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Democracy Dies in Darkness

In California, a drought turned to floods. Forecasters didn't see it coming.

California storms prompt questions about accuracy of seasonal predictions

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Coming into this winter, California was mired in a three-year drought, with forecasts offering little hope of relief anytime soon. Fast forward to today, and the state is waterlogged with as much as 10 to 20 inches of rain and up to 200 inches of snow that have fallen in some locations in the past three weeks. The drought isn't over, but parched farmland and declining reservoir levels have been supplanted by raging rivers and deadly flooding.

The National Oceanic and Atmospheric Administration's Climate Prediction Center (CPC) issues seasonal forecasts of precipitation and temperature for one to 13 months into the future. The CPC's initial outlook for this winter, issued on Oct. 20, favored below-normal precipitation in Southern California and did not lean toward either drier- or wetter-than-normal conditions in Northern California.

However, after a series of intense moisture-laden storms known as atmospheric rivers, most of California has seen rainfall totals 200 to 600 percent above normal over the past month, with 24 trillion gallons of water having fallen in the state since late December.

The stark contrast between the staggering amount of precipitation in recent weeks and the CPC's seasonal precipitation outlook issued before the winter, which leaned toward below-normal precipitation for at least half of California, has water managers lamenting the unreliability of seasonal forecasts.

"You have no idea come Dec. 1 what your winter is going to look like because our seasonal forecasts are so bad," said Jeffrey Mount, a senior fellow with the Public Policy Institute of California's Water Policy Center, in an interview. "They are just not reliable enough to make definitive water supply decisions."

An evolving forecast

The CPC's seasonal and monthly outlooks do not provide specific forecasts of precipitation amounts, but rather the probability that precipitation will be above or below average. Such information is intended to "help communities prepare for what is likely to come in the months ahead and minimize weather's impacts on lives and livelihoods," NOAA stated in its winter outlook.

The precipitation forecast for California remained virtually unchanged in the CPC's Nov. 17 update to the winter outlook. That forecast called for a 33 to 50 percent chance of below-normal precipitation in the southern half of California, and equal chances of precipitation being above or below normal in the northern half of the state.

CPC Director David DeWitt said the outlook was heavily influenced by the expected continuation of La Niña conditions. El Niño and La Niña — the cyclical warming and cooling of the eastern tropical Pacific Ocean that influences weather patterns around the globe — often have an outsize effect on prevailing seasonal conditions in many parts of the world.

"Forecasting on a seasonal time scale is dominated by the El Niño/La Niña cycle," DeWitt said in an interview. "La Niña conditions are generally characterized or associated with below-normal precipitation for central and Southern California. Northern California is kind of a dice roll."

Back in mid-November, chances were seen as high that La Niña would continue for a third winter in a row, which it has thus far, although it appears to be weakening. In both of the two previous "three-peat" La Niña winters since 1950, much of California recorded below-normal precipitation.

Despite their typically strong influence on seasonal conditions, El Niño and La Niña aren't the only game in town. They can be counteracted by other large-scale atmospheric phenomena that evolve on shorter time scales. One such factor is a cluster of storms in the tropics, known as the Madden-Julian Oscillation, that travels around the globe approximately every 30 to 60 days.

While such factors "can leave a big imprint on average winter conditions … they're very difficult to predict more than a few weeks in advance," wrote Nat Johnson, a researcher and meteorologist with the Geophysical Fluid Dynamics Laboratory at Princeton, in a blog post about NOAA's winter outlook.

As these additional factors started to come into focus in mid-December, the CPC began to shift its forecast for California. For example, its monthly precipitation outlook for January, issued on Dec. 15, showed a smaller portion of the state expected to see below-normal precipitation.

The first signs of above-normal precipitation for California did not appear until Dec. 19, when CPC issued its precipitation outlook for the next eight to 14 days. That outlook, which

covered the period from Dec. 27 to Jan. 2, called for a 33 to 70 percent chance of above-normal precipitation across all of California, with the highest chances in the northern part of the state.

“Those day eight-to-14 products are really generally going to have much higher skill than a monthly or seasonal outlook because of that shorter time scale,” DeWitt said.

On Dec. 31, with what would become a weeks-long drenching already underway, CPC issued a monthly precipitation outlook suggesting the wet weather could continue through January.

‘Can’t rely’ on long-range forecast

Experts say that seasonal precipitation outlooks should be viewed with caution, and not interpreted as weather forecasts.

“They are meant to show end users how the odds are stacked one way or another for wet, dry or normal conditions based on all relevant available information at the start of the water year,” Michael DeFlorio, a research analyst with the Center for Western Weather and Water Extremes at Scripps Institution of Oceanography in San Diego, wrote in an email. Such outlooks are particularly difficult for California, which experiences wild year-to-year swings between wet and dry conditions.

“California receives a large fraction of its annual precipitation from a small number of intense storms, often in the form of atmospheric rivers,” Johnson wrote in an email. “That means that California’s seasonal-to-annual precipitation totals can be significantly influenced by the chaotic weather variability that occurs only within a few days.”
The winter guessing game has been a long-standing challenge for state officials and water managers who need to make decisions about how much water to allocate to farms and cities, plan reservoir and dam releases, and prepare for effects on agricultural production and hydropower generation.

Climate change has made the task even more complicated, because historical experience may no longer be a useful guide for estimating the severity of droughts and floods. “Conditions are shifting,” Mount said. “What we’re seeing in long-term trends is drier dry periods and wetter wet periods.”

At the local level, agencies may use seasonal outlooks for background guidance but not necessarily for critical decisions.

“We plan to be able to manage anything that comes our way,” said Willie Whittlesey, general manager for the Yuba Water Agency, which manages flood risk and water supply on the Yuba River northeast of Sacramento, in an interview. “Even during La Niña, you can have significant storms at the watershed level — you really can’t rely on the general longer-range forecast for watershed management.”

Pathways to better precipitation forecasts

Ongoing research at Scripps Institution of Oceanography is aiming to improve shorter-range forecasts for atmospheric rivers. This winter, data from reconnaissance flights into these sprawling storms has been fed into forecast models in real time, helping to boost their accuracy at the five- to 10-day range, and possibly beyond that, Whittlesey said. Researchers also are tackling the problem of predicting extreme rainfall with new tools, such as artificial intelligence.

However, the known gap in subseasonal-to-seasonal prediction remains.

"Precipitation forecasts beyond two weeks are inherently valuable to society," DeWitt said. "They have inherently low skill because of the state of the science."
To improve precipitation forecasts, DeWitt points to the importance of programs that span from research to operations, such as NOAA's Precipitation Prediction Grand Challenge. That program's strategy aims to provide more accurate precipitation forecasts — at time scales from a day to a decade — by addressing major gaps in observations of the atmosphere, reducing model errors and developing products that more effectively communicate the forecast.

"We continue to pursue getting that program funded at a sufficient and sustained level because that is what it's going to take. … That will accelerate our ability to improve precipitation forecasts for stakeholders," DeWitt said.

As evidence of what the Precipitation Prediction Grand Challenge could accomplish, DeWitt cites the success of NOAA's Hurricane Forecast Improvement Program, a research-to-operations program that began in 2009. The program achieved its original goal of reducing hurricane track and intensity errors by 20 percent in five years and continues to strive for further increases in hurricane forecast accuracy.

"We would like to do the same thing for precipitation forecasts across time scales, but especially on the subseasonal-to-seasonal time scales," Dewitt said.