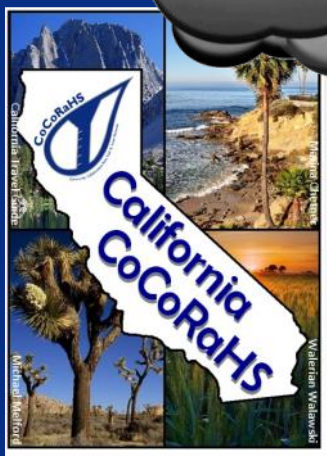
California Cumulonimbus

Fall/Winter 2022



Articles in this Edition:

Where is the Storm?

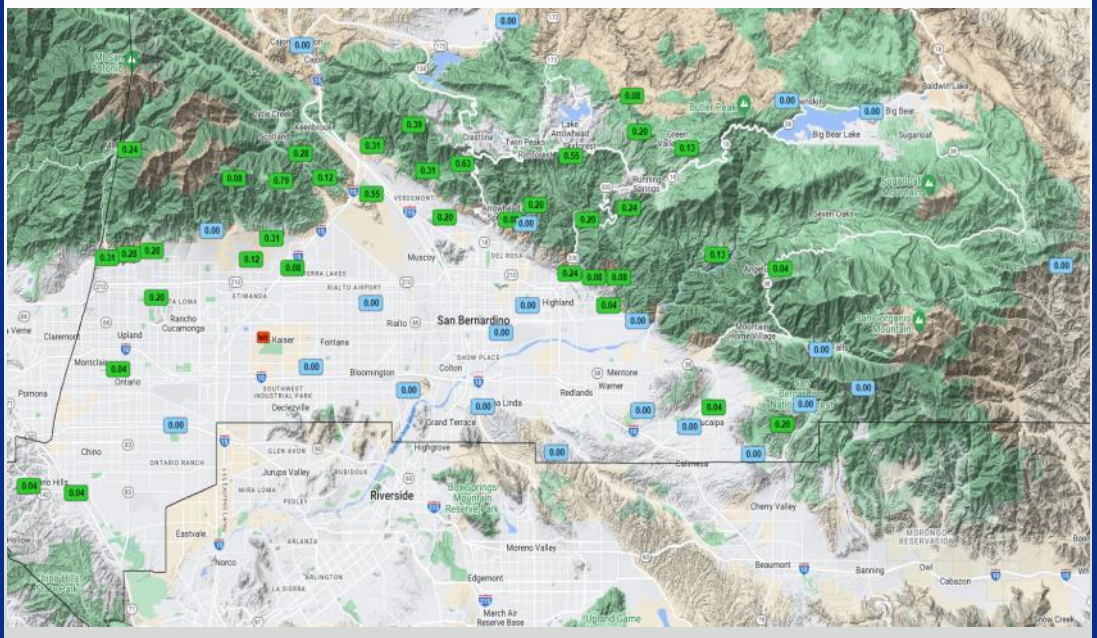
By Joe Dandrea

The precipitation event over Southern California on October 22-23 will likely not be remembered for long, nor was it impressive, but it did highlight mechanisms that can produce rain and snowfall with no "storm" nearby, and very little synoptic lift.

In this case, we had a fairly strong low pressure system digging south over the Great Basin, but nothing to provide synoptic lift near Southwest California. Still, rainfall was widespread, and over one-half inch fell in some areas before all was said and done.

This is where the local geography and the existing atmospheric condition is critical to predicting how much rain will fall. As the low pressure system moved into Nevada, pressure fell over the deserts, and drove strong winds across far southwest California. The low-level wind (below 5000 feet) was from the southwest to west during the night, and the atmosphere at this level was moist and saturated. This wind was optimal for the saturated air mass to be lifted along the coastal slopes, releasing hours of precipitation, while at lower elevations, there was little forcing to lift the air mass, and hence little precipitation fallout occurred. Rainfall in some parts of the coastal basin was non-existent, while the slopes were well watered.

Local forecast models that are higher resolution and can capture in more detail, the local elevation differences, and do better at predicting the rain and snowfall potential with this type of event.



Storm Total Precipitation from the October 22-23, 2022 precipitation event. The highest rainfall totals occurred just south of Lytle Creek and just south of Crestline in the San Bernardino Mountains. Map provided by San Bernardino County Flood Control.

The History of Rain Gauges and Measuring Rainfall

By Samantha Connolly

The rain gauge is one of the most simple, yet most valuable, weather instruments in the modern world today. How did this instrument come to be? Who invented it?

The standard 4 inch rain gauge with a rainbow in the background. Photo credit: Henry Reges/CoCoRaHS

The practice of measuring and recording rainfall goes all the way back to 17th century Europe, during the Age of Enlightenment. During this time period, there was an explosion of inventiveness, and a drive to observe and learn more about our world. Earlier attempts at measuring rainfall were conducted in places like India, China, and Korea, however regular practice of rainfall measurements did not occur until the late 1500s in Europe.

History indicates it was likely Benedetto Castelli (1578-1643) who took the first modern rainfall measurement. He wrote in a letter to Galileo in 1693:

"I took a glasse formed like a cylinder, about a palme high, and half a palme broad [12 centimetres diameter]; and having put in it water sufficient to cover the bottom of the glasse, I noted diligently the mark of the height of the water in the glasse, and afterwards exposed to open weather, to receive the rain water, which fell into it; and I let It stand for the space of an hour; and having observed that in that time the water was risen in the vessel the height of the following line [about10 millimetres long to represent the depth]. I considered that if I had exposed the same rain such other vessel equal to that, the water would have risen in them according to that measure."

In the late 17th century, Sir Christopher Wren and Robert Hook developed a 'weather-wiser' powered by a weighted clock. This contained many weather instruments, including a tipping bucket to measure rainfall. The first tipping bucker was only a single-bucket, while now many of the modern tipping buckets are double-sided. Robert Hooke also developed a non-recording rain gauge, consisting of a bottle with a glass funnel on a wooden pole. This non-recording rain gauge was not operated for a long time.

It was Richard Towneley who made the first continuous record of rainfall from 1677 to 1703. The gauge was connected to his roof through a pipe in his house, with the water being measured by a graduated cylinder. Interest in measuring rainfall increased rapidly in the 18th century. Dr. Dobson (1777) was one of the first to create a rain gauge resembling today's standards for rain gauges. The rain gauge was set up in a large, open, grassy patch overlooking Liverpool , England. Until this point, most rain gauges had been placed on roofs.

There are over 50 different kinds of manual rain gauges in use worldwide today. The standard manual rain gauge used in the United States (and also used for CoCoRaHS!) is the high capacity 4 inch rain gauge. These gauges are manually measured and emptied by an observer. Automated rain gauges are commonly used worldwide as well, with the tipping bucket as the most commonly used. The modern tipping bucket is a double-sided bucket that empties ("tips over") once it reaches a certain amount in the bucket. The tipping of the bucket moves a magnet past a reed switch giving a contact-closure which is recorded by data logger. Tipping buckets are commonly used in locations where it is not readily accessible for an observer to empty the gauge, such as at airport weather stations.

Developments in rain gauges will certainly continue moving forward in the future, though the simplicity of the rain gauge will likely continue as it has for many centuries.

Winter Outlook and La Niña Conditions

By Alex Tardy

We are entering the third straight year of La Niña conditions, which are colder than average sea surface temperatures along the equatorial Pacific Ocean. The last time we had three consecutive years was 1998-2001. Prior to that, it was in the mid 1970s. Correlations for back to back La Niña conditions, or 3 consecutive years, indicate slightly drier than average for Southern California and notably cooler than average in the winter season from November through April.

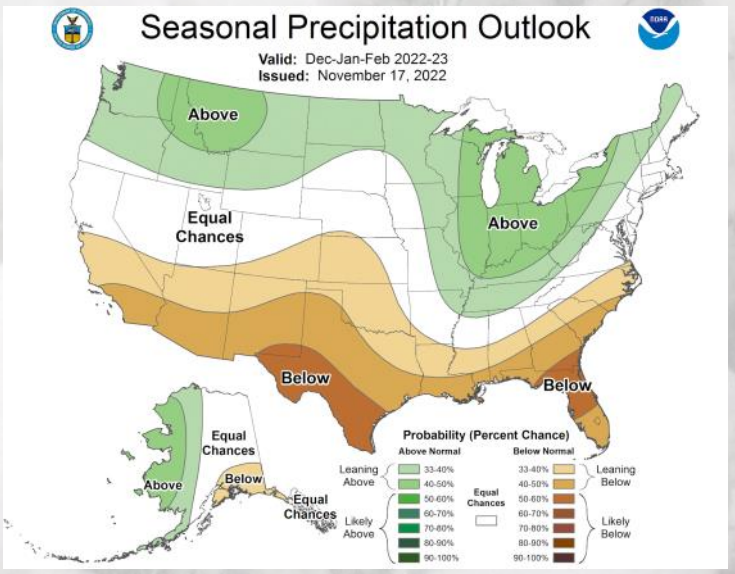
It is important to remember that La Niña is a condition in the ocean and not the atmosphere. However, it has been observed that the tropical oceans can alter and become coupled with the atmosphere (merged), causing changes in the jetstream patterns, which is the storm track for precipitation in California.

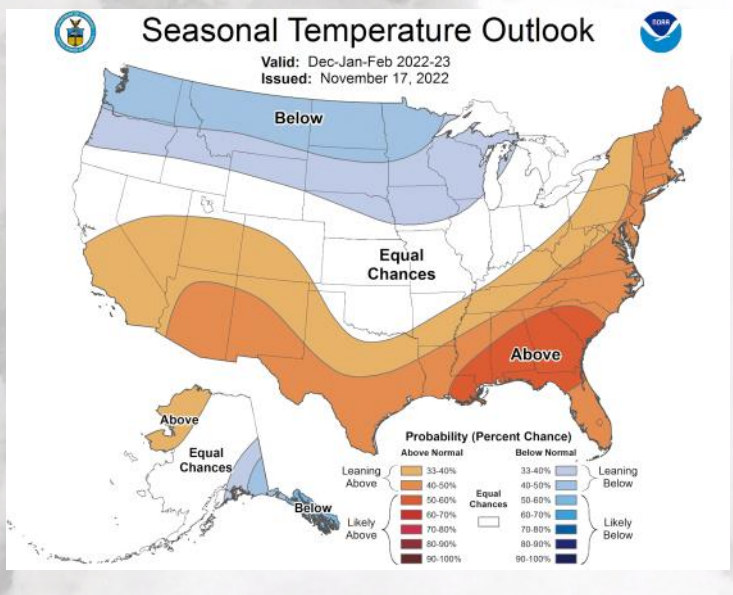
During La Niña years, it is common to see high variability, and therefore long stretches of dry conditions and worsening drought, but large significant storms may occur and even flooding such as 2010-11 and 2016–17 (both wet above average precipitation years). 2022-23 is also entering the third year of drought for Southern California and the fourth year of drought in northern California.

The drought in Northern California started in 2019-20, which was not a La Niña year, and was also a wet year in Southern California. Precipitation deficits in Southern California in the past 3 years average about 1 season, so we are missing one full season of precipitation due to the limited amount of storms. On an average year, California gets 50 to 60% of its precipitation from atmospheric rivers, and those are also affected and reduced during La Niña (displaced northward), however it's important to understand that major flooding events have occurred even in La Niña conditions historically.

The wettest year on record in the Sierra Nevada was 2016-17 during La Niña oceanic conditions and the largest most impactful flood in San Diego in recent years was during La Niña 2010 to 2011. The strongest (warmest) El Niño condition, opposite of La Niña, on record was 2015-16 (2.5 Ocean Nino Index) which failed to bring drought improvement across much of California.

For winter 2022-23, NWS Climate Prediction Center expects below average precipitation and overall milder conditions in Southern California, but there also will be long breaks in precipitation (dry periods) and below average cold snaps. Unfortunately, drought conditions are not expected to improve overall and fire weather danger could return as early as late winter, and early spring or never decrease entirely.

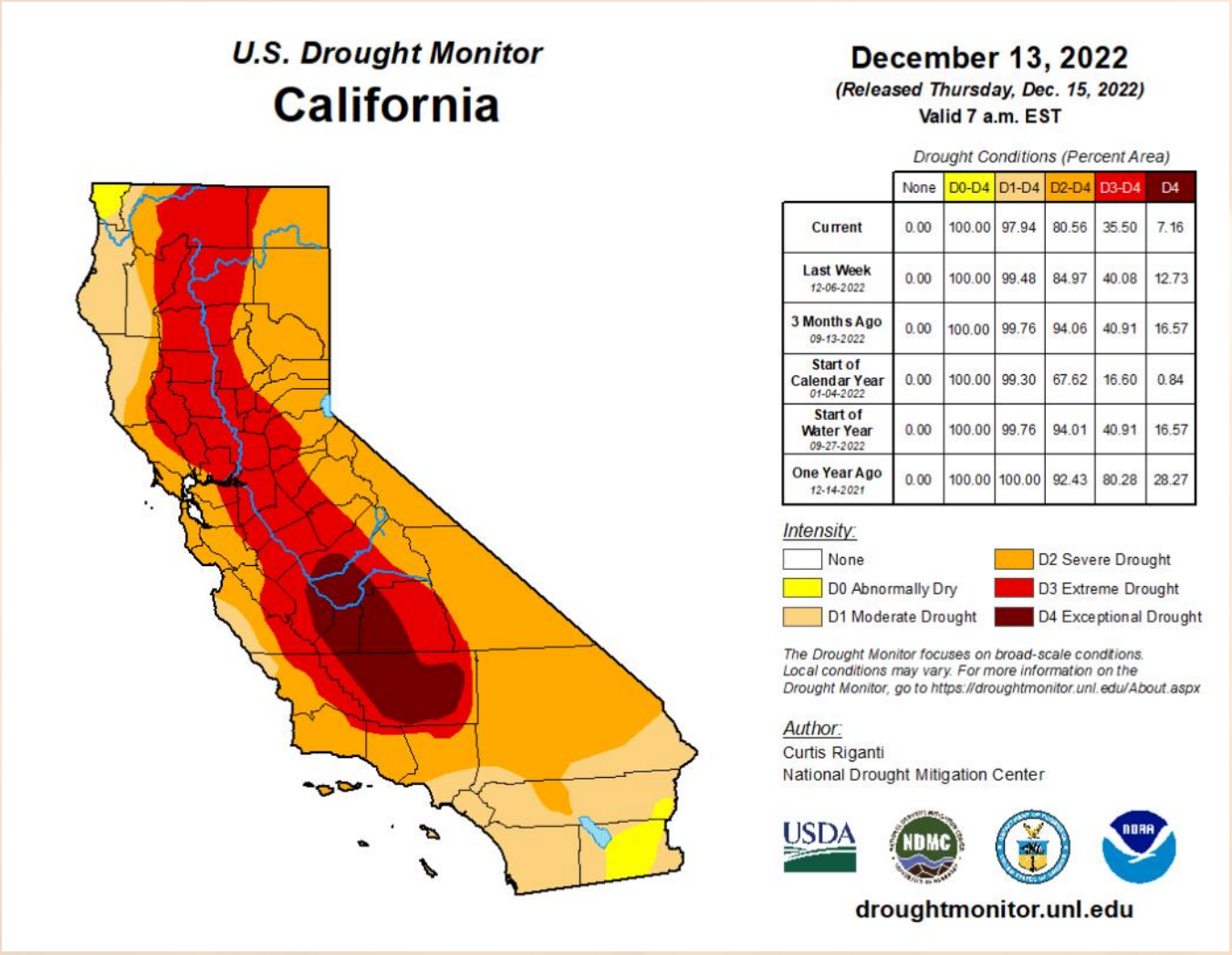




Drier than average conditions for southern California for **December to February 2022-23** due to a storm track displaced further north and less storms for southern California. Slightly warmer overall for southern California due to drier conditions (less storms and more upper ridging of warm air). Source: NOAA Climate Prediction Center. https://www.cpc.ncep.noaa.gov/

Drought Conditions in California

by Samantha Connolly

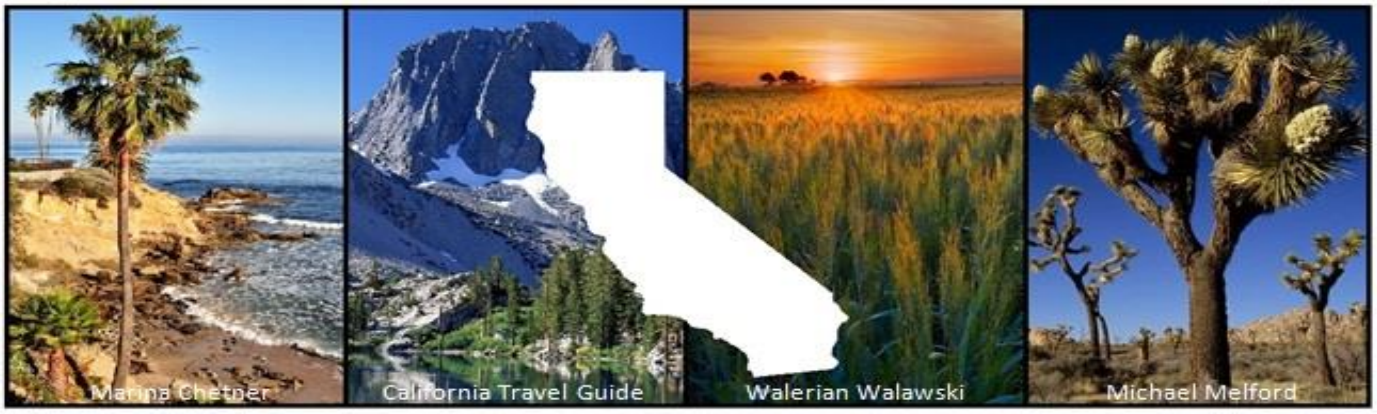


Drought conditions have improved slightly in California over the last couple of months, thanks to a few winter storms in November and early December. However, over 97 percent of the state remains in drought, including 35 percent in severe and exceptional drought. While the rainfall has certainly helped out the fire season in California, long-term drought deficits still exist across much of the state. To put it in simple terms, picture drought like a large bank debt. A few large paychecks won't even come close to wiping out that debt. You'll need many frequent large paychecks to make even a dent in the debt. Drought is very similar in that you need many large and frequent winter storms to make a dent in the drought.

Winter storms this year, and how much rain and snow California receives from those storms, will be crucial in how the drought plays out over the next few months. There were a few winter storm systems that brought rain and mountain snow to California during November and early December, but we will need to see many, many more of those storm systems to improve the drought conditions before we get back into the dry season later next Spring. As we head into the third consecutive year of La Niña, climatology favors more dry conditions for California, but not all hope is lost. Though drier conditions are more favorable in a La Niña pattern, wet years during La Niña can and have happened.

The U.S Drought Monitor is evaluated and updated weekly on Thursday. Check out the latest Drought Monitor and discussion here: https://droughtmonitor.unl.edu/

California CoCoRaHS



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Also, a big thank you to one of our dedicated CoCoRaHS observers for the topic idea for “The History of Rain Gauges and Measuring Rainfall” article

What is CoCoRaHS?

CoCoRaHS, which stands for Community Collaborative Rain Hail and Snow Network, is a non-profit group of volunteer precipitation observers. Anyone can join, and it's easy to report the information. All you need is a 4 inch rain gauge, the internet, and a few minutes each day. The website is easy to navigate and has different instructional materials for anyone to learn how to record an observation.

The site also has daily maps of observer’s reports showing where precipitation fell the day before. It's fun to compare the different amounts of precipitation that can fall in an area from just one storm. Not only is the information interesting to look at, it is very valuable for organizations such as the National Weather Service, hydrologists, farmers and many others.

Visit cocorahs.org to sign up. Join CoCoRaHS, today!

Rain gauge required for the program.

cocorahs.org | California CoCoRaHS State Webpage | California CoCoRaHS | weather.gov

Do you have any ideas or suggestions of future topics that you would like to see covered in this newsletter? If so, simply send an email to Samantha at california.cumulonimbus@gmail.com!