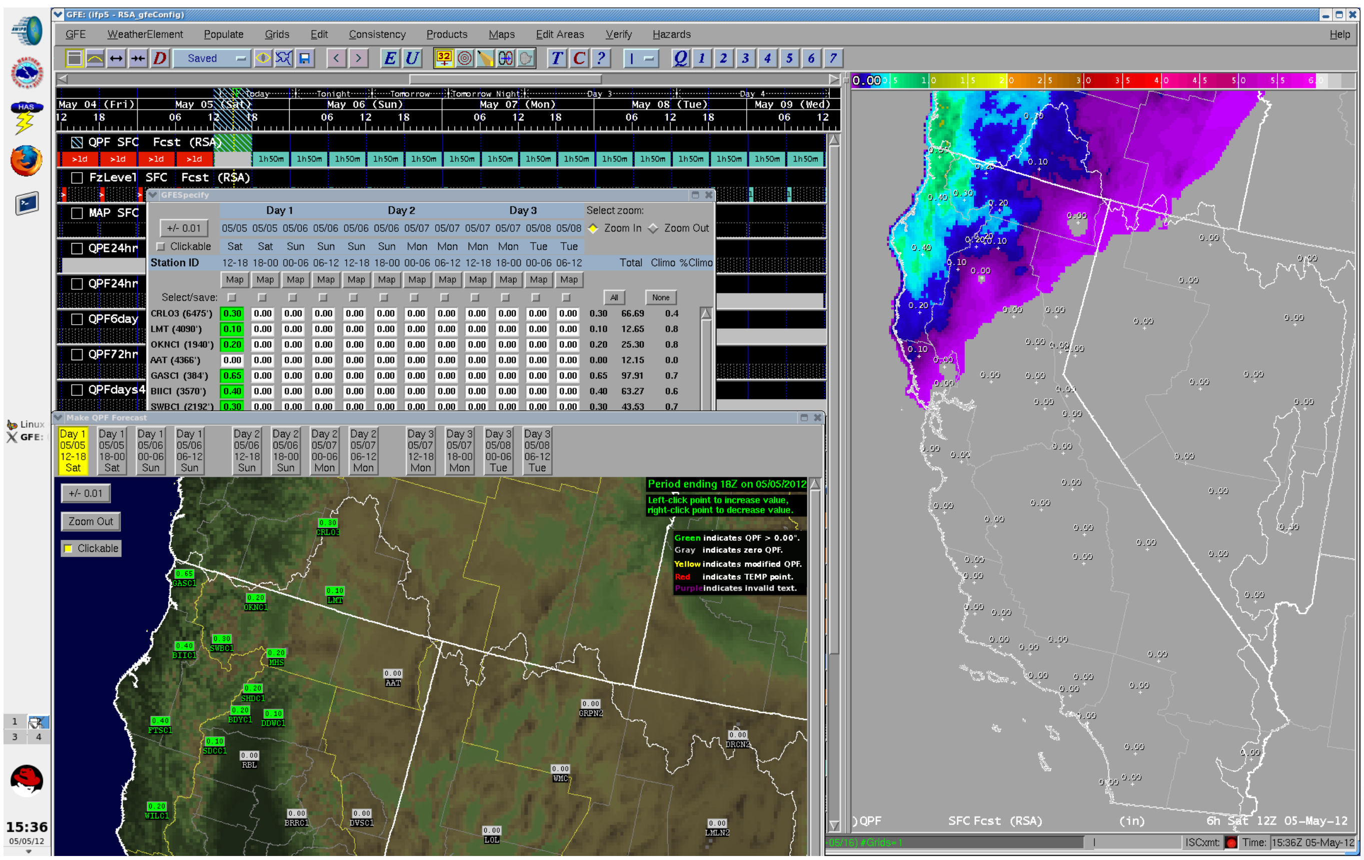
necessarily distributed climatologically within a 6-hour period, such as precipitation along frontal boundaries that cross the central valley of California as one example.

Additionally, QPF is now extended out to six days into the future, with the capability to blend QPF from multiple model sources to better account for the typical uncertainty of longer range guidance. Under the older method, QPF in the extended forecast periods generally followed guidance from the Rhea Orographic Aid, which did a good job for most events, but sometimes was inappropriate for precipitation caused by convection and under certain synoptic scale patterns such as closed upper lows that are more common in the spring, during the critical spring snow melt runoff period.

Finally, HAS forecasters are now able to view QPF guidance issued at the national scale by forecasters at the Hydrometeorological Prediction Center in Camp Springs, Maryland, as well as view QPF from the eleven Weather Forecast Offices served by the CNRFC, all in one tool. This benefit allows much better collaboration between forecasters, resulting in a more cohesive and coordinated forecast that can be supported as input to the hydrologic models, which is the ultimate goal.



The image above is a screen capture of our customized GFE QPF tools, showing the map interface option in the lower left of the image and table matrix interface just above that. On the right is a map of the CNRFC region showing the gridded QPF that is derived from the point QPF. Additional grid-editing tools are available from the pull-down menus located along the top.

Water Supply 2012 Summary

Scott Staggs
Sr. Hydrologist

The water supply outlook up until March appeared rather dismal for the CNRFC forecast area. Normal to much-above-normal precipitation for most areas in March and April improved the water supply forecast in many areas, especially in the northern river basins.

Despite above-normal Spring precipitation throughout the region, seasonal precipitation (October 31, 2011 to April 30, 2012) for the region still ranged from near-normal to below-normal:

Basin	WY % of Avg Pcpn
Klamath	90
Northern Sierra	85
Southern Sierra	60
Eastern Sierra	60
Humboldt	70

The April 1, 2012 snowpack was impacted by the lack of seasonal precipitation, resulting in a below-normal snowpack in all regions of the CNRFC forecast area:

Basin	April 1 percent of Avg Snowpack
Klamath	95
Sacramento	55
San Joaquin	50
Tulare	45
Eastern Sierra	50
Humboldt	40

The below-normal seasonal precipitation, resulting in a below-normal snowpack produced a near-normal to much-below-normal water supply forecast for all river basins in the CNRFC forecast area on April 1. Precipitation in April improved the forecast by 10–15% on May 1 in the Klamath, Sacramento, and Tulare drainages.

Basin	April 1 Forecast % AVG	May 1 Forecast % AVG
Klamath	95	110
Sacramento	75	85
San Joaquin	50	55
Tulare	45	55
Eastern Sierra	45	40
Humboldt	35	25

In summary, the May 1, 2012 water supply forecast ranged from near-normal in the Klamath and northern Sierra basins to well-below-normal in the southern and eastern Sierra, and Humboldt basins. Abundant precipitation in March and April saved the region from an otherwise dismal water supply forecast issued on March 1. Despite a below-normal water supply forecast for many areas, large scale water shortages are not expected. Last year's well-above-normal precipitation and resulting near-record snowpack resulted in large carryover storages in area reservoirs this year. Reservoir storage in most areas are near-normal as of May 1. Agriculture will see a reduction in water allocations, but domestic supplies should remain unaffected.

What Exactly Is CoCoRaHS?

Jamie Meier
HAS Forecaster

In the field of meteorological and hydrologic forecasting, a dense network of observing equipment serves an integral role in providing the data needed for a wide variety of post-storm analyses. While there are a variety of observing networks in place across the country, from FAA equipment, to state and county gauges, to NWS-maintained sensors, there is still, and will always be, gaps in the network that can only be filled by volunteers willing to donate their time and effort. The Community Collaborative Rain, Hail, and Snow Network (CoCoRaHS) is a way to fill in these holes, through a non-profit high density network of volunteers who take daily precipitation measurements in the convenience of their own homes.

While there has always been a need for a network of this type, it was developed as the result of a small-scale, high impact precipitation event in Colorado. A localized convective downpour brought over a foot of rain to a portion of Fort Collins, CO in July of 1997, resulting in a major flash flood that caught many by surprise and did significant damage to the city. The need for a higher-density network of observations was brought to the forefront, and CoCoRaHS was thus born with the intention to better map and report these intense storms that would otherwise be missed by official observing networks.

The CoCoRaHS network consists of thousands of individuals or families across the country, comprised of all ages and walks of life, who are simply willing to make a small time commitment each day measuring and reporting precipitation. All reports make a difference, even when no precipitation falls. CoCoRaHS data is used by the NWS, private meteorological companies, hydrologists, emergency managers, insurance adjusters, the USDA, engineers, ranchers, those involved with water supply, and many others who value the importance of a high density data network.

Think the CoCoRaHS program is something you may be interested in participating in? You can find out more information on their webpage:

http://www.cocorahs.org/

You can also subscribe to more frequent updates through their facebook page:

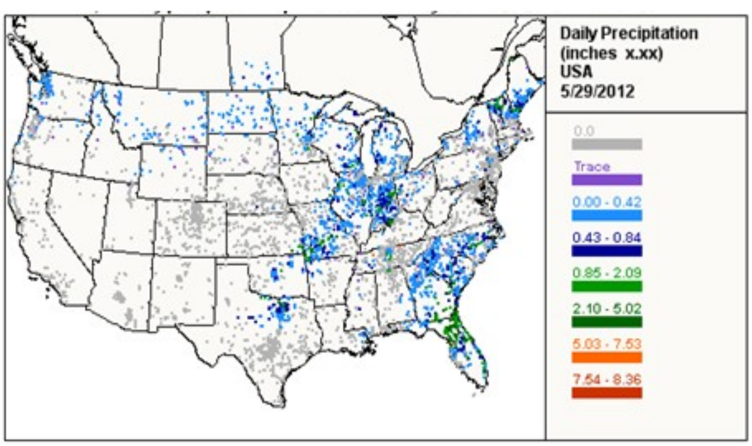
https://www.facebook.com/CoCoRaHS

Signing up is simple, and a short training session is available online. The only equipment needed is a high capacity 4" diameter rain gauge, which can also be purchased online. Measurements are taken daily and entered into a web interface, recording precipitation type and quantity for your location.

Manual rain gauges are the officially endorsed equipment used in CoCoRaHS measurements due to many studies proving the inaccuracy of automated gauges. Collection efficiency comes into question with automated gauges, with errors due to many reasons resulting in reporting up to 25% less precipitation over the course of a year than has actually fallen. This loss of precipitation and resulting degradation of accuracy is less than ideal for a program emphasizing the subtle differences in precipitation patterns across small areas. Taking reports via a manual gauge that is standard across the reporting network is the most efficient way to compare "apples to apples" from one site to another.

The CoCoRaHS network is sponsored by numerous organizations and individuals, with NOAA and the National Science Foundation as two of the largest. We look forward to seeing your reports soon!

Example of a standard 4" diameter rain gauge, used for precipitation measurements in the CoCoRaHS program



One day of precipitation reports from the CoCoRaHS network