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Record-breaking rain in California was caused by abnormally high temperatures on the other side of the world, study finds

Scientists have identified a "climate teleconnection" between the Rocky Mountains and the Tibetan Plateau, where warm spots left a kink in the jet stream that intensified weather in the western U.S.



By Sascha Pare | Edited by Laura Mondragón, Brandon Specktor

Published 60 minutes ago In [News](#) 4 min read



The raging Santa Ynez River in Solvang, California after rainstorms in March 2023.
(Image credit: George Rose/Getty Images)



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Abnormally high temperatures on the Tibetan Plateau triggered two catastrophic rainfall events halfway around the world in California and nearby states in early 2017 and 2023, a new study reports.

This is the first time that researchers have identified this link, known as a climate teleconnection. The results could improve forecasts of extreme weather in the western U.S., which, in turn, could improve warnings for coastal communities and potentially save lives as well as billions of dollars in property damage, the study's authors say.

In December 2016 and February 2023, the Tibetan Plateau was warmer than usual for these times of the year. Roughly one month after each of these hotspots appeared, parts of California, Nevada, Oregon, Utah and Arizona received record-breaking precipitation, causing a total of around \$6.6 billion in damage, according to the study, and [killing](#) at least [nine people](#).



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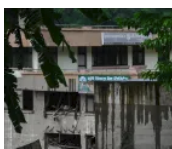
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State-of-the-art forecast systems, which rely heavily on ocean conditions like [El Niño](#), failed to predict this extreme rainfall, said study first author [Yongkang Xue](#), a distinguished professor of atmospheric and oceanic sciences at UCLA. The record precipitation occurred during La Niña years, which are typically associated with dry conditions in California and neighboring regions, further complicating the picture.

"This study provides the first evidence from observational data analysis and model simulations that abnormally high early-winter temperatures on the Tibetan Plateau led to stronger atmospheric rivers along the U.S. Pacific Coast, driving heavy regional precipitation," Xue told Live Science in an email.

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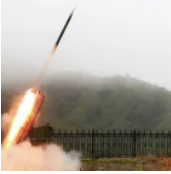


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Atmospheric rivers are narrow, elongated corridors of intense water vapor transport. They are key drivers of precipitation and floods in the western U.S., and in this case, they interacted with giant waves in Earth's atmosphere, called Rossby waves, to produce devastating rainfall in the winters of 2017 and 2023.

As temperatures increased over the Tibetan Plateau in late 2016 and early 2023, a strong gradient formed with the regions north and south of the plateau. This generated an atmospheric disturbance that propagated eastward along the jet stream via Rossby waves, triggering what is known as a Rossby wave train between the Tibetan Plateau and the Rocky Mountains, Xue said.

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A Rossby wave train is a series of waves

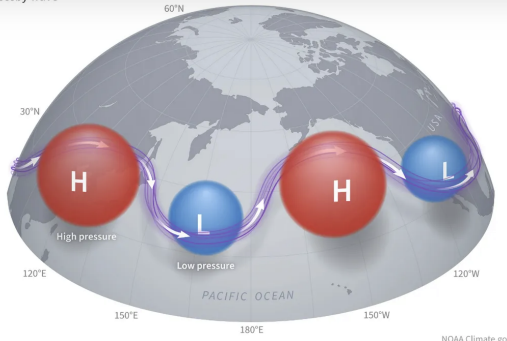


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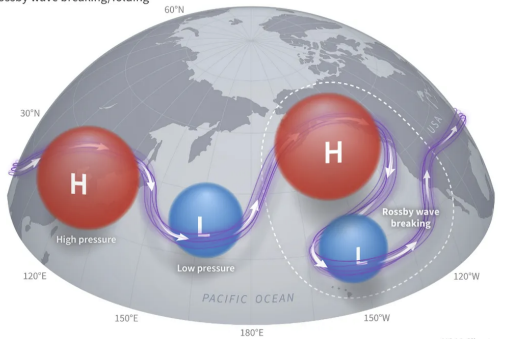


Rossby wave



NOAA Climate.gov

Rossby wave breaking/folding



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Rossby waves are waves in Earth's atmosphere that wrap around high- and low-pressure systems. When there is an atmospheric disturbance, it can propagate in what is known as a Rossby wave train.

(Image credit: NOAA Climate)

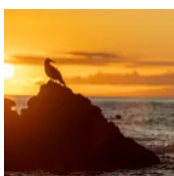
regular intervals around alternating high- and low-pressure systems. As the wave trains initiated over the Tibetan Plateau reached the northeastern Pacific Ocean, they suddenly broke, and this supercharged the weather above California and adjacent states, Xue explained.

"Over the eastern Pacific, the wave breaks — much like a towering ocean wave crashing near the shore," he said. "This wave-breaking mechanism reduces static stability and significantly intensifies atmospheric rivers, ultimately driving extraordinary, heavy precipitation along the West Coast."

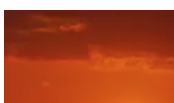
The findings, published Wednesday (Sept. 9) in the journal [Science Advances](#), are based on complex modeling and analyses

of precipitation and surface temperature data, among other observations. The results are part of a new body of research examining the influence of land temperatures on weather patterns, and this is the first study of a winter season, Xue said.

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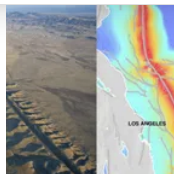


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The analysis is a "very specific and impactful case study," said [Matthew Huber](#), a professor in the Department of Earth, Atmospheric, and Planetary Sciences at Purdue University in Indiana, who was not involved in the research. The results build on the well-established idea that extra heat on a mountaintop affects Rossby waves almost as if the mountain had suddenly grown, Huber told Live Science in an email.

Large mountains and plateaus generate waves in the jet stream that are thousands of miles long — "so long that we also call them planetary waves," Huber said. An increase or drop in temperature so high up above sea level adds or subtracts from the atmospheric disturbance that already exists due to the elevation.

"You can imagine the waves in the jet are kind of like a motorcycle rider going off a jump," Huber said. "How far and how high they jump depends on how fast they are going and how big a ramp they are going over."

The models replicated the extreme weather with surprising accuracy, raising hopes that the Tibetan Plateau could be integrated into early warning systems for the western U.S., Xue said. "As similar, though less severe, events become more [frequent] and extreme weather

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agencies to better warn coastal communities of impending extreme conditions," he said.

Huber agreed that the results could help to better prepare for weather hazards. "This study shows that accurate predictions of weather events in the U.S. West are very sensitive to tiny changes very far 'upstream' and these upstream features are identifiable and traceable," he said.

Article Sources

Xue, Y., Li, Q., Lau, W. K.-M., Neelin, J. D., Zeng, X., Zhang, Y., Li, S., Kong, X., Guan, B., Boone, A., Cao, Z., Wang, A., Pan, Y., Tang, Q. and Prasad Nayak, H. (2026). Extraordinary Tibetan Plateau early- winter heating drove record- breaking winter precipitation in California and adjacent regions. *Science Advances*. <https://doi.org/10.1126/sciadv.aeg3577>

