Coast to Cactus Weather Examiner

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Understanding This Season's El Niño by Miguel Miller

Last fall, Californians were informed that a strong El Niño was brewing in the Pacific, suggesting a heavy tilt in the odds toward a wetter-than-normal winter. But Southern Californians in particular have felt misled by prognostications over the years: the strong El Niño of 2015-2016 failed to deliver, despite higher than usual confidence that it would be a wetter than normal season (graphic below). Then came a series of La Niña episodes. Usually bringing drier-than-normal winters, instead they brought wetter-than-normal winters in 2010-2011, 2016-2017 and most memorably, 2022-2023.

Bob Henson, a meteorologist/journalist writing for the Yale Climate Connection in December 2023, seemed to get it: "After a manna-from-heaven, drought-denting winter across the western U.S.,

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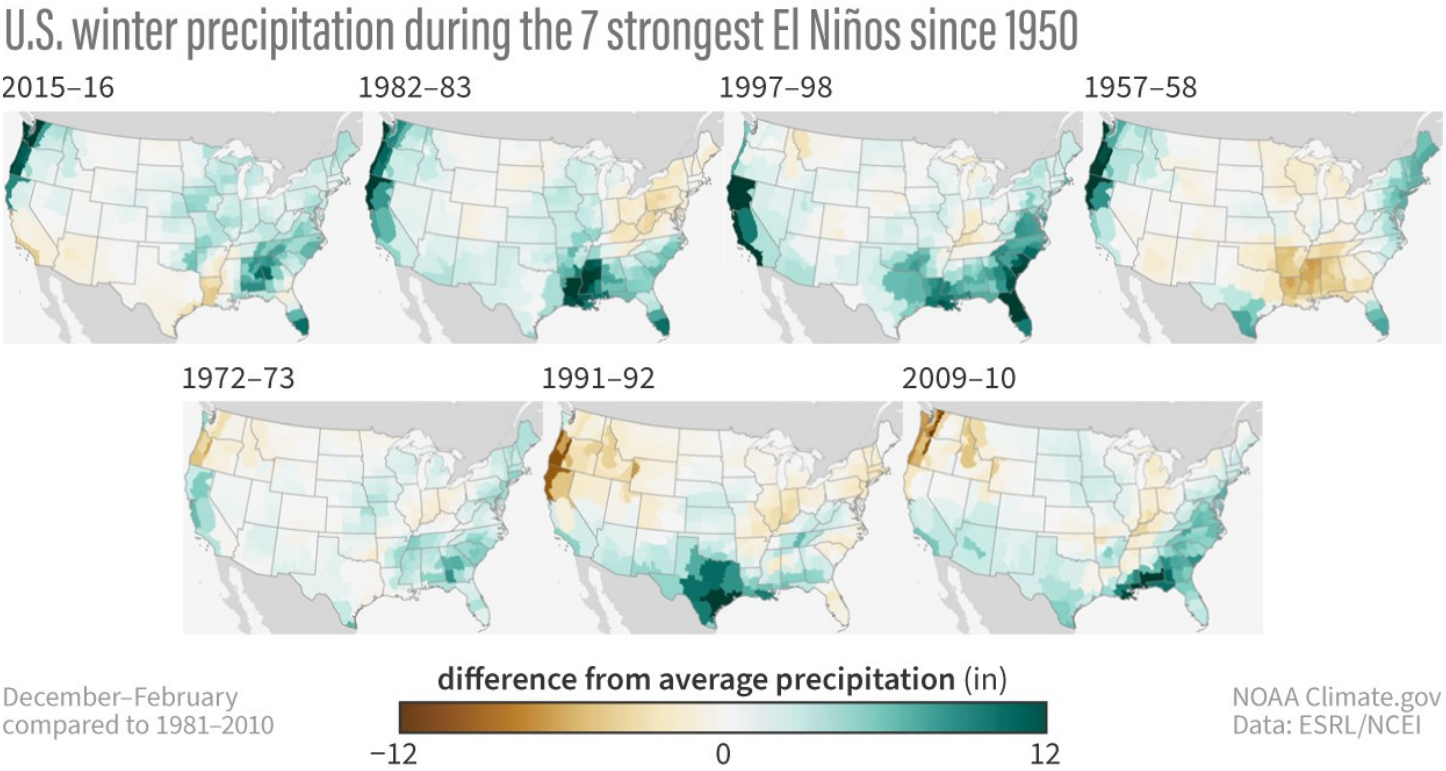


U.S. winter (Dec-Feb) precipitation compared to the 1981-2010 average for the past 7 strong El Niño events. Details differ, but most show wetter-than-average conditions across some part of the South. NOAA Climate.gov image, based on data from NOAA Physical Science Lab online tool.

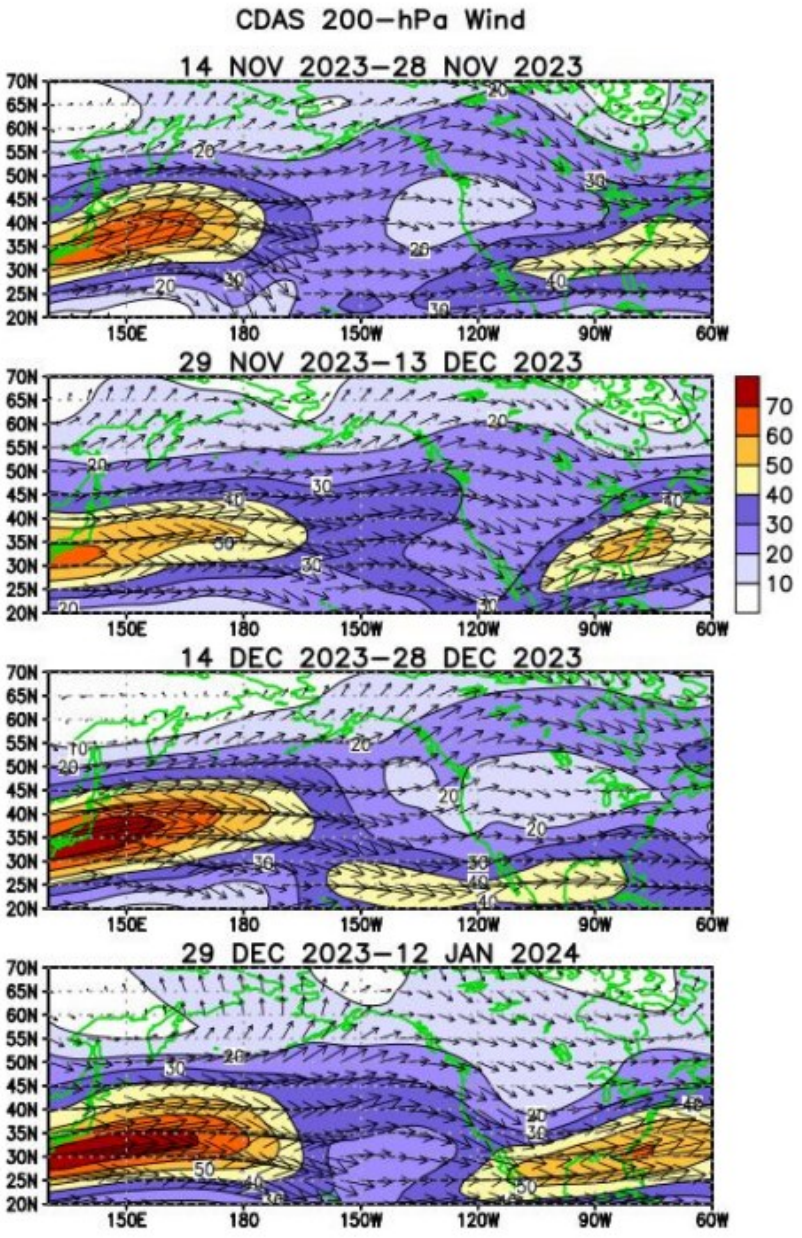
El Niño—continued

followed by unusual western rains from Hurricane Hilary in August, the Southwest saw an unusually dry autumn. It's easy to see why folks from Southern California to New Mexico might be skeptical about the likelihood of El Niño moisture this winter. During the strong 2015-16 event, the western U.S. playbook got turned upside down. Rain and mountain snow were well below average across the Southwest, including much of California, while the Pacific Northwest — where dryness is favored during El Niño — was doused with huge amounts of moisture. In fact, Seattle had its wettest winter on record. Time will tell about the forthcoming winter, but it's noteworthy to see a strong North Pacific jet consolidating in the extended forecast models. Even if the timing and strength are still works in progress, the overall model trends point toward the possibility for a powerful, moisture-bearing Pacific jet slamming into California several weeks from now (editor's note: written in Dec 2023, we can verify Henson's suggestion that such a moisture laden jet did in fact materialize on 22 January, producing record rainfall and flooding in the San Diego region). Note that a strong El Niño only tilts the odds modestly toward a wetter-than-usual winter across Northern California, and even the more robust relationship in Southern California still isn't a guarantee, as demonstrated in 2015-16."

Now it's January, traditionally the middle of our wet season in Southern California. Some (let's face it, many) are asking: Where is our El Niño winter that's supposed to bring us above normal rainfall? Is this going to be a bust like the strong and promising El Niño of 2015-2016? (Luckily, we currently don't have a multi-year drought to put California in a desperate situation). And we just received an El Niño-like wet storm on 22 January.

The atmosphere over the Pacific Ocean has responded to El Niño: the jet stream has become stronger, farther south, and more elongated than is typical. However, except for a few storms through mid-January, the season-to-date rainfall had underwhelmed. Can climate scientists explain why?

Emily Becker (University of Miami/ CIMAS), writing for climate.gov on January 11, 2024, said, "Over the past few months, we have observed all the characteristics of El Niño's typical weaker-than-average Walker circulation, including more clouds and rain than average over the central

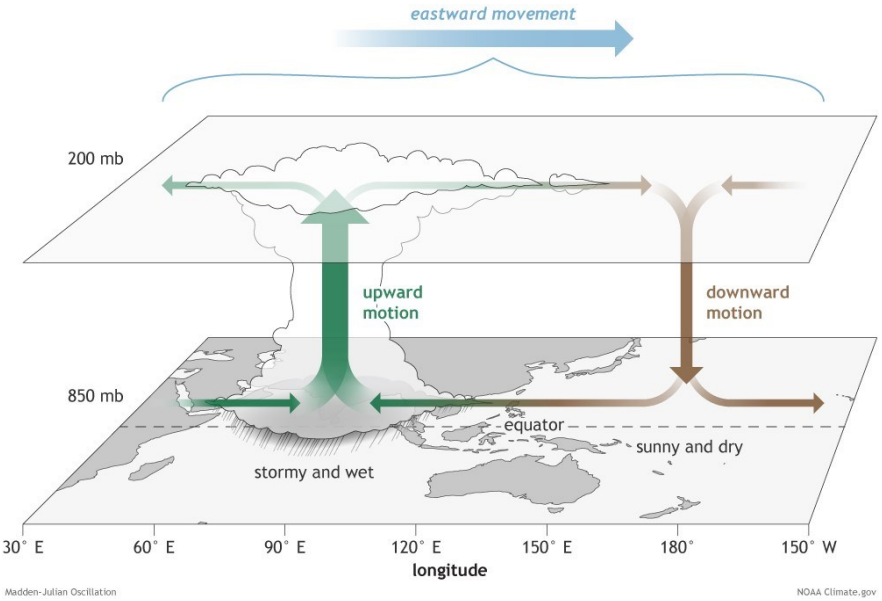


Jet stream wind anomalies across the northeast Pacific (continents outlined in green) show the stronger than normal winds (tongues of warm colors) sagging southward and strengthening since mid-November, yet not quite reaching the West Coast. (Climate Prediction Center)

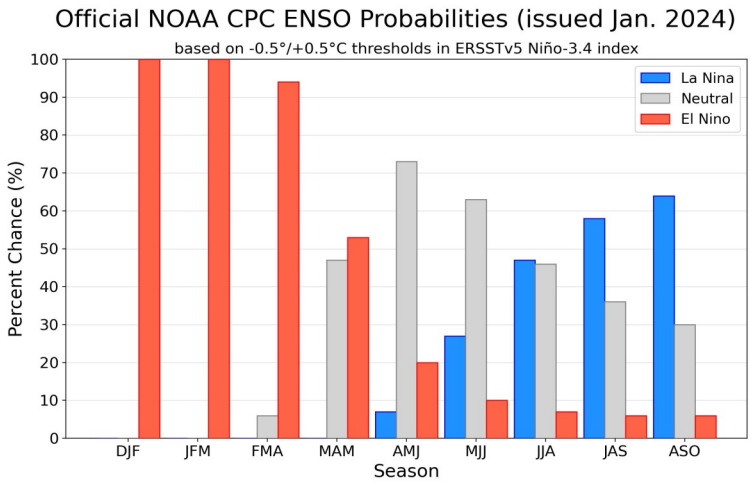
El Niño—continued

tropical Pacific, as El Niño's warmer waters lead to more rising air and storms than average. We've also seen the expected drier conditions over Indonesia and the far western Pacific." Becker also suggested that the Madden-Julian Oscillation (MJO) may have been in a phase that has destructively interfered with the rising motions that lead to enhanced rainfall in certain regions, suppressing rainfall (graphic right).

A question appeared in the comments section to Becker's article: "Do you believe the MJO's destructive interference with El Niño forcing is what has caused California to experience drier than normal conditions this winter?" Climate.gov associate Nat Johnson, (NOAA Geophysical Fluid Dynamics Laboratory), responded: "I think the MJO interference may be a contributor to the dry start to California's winter. However, I don't see an obvious smoking gun that points to the MJO as the primary culprit. The atmospheric circulation has looked pretty similar to what we expect for El Niño, but the anomalous Aleutian low has been displaced a bit north and west of what's typical, and the west has seen more atmospheric ridging than usual. That's what's so tricky about California precipitation - it's sensitive to these details. In any case, perhaps the situation will change if we get some constructive interference between the MJO and El Niño signal."



The surface and upper-atmosphere structure of the MJO for a period when the enhanced convective phase (thunderstorm cloud) is centered across the Indian Ocean and the suppressed convective phase is centered over the west-central Pacific Ocean. Horizontal arrows pointing left represent wind departures from average that are easterly, and arrows pointing right represent wind departures from average that are westerly. The entire system shifts eastward over time, eventually circling the globe and returning to its point of origin. Climate.gov drawing by Fiona Martin.



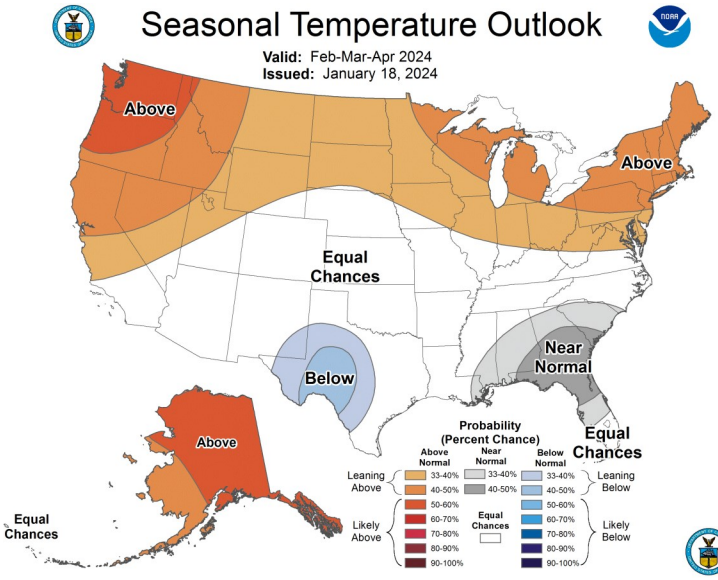
NOAA CPC forecast for each of the three possible ENSO categories for the next 8 overlapping 3-month seasons. Blue bars show the chances of La Niña, gray bars the chances for neutral, and red bars the chances for El Niño.

So there are probably some inhibiting factors at play in the Pacific that are suppressing Southern California rainfall so far this winter… *so far*.

The very wet storm of 22 January could be the first of many wet storms lining up to hit California, and it quickly brought some stations up to normal season-to-date rainfall. As of this writing, more wet storms are on the way in early February. There's a lot of time and potential for February and March to keep the water spigot turned on.

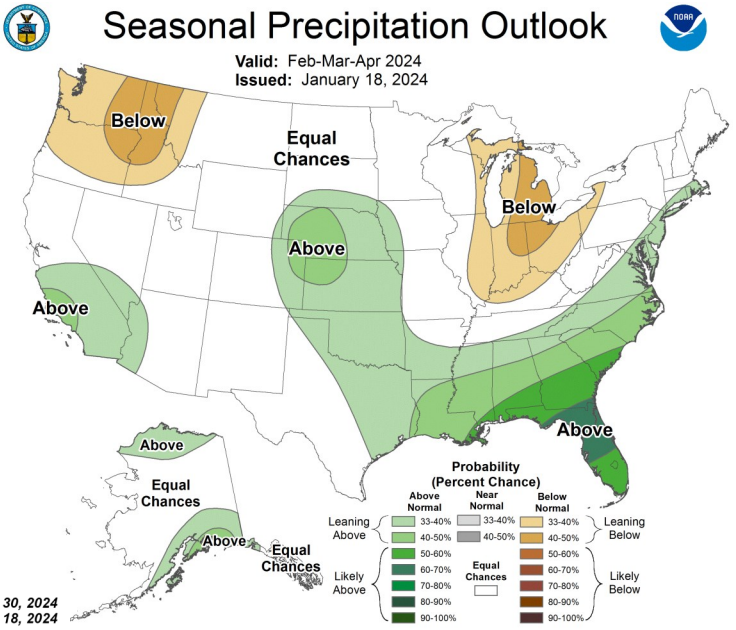
Seasonal Outlook

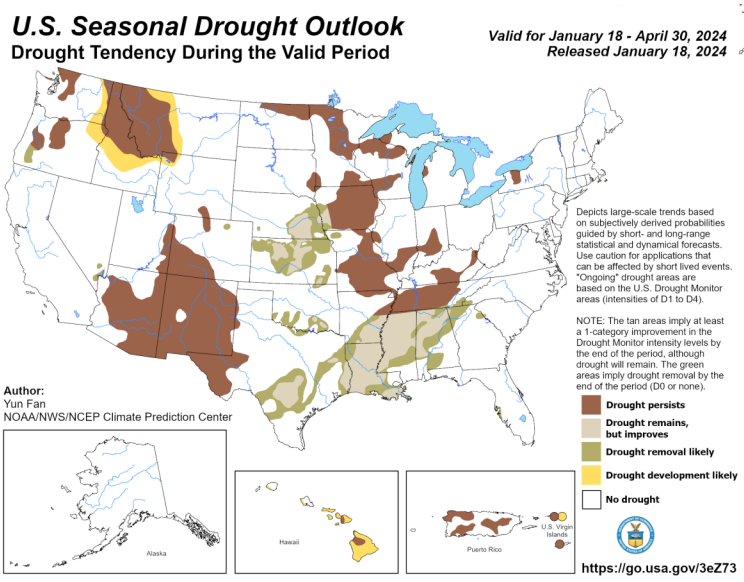
On 25 January, Michelle L'Heureux of the Climate Prediction Center helped us learn how to think about our current wet season. Please check it out. **www.climate.gov/news-features/blogs/enso/weather-repetitions-and-climate-fitness**



The Temperature Outlook (left) shows the chances of a warmer-than-average **February-April** (orange and red) are higher than the chances of a cooler-than-average winter across much of the northern part of the country, including Alaska. White areas have equal chances for a relatively cool, warm, or average period. Gray areas mean near-average temperatures are a little more likely than either warmer- or cooler-than-average temperatures, and the blue area in west Texas indicates a tilt in odds toward cool.

Out of three possible precipitation outcomes—wetter than average, drier than average, or near average—the outlook for **February-April** (right) says that odds are leaning toward a drier than average period for the Northwest, the Great Lakes and the Ohio Valley. Odds tilt toward a wetter than average period across Southern California, the central plains, the southeast and the East Coast.





The Drought Outlook (left) **through April** indicates persisting drought in the Southwest (but not California), and parts of the Northwest and Midwest. Drought improvement is expected through parts of the central and southern plains, and the Southeast.

Atmospheric River Reconnaissance Flights Begin —adapted from Scripps story

Seven atmospheric rivers classified as strong or greater dumped rain and snow on California during the 2022-2023 rainy season, lifting the majority of the state out of drought conditions and causing disastrous flooding. This duality of promise and peril typifies atmospheric rivers, which are ribbons of water vapor in the sky that can deliver massive amounts of precipitation, and makes accurate forecasting essential to both water managers and public safety officials.

Left: Maj. Peyton Eustis and 1st Lt. Zach McDermott, 53rd Weather Reconnaissance Squadron pilots, fly the WC-130J Super Hercules aircraft. Right: Tech. Sgt. Larry Banks checks the dropsonde prior to use. Photos by Senior Master Sgt. Jessica Kendziorek.

To better understand and forecast atmospheric rivers, “Hurricane Hunter” aircraft from the U.S. Air Force Reserve 53rd Weather Reconnaissance Squadron began flights over the Pacific Ocean in November 2023 as part of Atmospheric River Reconnaissance program (AR Recon), led by the Center for Western Weather and Water Extremes (CW3E) at UC San Diego’s Scripps Institution of Oceanography. The program represents a research and operations partnership between science and operational weather forecasting, which ensures that methods and their impacts are continually refined and improved over time.

This year, AR Recon is taking the first step toward expanding its reach farther west across the Pacific by testing flight operations from Guam for a two-week period. This adds to the Air Force aircraft stationed in California and the National Oceanic and Atmospheric Administration (NOAA) Gulfstream IV (G-IV) jet stationed in Hawaii, which could facilitate even earlier warnings of incoming severe rain and snowfall. The 2023-2024 campaign also features a longer season of potential flights, new sensors aboard the aircraft, and the deployment of more than 80 additional drifting ocean buoys.

“The AR Recon partnership is a great example of state, federal, and academic collaborative research using emerging technologies to improve California's ability to manage water with increasing weather extremes,” said Michael Anderson, state climatologist with the California Department of Water Resources (DWR). “This critical research allows for DWR to use new innovative strategies for water management in a changing climate.”

The opening November window for forays into the skies over the Pacific comes as the traditional rainy season begins and with El Niño conditions in the Pacific Ocean, which can create a more active North Pacific storm track and steer more storms towards Southern California. Despite the importance of accurately forecasting where atmospheric rivers will make landfall and how strong they will be, doing so is challenging with traditional sources of meteorological data such as weather satellites, which often cannot measure the key patterns of water vapor, wind, and temperature within atmospheric rivers.

“If you want to predict where a car is going to be five minutes from now you need to know

AR Recon Flights—continued

where it's starting from and how fast it's moving," said Marty Ralph, a research meteorologist at UC San Diego's Scripps Institution of Oceanography and founding director of Scripps' Center for Western Weather and Water Extremes (CW3E). "Similarly, if there is an atmospheric river out near Hawaii, and we want to forecast where it will hit the California coast a few days later and how strong it is, we need to get out there and take direct measurements."

Ralph leads the AR Recon program along with Vijay Tallapragada, Senior Scientist at NOAA's Environmental Modeling Center. The program's partners include the U.S. Army Corps of Engineers, the California Department of Water Resources, NOAA Office of Marine and Aviation Operations, and the U.S. Air Force Reserve 53rd Weather Reconnaissance Squadron.

"Data collected by NOAA's G-IV and the U.S. Air Force's WC-130's during an unprecedented series of ARs in January 2023 contributed to more than 10% improvement in National Weather Service (NWS) Global Forecast System precipitation forecasts especially over the Central California and other regions impacted by landfalling atmospheric rivers," said Tallapragada.

Rivers in the Sky

NOAA: NOAA Gulfstream IV Flying over an Atmospheric River

Atmospheric rivers form when winds over the Pacific send a ribbon of warm, moisture-laden air toward the West Coast. These rivers in the sky flow at altitudes mostly below 10,000 feet altitude and can measure 500 miles across and 2,000 miles long. When an atmospheric river hits mountains, such as California's Sierra Nevada, it is forced even higher in the atmosphere where cooler temperatures condense its vapor, rapidly transforming it into huge amounts of rain or snow concentrated over one to three days.

The average atmospheric river carries an amount of water vapor roughly equivalent to 25 times the average flow at the mouth of the Mississippi River, but severe atmospheric rivers can transport even more. The intense rain and snow storms caused by atmospheric rivers can account for up to half of California's annual rainfall.

Atmospheric rivers are expected to become stronger as human-caused climate change heats up the globe, because hotter air can hold more moisture, said Ralph. Climate models also suggest that dry spells between these intense bouts of precipitation are likely to become more pronounced, ping-ponging California between bouts of extreme weather and creating what some call "weather whiplash."

Planes, buoys, and balloons

The aim of AR Recon is to "fill in information gaps with direct observations of atmospheric rivers and improve forecasting to inform Western decision-makers regarding storm impacts, water management, and flood mitigation," said Anna Wilson, Field Research Manager at Scripps' CW3E and AR Recon coordinator. Advanced warning can help reservoir operators to manage water levels or help state and local officials issue warnings to areas at risk of flooding, she added. Last year, AR Recon data improved three-day lead time forecasts of heavy precipitation over California by up to 12% – a level of improvement which roughly equates to 8 additional years of honing forecast models with traditional methods.

The core elements of the AR Recon program are the U.S. Air Force Reserve's WC-130J

AR Recon Flights—continued

Super Hercules aircraft and NOAA's Gulfstream IV. Each of these aircraft are outfitted to fly into and above intense weather to collect huge amounts of meteorological data. The primary way the aircraft collect these data is by dropping about thirty cylindrical instruments called dropsondes into the atmospheric river in each flight. Each dropsonde has a small parachute and as it floats down to the ocean it collects and transmits data back to the aircraft including air temperature, pressure, water vapor, and wind speed. The dropsondes are "a bit like an MRI for an atmospheric river, they let us see the internal structure," said Ralph.

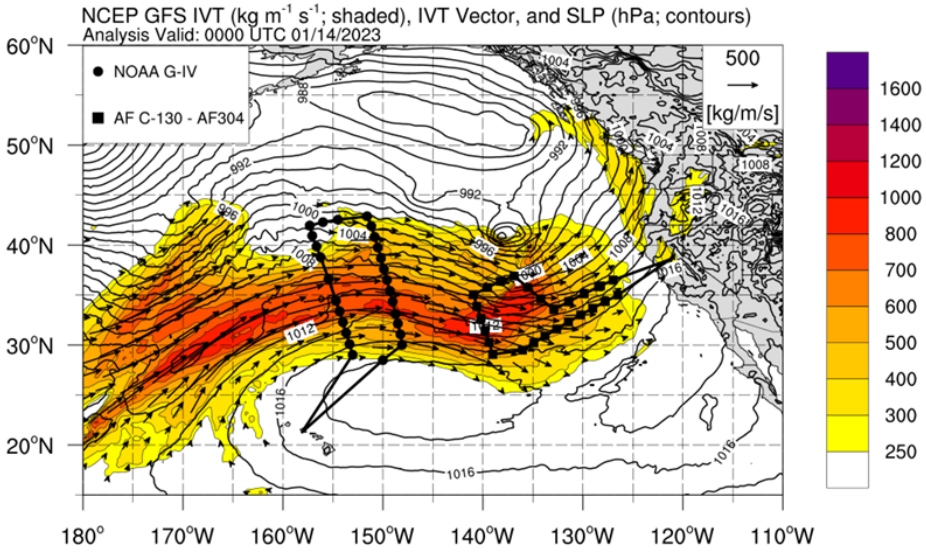
Each flight is meticulously coordinated between scientists, forecasters, and flight navigators to pinpoint where to deploy dropsondes into the atmospheric river to collect the most useful data. In the 2022-2023 season, AR Recon's 51 flights deployed 1,380 successful dropsondes in the North Pacific.

Four aircraft will be fully assigned to AR Recon beginning this month. Two will be stationed in California until February 28 and, for the first time, the other two will be stationed in Guam until January 13. Ralph said having aircraft in Guam this season will be a huge advance for AR Recon. "Atmospheric rivers usually move from west to east in the Pacific," said Ralph. "The farther west we can go in collecting observations the greater potential we have for improving the lead time in our forecasts."

NOAA's G-IV will be stationed in Hawaii and is set to be fully assigned to AR Recon from December 1-22 and January 3-February 20 for a total window of 71 days, a significant increase from last season's 49 days.

More data, better forecasts

Many of these observations will be assimilated in real-time into weather forecast models to deliver more precise forecasts to flood control managers, water supply authorities, and reservoir operators so they can prepare for and mitigate flooding or take advantage of the water supplied by atmospheric rivers.



Flight tracks and dropsonde deployment locations over an atmospheric river in January 2023.

To this end, the AR Recon program works closely with Forecast-Informed Reservoir Operations (FIRO), a multi-agency effort to efficiently manage water levels in California reservoirs. CW3E pilot studies showed that AR Recon-improved forecasts of atmospheric rivers increased water reliability at reservoirs across the state, including the Prado Dam in Southern California. NOAA and CW3E are also developing a new high-resolution system for improved prediction of atmospheric rivers and their impacts on the U.S. West Coast. Among other improvements, the new modeling system is being designed to make better use of AR Recon data.

"The AR Recon program fills a big information gap over the Pacific Ocean where these atmospheric rivers form," said Ralph. "Climate models suggest atmospheric rivers are only going to become more important as hazards and as water sources, making efforts like ours to better forecast and understand them an essential facet of adapting to our world's changing climate."

Media Relationships by Forecaster Adam Roser

And we're live in 3, 2, 1…

The National Weather Service has long had a strong relationship with community decision makers across Southern California that continue to keep people safe from harsh weather conditions. What may not be so apparent is the relationship between the NWS and the media outlets that serve our region, which is just as strong. Communication of the forecast and weather information is paramount to achieve our mission of protecting lives and property for those that live and visit Southern California. To aid in this weather awareness effort, the media plays a vital role in providing valuable and timely information to the public we serve. Whether it is through meteorologists and reporters on the news, newspaper editors and writers, or radio personalities, there are multiple ways we receive communication of local weather hazards each and every day. But as the storm system approaches or wildfires start to rage, how do we ensure a consistent message to those in our surrounding communities with the latest information?

One of the ways to ensure this consistent message is received to our community is by media visits and media workshops. We love being able to get outside the office and media visits let us do just that! These usually entail meeting various broadcast meteorologists and other news personnel to discuss weather and communication best practices, while also seeing the various technology and techniques used by media personnel in their workspaces. Last November, the NWS office hosted a virtual media workshop, where various media personnel across Southern California had the ability to meet with one another to discuss weather hazards and how best to get the public prepared for the next impactful weather event.

Members from NWS San Diego visit with ABC news personalities. Left to Right: ABC News Anchor Vanessa Paz, NWS forecasters Adam Roser, Casey Oswant, James Brotherton, and ABC Meteorologist Megan Parry. Photo Adam Roser, NWS.

Specifically, NWS meteorologists explained different weather hazards, such as heavy rain and snow, high surf and marine hazards, as well as best communication methods when it comes to explaining weather and climate phenomena. We were also delighted to have media meteorologists, Haley Clawson and Kelley Moody, from the Coachella Valley explain how hazards such as wind, dust, and frost can have large impacts on their local communities. Like many other meetings, we at the NWS are always looking for ways to improve our forecasts and weather products for our media to use. This was also discussed, where media folks gave feedback on how they interpret our messaging, stating what is working well and what can be improved.
We are excited to continue working with our local media outlets to deliver factual information that people can use to stay informed and safe about upcoming weather and climate conditions that will impact us in 2024 and beyond.

Thanks for watching! And that's a wrap!

Promotions, a Departure and Retirements

Two new lead forecasters have been promoted from the ranks of our general forecasters already here in San Diego. One forecaster is departing to take a new position. A lead forecaster and our Observing Program Leader have retired.

Promotions

Stefanie Sullivan was promoted to the lead forecaster position in early November. She has contributed greatly to maintaining and improving local network workstations ever since she arrived back in 2008. The Southern California native (represent UCLA and Simi Valley!) has also served as our Fire Weather Program Leader and as Incident Meteorologist. She makes things better wherever she goes, fixing programs that break and improving our graphical messaging systems.

Adam Roser was also promoted to lead forecaster in November. He brings a wealth of enthusiasm and people skills to a rapidly evolving position. Adam has deployed many times to county and state emergency operations centers during stormy weather to provide on-site decision support service when and where our core partners need it most. Adam also works on the Belonging, Inclusion, Diversity and Equity (BIDE) team, and also heads the media relations team.

Departure

Samantha Connolly accepted a Meteorologist/Emergency Response Specialist position with the NWS Operations Center in College Park, Maryland. The native of North Carolina will return to her East Coast home, situated among family and friends. She came to NWS San Diego in 2018 as the first of a group of young, entry-level meteorologists. In addition to her forecasting and warning duties, she assisted with, and later led, the hydrology/drought program and led the climate team. She also deployed many times to Emergency Operations Centers as an embedded meteorologist during major storms. She is a tremendous asset, with a special ability to solve problems and think of new, innovative ways to improve our services. We already miss her greatly and wish her the best.

Retirements

Joe Dandrea is retiring after completing 29 years of Federal Civil Service in Southern California.

Joe began his career in the media in 1979, working as lead and fill in meteorologist at a number of television and radio stations in the St. Paul/ Minneapolis area, and Eau Claire Wisconsin.

After 14 years, he relocated to Southern California, joining the NWS as an intern at the NWS Los Angeles-Oxnard in October of 1994. From there, he transferred to the then recently established San Diego Forecast Office in 1996, and was promoted to a general forecaster position.

Joe was promoted to lead forecaster in 2011 and has received numerous Special Act and Service awards for forecasting, hydrology, and Decision Support Service during some of the most impactful storms to hit Southern California in history.

For most of his tenure in San Diego, he managed the Hydrology Program, coordinating with

Promotions, a Departure and Retirements—cont'd

the various counties and federal agencies to ensure a reliable flow of rainfall and weather data from their disparate and extensive observation networks. Joe also helped establish four new river forecast points and assigned flood levels, refining them through the years. He maintained dam information, inter-agency coordination, staff training, hydrology systems management, and Drought Program.

During Joe's distinguished career, he was awarded numerous awards for his work with the USGS and other agencies, in planning and deploying the first NOAA/USGS Debris-Flow Warning System for forecasters in Southern California. He also received a joint Regional Cline award for support for burn scars, and for support during the devastating floods in 2005 and the massive wildfires of 2003.

Joe visits the stream flow measuring station in San Diego's Mission Valley. Photo NWS.

Noel Isla wrote his own thoughts as he retires.

As I reflect back on my 28-year tenure at NWS San Diego, first I would like to say thank you to all of the dedicated civic-minded partners and volunteers who have supported the NWS mission. It's you that have made my "cool" job very gratifying. From the lifeguards up and down the PCH beaches in Orange and San Diego Counties and to the park rangers at Cabrillo, Joshua Tree, Borrego Desert, Ocotillo and Mt. San Jacinto, and to the many volunteers at the fire departments, flood and water districts, and to our Coop observers at Mt. Laguna, Palomar Mountain, Sea World, Deep Canyon and Campo, I would like to say that it's been a privilege to visit and to know many of you.

Your continued support (even during times of bad weather and the data that you share) are going to benefit the future generations.
Your hospitality and kindness towards me has made my job fun and easy, and I am sincerely grateful to all of you for that. I can say that the area of SoCal where we live that I have covered for 28 years driving thousands of miles has some of the most beautiful beaches, landscapes and sceneries. We're blessed!

I'll have plenty of memories to reminisce about in retirement. Finally, I want to wish everyone all the best and a Happy New Year.

Above: Noel (second from left) awards the Johnsons, coop observers in Campo, for their dedicated service in 2023. Below: Noel inspects weather instruments on a NOAA ship in 1998. Photos NWS.

Quarterly Summary
October

The month started off cool and breezy as an anomalous low pressure trough traversed the region.

The trough moved east, putting Southern California under a building ridge and northerly flow. This combined with an offshore pressure gradient at the surface to produce the season's first Santa Ana episode from the 3rd through the 8th. The heat peaked of the 5th through the 7th, when mid 90s to lower 100s were common in the lower elevations. Dense fog appeared along the San Diego coast on the 7th.

San Diego Data - October				
	Max	Min	Avg	Rain
Actual	74.7	60.2	67.4	0.01
Normal	74.6	61.5	68.1	0.50
Anomaly	0.1	-1.3	-0.7	-0.49
% of normal				2
Max	84	66		0.01
Min	67	47		

A bird's eye view looking south over the San Gorgonio Pass on 11 October. Note the deep marine layer cloudiness in the coastal basin at right, and the blowing dust in the Coachella Valley at left (Bill Callahan).

A trough of low pressure rebuilt the marine layer to such a degree on the 10th and 11th that some drizzle and light rain (less than 0.15 inch) was measured in coastal inland areas. This system also brought strong winds to the desert that stirred up dust.

The script flipped on the 12th, when offshore flow quickly developed, generating northeast winds below passes and canyons into some of the Inland Empire.

Seasonal weather followed through the 17th as a ridge of high pressure gradually amplified. That ridge produced hot weather inland, with 90s and even a few 100+ -degree readings. 90s even approached the coast on the 20th.

The high pressure ridge broke down over ensuing days, with a trough of low pressure that moved through Southern California. This brought some showers and wind on the 22nd and 23rd. About 0.25 to 0.33 inch fell in foothills, and less than 0.10 inch for many coastal areas and valleys. Top wind gusts were 40-50 mph on the mountain ridges.

Halloween brought a scare to residents of Aguanga. The Highland Fire started, crossed Highway 371 and threatened homes. It eventually burned 2,500 acres (Alex Tardy).

A series of low pressure troughs rotated through the West to finish out the month. On the 27th, offshore winds blew, reaching 50-80 mph in the foothills and below Cajon Pass. Several big rigs overturned in Fontana and Rialto.

On Halloween, the Highland Fire roared to life, threatening homes in the Aguanga area.

Quarterly Summary—continued

November

The first several days of the month began warm under Santa Ana conditions and a high pressure ridge; temperatures near the coast were in the 80s.

The ridge broke down as a weakening trough of low pressure moved into California on the 6th and 7th, followed by offshore flow on the 8th and 9th. Top gusts in the San Bernardino Mountain foothills reached 55-70 mph.

Over the next few days, a deep and large trough of low pressure developed over the northeast Pacific. It drew copious moisture and unstable air from the tropics as it moved through Southern California to produce the first widespread rain event of the season on the 15th and 16th. Lytle Creek got the most rain with 2.24 inches, and amounts of 1 to 2 inches were common in foothills and mountains. Other areas got from 0.25 to 1.25 inch, but the southern San Diego area got less than one quarter inch. Thunderstorms erupted across much of the region, producing some intense bursts of rain and strong, gusty winds. Gusts over 40 mph produced localized property damage. Lingering showers continued into the 18th.

San Diego Data - November				
	Max	Min	Avg	Rain
Actual	72.8	50.8	61.8	0.61
Normal	70.7	54.8	62.7	0.79
Anomaly	2.1	-4.0	-0.9	-0.18
% of normal				77
Max	85	60		0.20
Min	64	44		

Thunderstorms brought bursts of heavy rain across much of the region and quite a light show for these surfers in Coronado on 15 November (above, Kyle Goff). The sunrise in Escondido on 10 November was especially colorful (below, Kim DeCew).

Strong offshore winds developed on the 20th and continued through the 21st. Wind gusts in the foothills were impressive, reaching as high as 89 mph at Santiago Peak. Many valley areas recorded gusts of 40-70 mph, with Grand Terrace clocking 74 mph. The winds overturned big rigs in the northern Inland Empire. A high pressure ridge combined with these offshore winds to boost temperatures near the coast into the 80s on the 21st and 22nd.

Much cooler weather arrived on the 23rd and 24th as a deep trough dug southward into the region. Light showers brought less than 0.10 inch to many low elevations on the 24th and 25th, and 0.20 to 0.41 inch in the mountains.

Offshore flow brought areas of northeast winds to foothills again on the 26th.

A final, quick storm brought rain that favored San Diego County on the 29th and 30th. Mountains received over 1 inch, with Julian measuring the greatest amount of 1.45 inch. Elsewhere, amounts were less than one half inch, and less than one quarter inch in Orange County and the Inland Empire.

Quarterly Summary—continued

December

San Diego Data - December				
	Max	Min	Avg	Rain
Actual	68.4	50.1	59.2	0.79
Normal	66.0	49.8	57.9	1.67
Anomaly	2.4	0.3	1.3	-0.88
% of normal				47
Max	78	59		
Min	61	43		

December started cool and brisk the first three days, but high pressure brought dry and warmer weather from the 4th through the 6th.

Onshore flow through the 8th turned offshore to produce northeast winds. These winds were strongest in the foothills where gusts of 60-70 mph were measured.

Several offshore wind events followed through the 15th. High pressure and offshore breezes boosted temperatures west of the mountains on the 9th and 10th. A cold but dry trough moved through the region on the 11th and 12th setting up another offshore wind event on the 13th through the 15th. Wind gusts reached 45-55 mph at the top foothill areas.

Fair and warm weather prevailed through the 20th as a high pressure ridge moved through the West Coast.

Intense rain ripped through Canebrake, washing out this creek crossing on 22 December (Natalie Spandau).

After a dry three weeks, a legitimate storm finally arrived on the 21st and 22nd, bringing rain and high mountain snow. It also brought some thunderstorms and hundreds of lightning strikes to much of the region. Rain and gusty winds were intense with these storms, particularly in an organized squall that moved ashore in San Diego County. Carlsbad reported a gust of 55 mph, which knocked down several trees. Moonlight Beach hit 61 mph. The strongest winds with this system were associated with this thunderstorm squall, and not in the mountains and deserts as usual. Rainfall exceeded 2 inches in the San Bernardino Mountains, with Lytle Creek topping the list at 2.58 inches. Other storm totals were variable, depending on whether thunderstorms hit rain gauges. Lower elevation totals ranged from one-third to about 1.50 inch. Localized flooding was reported in urban areas when the most intense rains pushed through. A creek crossing in Canebrake was washed out.

The storm wrapped up in time for Christmas Eve and Christmas Day, which were fair and seasonal. High pressure aloft maintained the dry and seasonal weather until the final weekend of the year.

Extremely large surf of 10-18 feet struck the beaches on the 28th through 30th, generating coastal flooding of parking lots and beach erosion.

On the 30th and 31st, two shortwave troughs from the west moved through the region, each bringing rain. A few mountain locations accumulated over 1 inch, with Wrightwood taking top honors with 1.31. Snow levels remained high during this warmer maritime storm. Less than 0.40 inch fell on most of the lowlands. Northern Orange County, the Inland Empire, the eastern San Bernardino Mountains and the high desert got less than 0.10 inch.