UC San Diego
UC San Diego News Center

July 09, 2019 | By Robert Monroe

Atmospheric Rivers to Become Even More Dominant Source of California Water Resources and Flooding

Research projects that, as other storms decline, atmospheric rivers will strengthen, bringing greater proportion of annual precipitation

A new study led by Scripps Institution of Oceanography at UC San Diego suggests that a new regime of wet and dry extremes is emerging in California and that the projected bolstering of extreme precipitation is likely to be caused by streams of moisture in the sky known as atmospheric rivers (ARs).

Flooding near Elk Grove, Calif. during record rain year 2017

California already has the most volatile water resources in the country. Scripps scientists discovered that the state's precipitation, as it becomes less frequent but preferentially stronger, will vacillate even more wildly between extremes of drought and flooding as a consequence of climate change.

The federal Bureau of Reclamation, the Southwest Climate Adaptation Science Center, NOAA, the U.S. Geological Survey, and NASA funded the study, "Precipitation regime change in Western North America: The role of Atmospheric Rivers," which appears July 9 in the journal Nature Scientific Reports.

The researchers examined simulations of historical and future "business-as-usual" climate scenarios from sixteen global climate models, focusing on western North America. They found that all 16 models project that the heavy precipitation the West gets in the future will come more prominently from atmospheric rivers. Overall, California is expected to get about the same or slightly more precipitation over the long term but in a progressively more dramatic

fashion. The frequency of precipitation will diminish because storms not related to atmospheric rivers will venture less frequently into the region, while ARs will be more potent in a warming climate.

This future is emerging now and it means that ARs will be even more crucial determinants of water supply especially in California, said lead author Alexander Gershunov, a climate scientist at Scripps.

“As Mediterranean climate regions around the world are becoming more subtropical, the dry season is expanding. California is no exception,” Gershunov said. “What is exceptional about California is that the heavy precipitation is projected to become more extreme. We knew this from our past work. Now we have identified the mechanism responsible for this bolstering of extremes, and that gives us a more nuanced understanding of what to expect from future hydroclimate and a clearer interpretation of ongoing changes.”

If the projections are accurate, resource managers may need to revise procedures for storing water to sustain California through increasingly warm years. Mountain snowpack, which historically has portioned out water from melting snow during summer, will be less of a resource. ARs are warm storms with high snow levels. They are becoming wetter as they warm, causing even more precipitation to fall as rain and less as snow. It will fall in progressively less frequent but more extreme bursts requiring more adaptive reservoir management based on better AR forecasts.

“Current forecasting of ARs has substantial skill, and projects are underway to enhance that skill through better science, observations and models,” said coauthor F. Martin Ralph, who is director of the Center for Western Weather and Water Extremes at Scripps and co-chair of Forecast-Informed Reservoir Operations projects in California. “This skill has been shown recently to be adequate to improve water supply reliability and flood risk mitigation on Lake Mendocino, in collaboration with Sonoma Water and the US Army Corps of Engineers.”

Study authors said that the increased intensity of ARs paired with California’s topography – in which the Sierra Nevada and coastal mountain ranges pose a barrier to eastward-moving moisture streams – could mean that the state’s future will be wetter on balance.

“ARs are strengthening and becoming even bigger contributors to the annual [precipitation] total, and California’s topography is ideally aligned to extract increasingly heavy precipitation from strengthening ARs,” the study said. “Notwithstanding the challenges stemming from a more volatile precipitation regime, California can take solace in the fact that it is not projected to dry as are the other Mediterranean climate regions around the world.”

So far in the 21st century, only four years have been considered “wet” in California, with precipitation totals exceeding the historical average. One of those, 2017, was the wettest year on record for many parts of the state but it had been preceded by five years of historic drought.

Gershunov and Ralph are among several climate scientists at Scripps seeking to understand the nature of atmospheric rivers, which are ephemeral streams of water vapor, each routinely carrying more than twice the amount of water than is carried by the Amazon River, the largest river on Earth. Atmospheric rivers often elude accurate prediction, landfalling up to several hundred miles away from the West Coast locations where they were expected and sometimes producing very different amounts of precipitation than forecast.

In June, California legislators directed more than $9 million (PDF) to ongoing research led by the California Department of Water Resources that aims to improve the scientific understanding, observations and predictions of atmospheric rivers so as to enable enhancements in water supply reliability, and flood risk mitigation. This could become a key tool in the state’s climate adaptation toolbox, Ralph said. Officials in one Southern California county estimate that such an improvement could enable them to meet the needs of 165,000 more people in its jurisdiction.

In addition to Gershunov and Ralph, study coauthors are Tamara Shulgina, Rachel Clemesha, Kristen Guirguis, David Pierce, and Dan Cayan of Scripps Oceanography, Michael Dettinger of the U.S. Geological Survey, David Lavers of the European Center for Medium-Range Weather Forecasts in Reading, United Kingdom, and Suraj Polade of the Finnish Meteorological Institute in Helsinki.

MEDIA CONTACT

Robert Monroe, 858-534-3624, scrippsnews@ucsd.edu