Q&A: Climate expert explains why atmospheric rivers are causing historic rainfall in California

February 6 2024, by Emely Mendez

California National Guard Soldiers support local first responders in rescue operations due to flooding in Monterey County, California, March 11, 2023. Credit: 1-184 Infantry Regiment, California National Guard

In December 1861, intense rainfall began pounding central California, thrashing the state for the next 43 days. The rain, which scientists now think was caused by atmospheric rivers, killed thousands of people and destroyed the state's economy, transforming the Central Valley into a sea nearly the size of Lake Ontario.

Once again, atmospheric rivers are drenching the state of California. While atmospheric rivers are endemic to the region and play a critical role in replenishing water supplies, their frequency and ferocity is on an upswing, says Mingfang Ting, professor of climate at the Columbia Climate School and climate scientist at Lamont-Doherty Earth Observatory.

Ting's current research focuses on understanding monsoon variability, the impacts of heat waves and the effects of extreme heat on agriculture and human health. She is an expert on ocean-atmosphere interactions and long-term climate phenomena. "We are definitely seeing an overall increase in atmospheric-river frequency and intensity in recent years," she says.

Below, Ting explains what causes atmospheric rivers, how they are connected to climate change and what communities can do about them.

What are atmospheric rivers and how do they contribute to weather patterns and climate events globally?

Atmospheric rivers are narrow bands of concentrated water vapor in the atmosphere, typically extending from the tropics to mid- and high latitudes. These intense atmospheric moisture bands are invisible to the naked eye, but satellite instruments can help us see these "rivers in the sky" by using infrared sensors, which is how scientists visualize them.

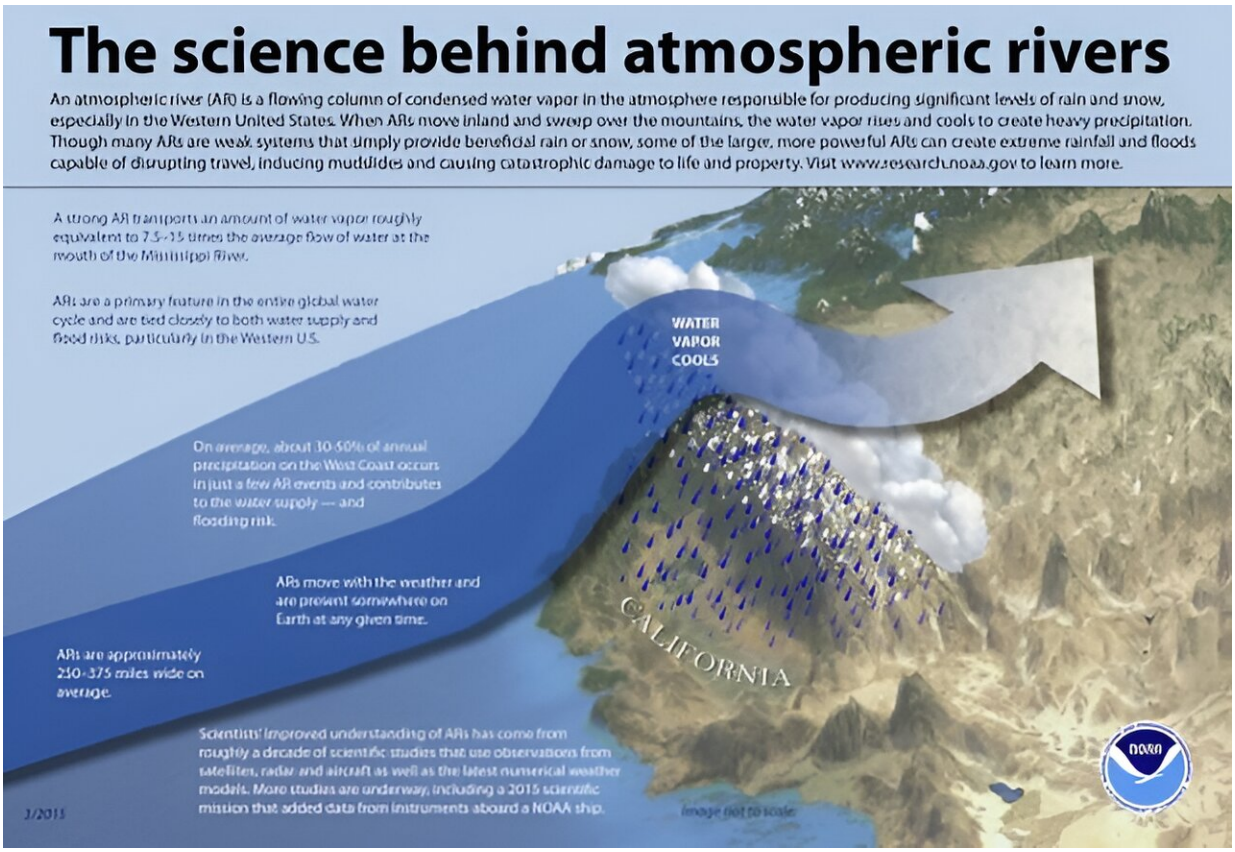
Atmospheric rivers are responsible for transporting large amounts of water vapor across the globe, particularly from the tropics to the poles. Atmospheric rivers are often associated with strong low-level wind ahead of the cold front of an extratropical cyclone, particularly during the winter. When they make landfall in a region, atmospheric rivers frequently lead to heavy precipitation, which can be vital to a region's water resource needs, but they can also pose serious risks for flooding and mudslides.

For example, in California, up to 50% of total annual precipitation and streamflow can come from a few intense atmospheric rivers during fall and winter. Although they provide essential water resources and relieve regional drought, strong atmospheric rivers often pose serious risks including floods, landslides and levee breaks in California, as we've seen this winter.

It seems California is experiencing an increase in atmospheric rivers. Can you explain why and how these events are occurring and what potential impacts they may have on the region's climate and ecosystems?

California is ideally located for atmospheric rivers, as extratropical cyclones formed over the North Pacific Ocean can tap into warm tropical air and, when positioned right, transport a large amount of water vapor from the tropics to the California coast. The term Pineapple Express is often used to refer to a strong atmospheric river that can bring moisture from the tropics near Hawaii over to the US West Coast. While atmospheric rivers frequently make landfall in California during winter, 2024 has the added effect of being an El Niño year, which tends to alter the atmospheric circulation patterns over the Pacific Ocean and lead to changes in the position and intensity of the jet stream.

These changes can enhance the formation and persistence of atmospheric rivers in the subtropical Pacific region. The warmer sea surface temperatures associated with El Niño provide additional moisture to the atmosphere, contributing to the development of more intense atmospheric rivers and extreme precipitation.



The science behind atmospheric rivers. Credit: NOAA

Atmospheric rivers have recently gained significant attention in the news. What factors or events have led to the increased focus on these phenomena, and how do they relate to broader discussions about climate change and extreme weather events?

Climate change due to increased anthropogenic greenhouse gases contributed to substantial warming of the atmosphere, which subsequently has the capacity to hold more moisture according to the well-known Clausius-Clapeyron relationship. So even if the extratropical cyclones do not change their intensity or pattern significantly due to climate change, the increased moisture in the atmosphere will lead to more intense atmospheric rivers and more extreme precipitation. We are definitely seeing an overall increase in frequency and intensity of atmospheric rivers in recent years, as well as an increase in extreme precipitation events.

Given your expertise in climate science, do you think the rise of atmospheric rivers is a cause for concern in terms of long-term climate trends? What steps can individuals and communities take to mitigate potential risks associated with these weather patterns?

While precipitation in a region, particularly in the western United States, is extremely beneficial for agriculture and general water resources needs, extreme precipitation events often lead to floods, severe mudslides and a large amount of runoff, which poses serious risks to the safety of people's lives and property. So it is definitely a cause for concern as the climate continues to warm due to human activities.

To better prepare for these extreme weather events, it is essential to invest in and maintain robust early warning systems to provide timely information about potential weather-related hazards, allowing communities to prepare and evacuate if necessary. Another step communities and local government can take is to enhance infrastructure resilience by investing in flood control measures, such as levees, dams

and stormwater management systems, and upgrade critical infrastructure to withstand extreme weather events.

Community education and outreach programs can also help raise awareness about the risks associated with atmospheric rivers and other extreme weather events. Ultimately, the solution is to reduce the amount of greenhouse gases in the atmosphere by reducing fossil fuel burning and reach net-zero emission goals sooner than later.

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