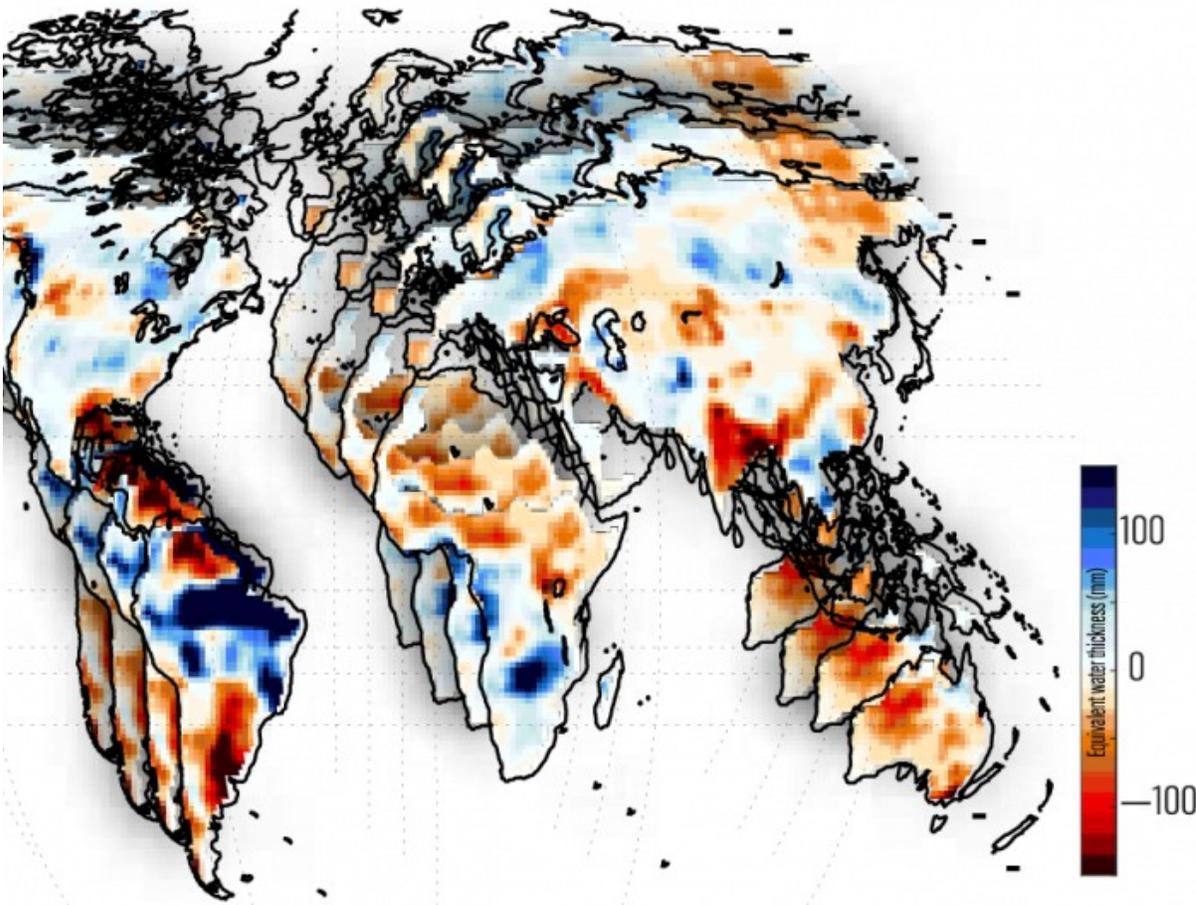


El Niño and La Niña Make Water Extremes Move in Sync

JANUARY 12, 2026



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om the paper showing extreme water storage anomalies across the world as detected by the GRACE and GRACE Follow-On 2-2024. Credit: Ashraf Rateb.

Water extremes such as droughts and floods have a huge impact on communities, ecosystems, and economies. Researchers with The University of Texas at Austin have turned their attention to tracking these extremes across Earth and have discovered what is driving them.

In a recent study published in [AGU Advances](https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2025AV001684?countTerms=true&af=R&SeriesKey=2576604x&sortBy=Earliest&mi=17h1bsr&content=articlesChapters&ta) ([https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2025AV001684?](https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2025AV001684?countTerms=true&af=R&SeriesKey=2576604x&sortBy=Earliest&mi=17h1bsr&content=articlesChapters&ta)

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the researchers found that over the past two decades ENSO, a climate pattern in the equatorial Pacific Ocean that includes El Niño and La Niña, has been the dominant driver of total water storage extremes at the global level. What's more, the researchers found that ENSO has a synchronizing effect on water storage extremes across continents.

Study co-author Bridget Scanlon, a research professor at the Bureau of Economic Geology at the UT Jackson School of Geosciences, said that understanding how extremes unfold across the world has humanitarian and policy impacts.

“Looking at the global scale, we can identify what areas are simultaneously wet or simultaneously dry,” Scanlon said. “And that of course affects water availability, food production, food trade — all of these global things.”

Total water storage is an essential climate metric that captures all the water in a specific area. This includes everything from surface water in streams and lakes to snowpack, soil moisture, and groundwater. This study is among the first to track total water extremes and ENSO (The El Niño-Southern Oscillation) at the global level, enabling researchers to observe how water extremes are connected, said the study's lead author Ashraf Rateb, a research assistant professor at the bureau.

“Most studies count extreme events or measure how severe they are, but by definition extremes are rare. That gives you very few data points to study changes over time,” Rateb said. “Instead, we examined how extremes are spatially connected, which provides much more information about the patterns driving droughts and floods globally.”

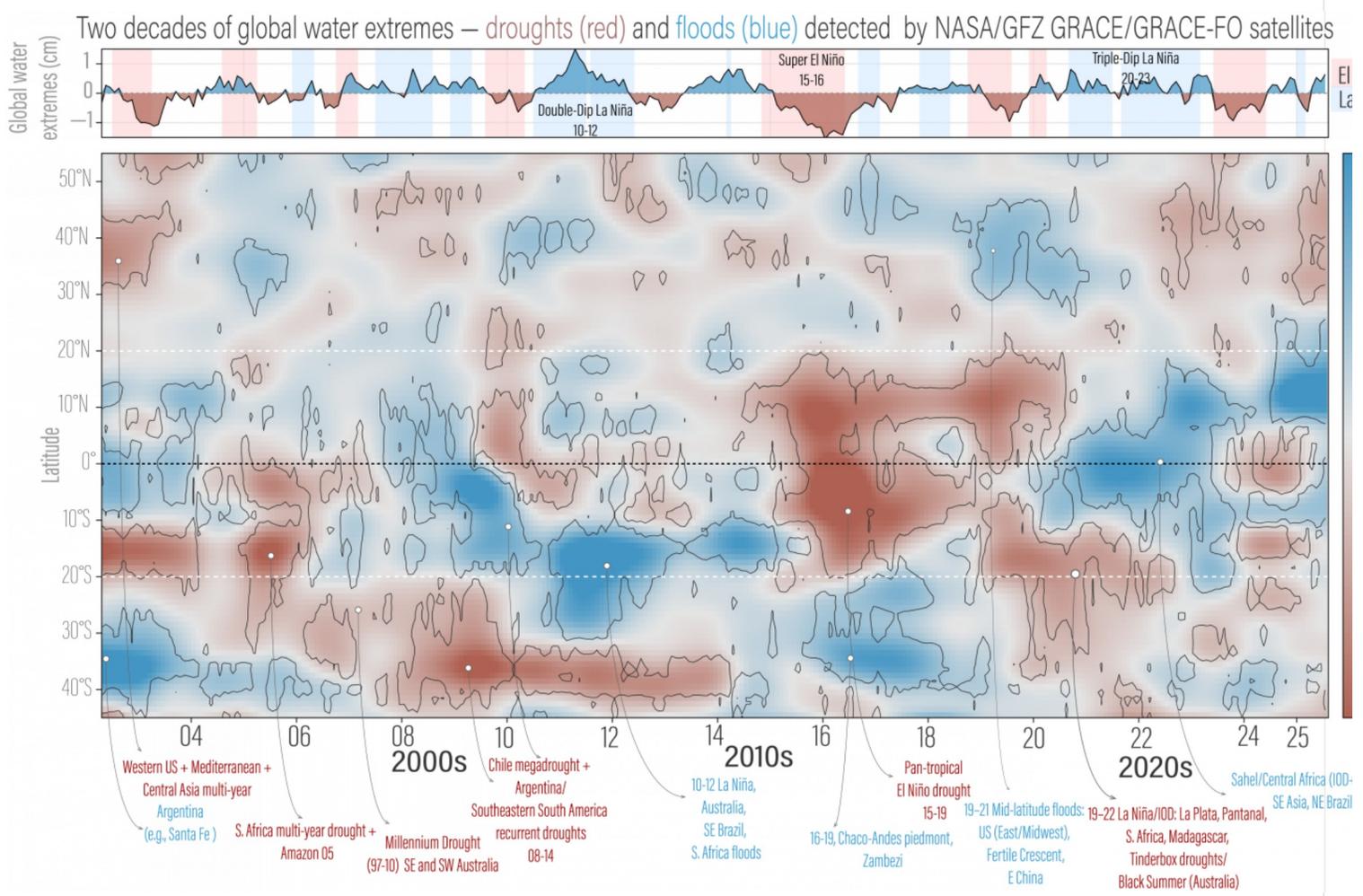
Using gravity data measured by NASA's GRACE and GRACE Follow-On (GRACE-FO) satellites, total water storage was estimated at spatial scales roughly 300 to 400 kilometers across — areas comparable to the size of Indiana.

The scientists defined wet extremes as anything above the 90th percentile of total water storage for a region, and dry extremes as anything below the 10th percentile.

The researchers found that abnormal ENSO activity can push far-flung regions simultaneously into dry or wet conditions. Dry extremes are associated with El Niño in some regions and La Niña in others, with the opposite pattern for wet extremes.

For example, dry extremes occurred during El Niño in South Africa in the mid-2000s and in the

Amazon during 2015–2016. In 2010–2011, La Niña coincided with extremely wet conditions in Australia, southeast Brazil and South Africa.



(https://www.jsg.utexas.edu/news/files/TWSExtremes_Hovmoller_AR_DEC11_simplified-scaled.png)

Global water storage extremes from 2002–2025 as observed by NASA’s GRACE and GRACE-FO satellites (above) and terrestrial storage extremes by latitude over time (below). The diagram shows how droughts (red) and floods (blue) propagate across the globe in response to climate drivers like El Niño and La Niña. Major events include the Australian Millennium Drought (1997–2010), the 2011 pan-tropical El Niño drought, and the 2019–22 La Niña-driven floods and droughts across multiple continents. Credit: Ashraf Rateb.

In addition to highlighting the global influence of ENSO on water, the research also revealed a global shift in water extremes occurring around 2011–2012. Before 2011, wet extremes dominated. After 2012, dry extremes became more common. This shift is attributed to a decade-long climate pattern in the Pacific that modulates ENSO’s effects.

For periods when GRACE and GRACE-FO data were not available, including an 11-month gap between missions in 2017–2018, the researchers used probabilistic models based on spatial patterns to reconstruct total water storage extremes.

Data provided by the GRACE and GRACE-FO satellites span only 22 years (2002–2024). Still, even in this relatively short time frame, the research shows how interconnected climate and water are across the planet, said JT Reager, the deputy project scientist for the GRACE-FO mission at

NASA's Jet Propulsion Laboratory and the JPL Discipline Program manager for the Water and Energy Cycle.

"They're really capturing the rhythm of these big climate cycles like El Niño and La Niña and how they affect floods and droughts, which are something we all experience," said Reager, who was not part of the study. "It's not just the Pacific Ocean out there doing its own thing. Everything that happens out there seems to end up affecting us all here on land."

Scanlon said that the connection between water extremes and climate patterns also highlights the importance of understanding extremes as part of the climate cycle and preparing for them.

"Oftentimes we hear the mantra that we're running out of water, but really it's managing extremes," Scanlon said. "And that's quite a different message."

The research was funded by the UT Jackson School of Geosciences.

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