Scientists find evidence of a wetter world, recorded in Australian coral colony

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When climate scientists look to the future to determine what the effects of climate change may be, they use computer models to simulate potential outcomes such as how precipitation will change in a warming world.

But University of Michigan scientists are looking at something a little more tangible: coral.

Examining samples from corals in the Great Barrier Reef, the researchers discovered between 1750 and present day, as the global climate warmed, wet-season rainfall in that part of the world increased by about 10%, and the rate of extreme rain events more than doubled. Their results are published in *Communications Earth & Environment*.

"Climate scientists often find themselves saying, 'I knew it was going to get bad, but I didn't think it was going to get this bad this fast.' But we're actually seeing it in this coral record," said principal investigator Julia Cole, chair of the U-M Department of Earth and Environmental Sciences.

"Studies of the future tend to use climate models and those models can give different results. Some may say more rainfall, some may say less rainfall. We're showing that, at least in northeastern Queensland, there is definitely more rainfall, it's definitely more variable and it's definitely already happening."

The study, led by U-M researcher Kelsey Dyez, analyzed core samples drilled from a coral colony situated at the mouth of a river in northern Queensland, Australia. During the summer rainy seasons, rainfall filtering into the river picks up nutrients, organic material and sediments, which are then carried to the river mouth and discharged into the ocean, washing over the coral colony.

As the corals are bathed in this freshwater outflow, they pick up geochemical signals from the river and record them into their carbonate skeletons. The core samples of the corals display faint bands of lighter and darker material. These bands reflect each rainy and dry season the coral lived through. The bands also hold information about the climate in each season, just as trees' rings record climate patterns during the years they grow.

"We want to know, as we warm the Earth, are we going to have more rainfall? Less rainfall? Maybe different parts of the Earth will respond differently?" Dyez said. "This project is especially important because we're able to put that warming and changes into context. We are able to record rainfall from the period before we have instrumental records for this part of the world."

To accurately determine how much rain fell each rainy season, and how many extreme rain events occurred during each season, the researchers compared instrumental rainfall records that began in the 1950s to the corresponding years in the coral. This gave the researchers a calibration period that they could use to determine the relationship between the coral characteristics and the amount of rainfall that fell each rainy season as long as the corals were alive, all the way back to 1750.

The coral core was taken from a remote region off northeastern Queensland by the Australian Institute of Marine Science. The land surrounding the river watershed is also in a protected area, meaning that nutrients and sediment flushed into the river by rains are unlikely to be generated by human activity.

"This is a region that has experienced pretty big swings in recent years between floods that have been devastating to communities, and then drier periods," Cole said. "Because northeastern Australia is an agricultural region, how rainfall changes in a warmer world is of real tangible importance. People might not sense a few degrees Celsius of warming, but they really suffer if there's a drought or a flood."

To reconstruct rainfall, the researchers used four different measures. First, the researchers looked at the luminescence of the bands in the coral. When they shine a black light on the coral, organic compounds in the coral cause it to fluoresce. The brighter the band fluoresces, the more organic compounds came down the river and were deposited onto the coral, reflecting a season of heavy rainfall.

The researchers also measured how much of the element barium is contained in each of the bands. The coral skeleton is composed of calcium, but when barium is deposited onto the skeleton, it can replace calcium. The more barium detected in the band, the more river discharge was flowing over the coral.

The researchers then looked at stable carbon isotopes (carbon-12 and carbon-13) within the coral. The more the ratio of these two isotopes favors carbon-12, the more water must have been coming down the river from greater rainfall.

Finally, the researchers examined stable oxygen isotopes (oxygen-16 and oxygen-18). When the ratio of these two isotopes favors oxygen-16, it is a signature of additional precipitation and freshwater coming down the river.

Because the coral record is located off northeastern Australia, the researchers wanted to understand if the whole of Australia experienced similar rainfall. Looking at instrumental rainfall records across Australia, the researchers found that the increased rainfall patterns did not occur evenly across Australia.

"It's not actually that well correlated to western Australia. That's too far away. But for most of eastern Australia, there is a significant correlation.

And that's where many people live," Dyez said. "It's especially strong across Queensland, which is where a lot of these rainfall extremes are happening right now."

More information: Rainfall variability increased with warming in northern Queensland, Australia over the past 280 years, *Communications Earth & Environment* (2024). DOI: 10.1038/s43247-024-01262-5 , www.nature.com/articles/s43247-024-01262-5

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