Strengthening cold ocean current buffers Galápagos Islands from climate change
13 October 2022, by Kelsey Simpkins

"There's a tug of war going on between our greenhouse effect causing warming from above, and the cold ocean current. Right now, the ocean current is winning—it's not just staying cool, it's getting cooler year after year," said Kris Karnauskas, lead author on the study, associate professor in the Department of Atmospheric and Oceanic Sciences and fellow in the Cooperative Institute for Research in Environmental Sciences (CIRES).

This phenomenon is a cause for cautious optimism for the second largest marine reserve in the world, and a biodiverse island ecosystem that is home to several endangered species and designated as a UNESCO World Heritage Site.

If corals don't bleach and die in these waters off the western coast of Ecuador, and the marine food web doesn't struggle like it will in nearby warming waters, flora and fauna in the Galápagos could help reseed struggling ecosystems and keep fisheries in the region functioning.

"As the Galápagos so far has been relatively unaffected by climate change, it's worth looking at the Galápagos as a potential site to really try to put some climate change mitigation efforts into," said Karnauskas.

But as one of the few places left in the world's oceans that are not currently warming up, the waters off the west coast of the Galápagos are also likely in need of additional protections from overfishing as well as the pressures of increased ecotourism.

"The human pressures on this area and this mechanism that keeps it alive are at odds," said Karnauskas. "It's a major resource that should be protected."

The Galápagos Islands are a volcanic archipelago situated west of Ecuador in the Pacific Ocean. Credit: European Space Agency

While most of the world's oceans are warming due to climate change, a new CU Boulder study explains how the waters around the Galápagos Islands are staying cool and getting colder.

Published in PLOS Climate, the study shows that not only does a cold, eastward equatorial ocean current provide the Galápagos Islands a buffer against an otherwise warming Pacific Ocean, but this current has been getting stronger for decades. In fact, the waters off the west coast of the Galápagos have cooled by 0.9 degrees Fahrenheit (0.5 degrees Celsius) since the early 1990s.
Observed sea surface temperature trends. a, SST trend (°C per 39 years) from Jan. 1982 through Dec. 2020. Black contours are the mean SST, contoured every 0.5°C; the innermost contour is 23°C. b, As in a but with the influence of large ENSO events removed prior to calculating the trend. c, as in a but for the period Jan. 1993 through Dec. 2018. The color scale next to b applies to all three trend maps (a–c). d, Histogram of SST trends throughout the world ocean (one for each square km), with the minimum and mean SST trend in the GCP region (white boxes in a–c) denoted by blue lines. e, Time series of SST averaged within the GCP region relative to the region west of the GCP (extending from the GCP to 100°W) with two (black line) and five (red line) year low-pass filters to remove high-frequency noise. The blue curve outlines the segment of the two year low-pass filtered time series spanning Jan. 1993 through Dec. 2018. Credit: PLOS Climate (2022). DOI: 10.1371/journal.pclm.0000056

An accident of geology

The Galápagos Archipelago may seem insignificant from space, as several tiny dots in the eastern Pacific Ocean. But it’s their location—exactly on the equator—that makes them quite significant.

Because the Earth rotates on an axis, this equatorial undercurrent in the Pacific Ocean is also stuck to the equator, locked in by the force of the planet’s rotation. This current under the surface of the ocean heads quickly from west to east, its cold water rich in nutrients. When it hits the Galápagos Islands, some of this water is forced up to the surface and the chemical reaction of photosynthesis causes an explosion in food for all manner of creatures.

So while the islands are located in the tropics, this cold ocean current that collides with them creates a cooler, stable environment for coral reefs, as well as marine animals and birds who normally live much closer to the poles. The endangered Galápagos penguin, Galápagos fur seal and Galápagos sea lion all thrive on these islands, touted as a “living museum and showcase of evolution” by the UNESCO World Heritage Convention.

Published this August in Geophysical Research Letters, another paper by Karnauskas, and fellow CU Boulder atmospheric and oceanic sciences assistant professor Donata Giglio, used data from thousands of floating ocean sensors, in place since 2000, to observe and confirm that this Pacific equatorial undercurrent is responsible for the cold water that rises from below to surround and support the islands' thriving ecosystem.

A strengthening cold current

Karnauskas used different data, when at Woods Hole Oceanographic Institution a decade ago, to show in Nature Climate Change how cold ocean currents might protect certain islands or coastlines from the detrimental warming effects of climate change. This new study shows that not only is that proving true for the Galápagos—but that the cold
current is strengthening.

"There's clear evidence that shows all the way back to 1982 that this current has been strengthening and the cold water on the western shores of the islands has been getting colder," said Karnauskas.

But why is this cold ocean current getting stronger?

This current, which starts near Australia, is already among the strongest in the world. Using a recently developed high-resolution ocean model, Karnauskas concluded that its continued cooling results from changes in the winds across the equator.

While this acceleration of the equatorial undercurrent is consistent with model simulations of future climate change, according to Karnauskas, it's not yet clear if this trend can be directly attributed to human-caused climate change or if it's the result of natural cycles.

Are the Galápagos Islands safe forever? Not quite, says Karnauskas.

El Niño (the warm phase of a recurring climate pattern across the tropical Pacific) poses a temporary threat—shutting down the cold current every couple of years, which causes penguin populations to crash. While El Niño occurs independently of the cold current, it offers a glimpse at what could happen without it.

"The worry is if in the future there are changes in this current, it could be really devastating for the ecosystem," said Karnauskas.

And if the oceans continue to warm the way they have been, says Karnauskas, this safe haven from climate change may not stay that way.

"What the data shows very clearly is that it's hanging on so far," said Karnauskas. "It doesn't imply that it's going to hang on forever."


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