

First evidence of surprising ocean warming around Galapagos corals

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Diane Thompson (left), Roberto Pépolas (center) and Alexander Tudhope (right) use a hydraulic drill to take a core from a *Porites lobata* coral head near Wolf Island in the Galápagos. Credit: Jenifer Suarez, courtesy of the Cole lab.

The ocean around the Galápagos Islands has been warming since the 1970s, according to a new analysis of the natural temperature archives stored in coral reefs.

The finding surprised the University of Arizona-led research team, because the sparse instrumental records for [sea surface temperature](#) for that part of the eastern tropical Pacific Ocean did not show warming.

"People didn't know that the Galápagos or eastern Pacific was warming. People theorized or suggested it was cooling," said lead author Gloria Jimenez, a UA doctoral candidate in geosciences.

Scientists thought strong upwelling of colder deep waters spared the region from the warming seen in other parts of the Pacific, she said.

"My colleagues and I show that the [ocean](#) around the northern Galápagos Islands is warming and has been since the 1970s," Jimenez said. The research is part of her doctoral work.

Jimenez studied cores taken from [coral](#) heads in the uninhabited northern part of Ecuador's Galápagos National Park. The cores represented the years 1940 to 2010. Corals lay down seasonal growth layers that serve as a natural archive of ocean temperatures.

Her analysis revealed that from 1979 to 2010, regional ocean temperatures increased almost 0.4 degrees F (0.2 degrees C) per decade—about 1.1 degrees F (0.6 degrees C) overall.

The very strong El Niño of 1982-83 temporarily warmed the surrounding ocean so much that most of the corals in the southern part of the Galápagos died, said co-author Julia Cole, who collected the coral cores while she was a faculty member at the UA.

She is concerned about ocean warming around the northern Galápagos and parts of the eastern tropical Pacific.



Cores collected in 2010 from a *Porites lobate* coral near Wolf Island in Galapagos Islands. The core, now broken into three pieces, is 3.5 inches (8.9 cm) in diameter. Credit: Julia Cole © 2010

"Warming in this area is particularly disturbing, because it's the only place that reefs have persisted in the Galápagos. This suggests those reefs are more vulnerable than we thought," said Cole, who is now a professor of earth and environmental sciences at the University of Michigan.

The research paper, "Northern Galápagos corals reveal twentieth century warming in the eastern tropical Pacific," by Jimenez, Cole and their co-authors, Diane M. Thompson of Boston University in Massachusetts and Alexander W. Tudhope of the University of Edinburgh in the UK, is scheduled to be published in *Geophysical Research Letters* on Feb. 21.

The National Science Foundation, the UK Natural Environment Research Council and the Philanthropic Education Organization Fellowship funded the research.

For 30 years, Cole, a paleoclimatologist, has been studying climate change and the El Niño/ La Niña climate cycle.

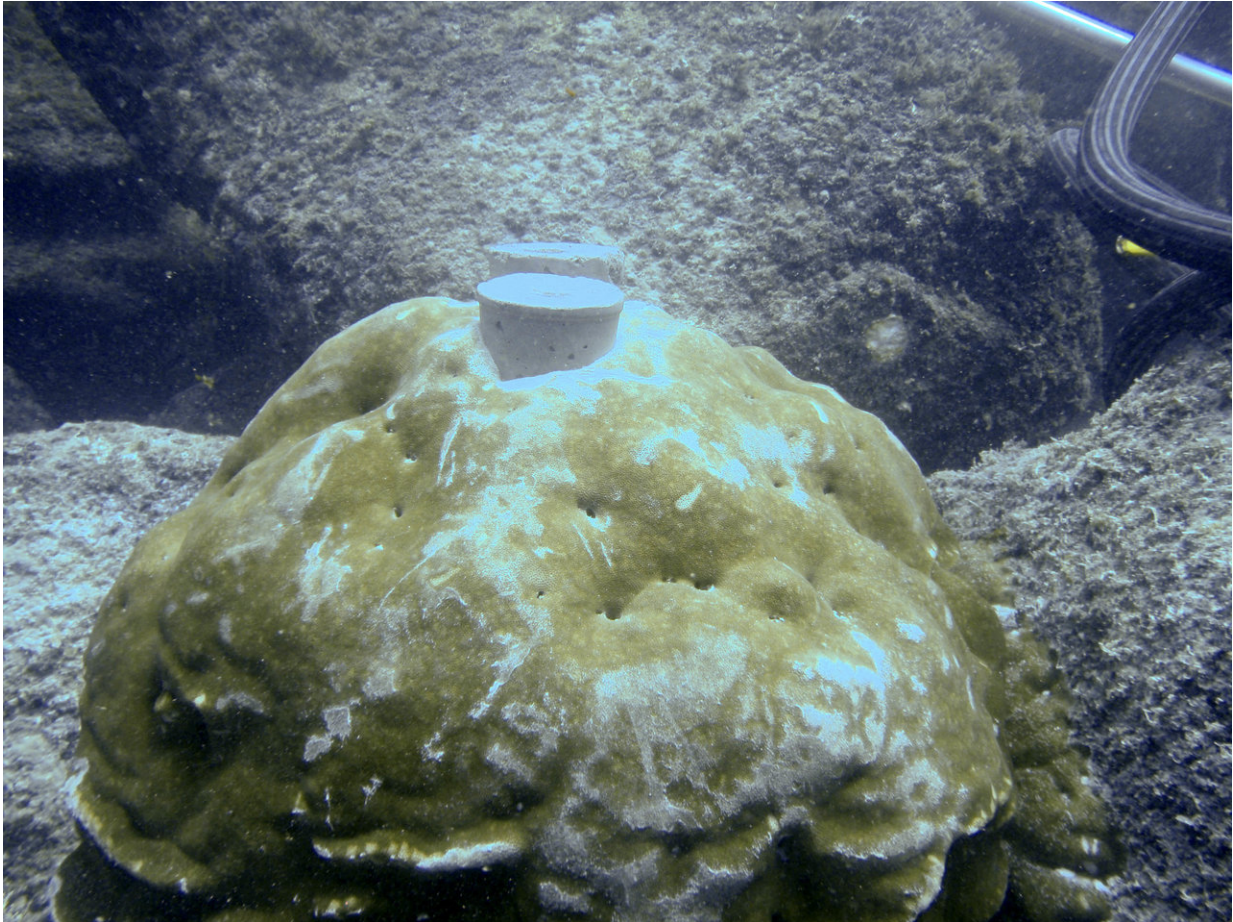
In 1989 she went to the Galápagos hoping to use the natural climate archives stored in corals to develop a long-term record of El Niño, but found that none of the large, old corals others reported had survived the intense warming of the 1982-83 El Niño.

"We went from site to site—and they were all gone," Cole said. "One of my co-workers said, 'There used to be corals here, and now all I see is sand.'"

Years later, she heard large corals were still alive near Wolf Island in the remote northern part of the Galápagos archipelago, so in 2010 she followed up on the tip with a team that included co-authors Tudhope and Thompson, then a UA graduate student.

The team members dove to the reef and took several cores from large, blobby dome-shaped *Porites lobata* corals using an underwater hydraulic drill powered by vegetable oil. The three-and-a-half-inch (8.9 cm) diameter cores ranged from two to three feet long and had annual bands 0.4 to 0.8 inches (1-2 cm) wide. Each core showed damage from when the coral stopped growing during the 1982-83 El Niño and then started growing again.

Jimenez used chemical analysis to tease temperature information out of two of those coral cores.



After removing two cores from this *Porites lobata* coral colony near Wolf Island in the Galápagos, the University of Arizona-led team of researchers plugged the drill holes. The cement plugs help the coral grow over the holes and keep out animals out of the holes. Credit: Diane Thompson © 2010

Coral skeletons are made mostly of calcium carbonate. However, corals sometimes substitute the element strontium for the calcium. Corals substitute more strontium when the water is cold and less when the water is warm, so the strontium/calcium ratio of a bit of skeleton can reveal what the water temperature was when that piece of skeleton formed.

Jimenez used a little drill bit to take a tiny sample every millimeter for

the length of each core. She took 10 to 20 samples from each annual band of each core and analyzed the samples for the strontium/calcium ratio using atomic emission spectrometry.

She then used that information to create a continuous record of the region's ocean temperature from 1940 to 2010.

Because the El Niño/ La Niña climate cycle generates large fluctuations in ocean temperatures around the Galápagos and in the eastern tropical Pacific, long-term changes can be hard to spot.

Jimenez wanted to determine whether the region's ocean temperature changed significantly from 1940 to 2010. Therefore she analyzed her Galápagos coral temperature chronologies alongside published coral temperature chronologies from islands farther north and west and instrumental sea surface [temperature](#) records from the southern Galápagos town of Puerto Ayora and the Peruvian coastal town of Puerto Chicama.

Jimenez said her research convinces her that the ocean around the Galápagos and much of the eastern tropical Pacific is warming. She's concerned about the effect of [warming](#) seas.

"The Galápagos National Park has been designated a World Heritage Site because it's a special and unique place," Jimenez said. "Losing the corals would be an enormous blow to the underwater biodiversity."

Jimenez's next project involves analyzing an eight-foot-long Galápagos coral core she collected in 2015 that goes back to about 1850.

More information: Gloria Jimenez et al, Northern Galápagos corals reveal twentieth century warming in the eastern tropical Pacific, *Geophysical Research Letters* (2018). [DOI: 10.1002/2017GL075323](https://doi.org/10.1002/2017GL075323)

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