

# Deep ocean currents around Antarctica headed for collapse, study finds

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The deep ocean circulation that forms around Antarctica could be

headed for collapse, say scientists.

Such decline of this [ocean](#) circulation will stagnate the bottom of the oceans and generate further impacts affecting climate and marine ecosystems for centuries to come.

The results are detailed in a new study coordinated by Scientia Professor Matthew England, Deputy Director of the ARC Centre for Excellence in Antarctic Science (ACEAS) at UNSW Sydney. The work, published today in *Nature*, includes lead author Dr. Qian Li—formerly from UNSW and now at the Massachusetts Institute of Technology (MIT)—as well as co-authors from the Australian National University (ANU) and CSIRO.

Cold water that sinks near Antarctica drives the deepest flow of the overturning circulation—a network of currents that spans the world's oceans. The overturning carries heat, carbon, oxygen and nutrients around the globe. This influences climate, sea level and the productivity of [marine ecosystems](#).

"Our modeling shows that if global carbon emissions continue at the current rate, then the Antarctic overturning will slow by more than 40 percent in the next 30 years—and on a trajectory that looks headed towards collapse," says Prof England.

## **Modeling the deep ocean**

About 250 trillion tons of cold, salty, oxygen-rich water sinks near Antarctica each year. This water then spreads northwards and carries oxygen into the deep Indian, Pacific and Atlantic Oceans.

"If the oceans had lungs, this would be one of them," Prof England says.

The international team of scientists modeled the amount of Antarctic deep water produced under the IPCC "high emissions scenario," until 2050.

The model captures detail of the ocean processes that previous models haven't been able to, including how predictions for meltwater from ice might influence the circulation.

This [deep ocean](#) current has remained in a relatively stable state for thousands of years, but with increasing [greenhouse gas emissions](#), Antarctic overturning is predicted to slow down significantly over the next few decades.

## **Impacts of reduced Antarctic overturning**

With a collapse of this deep ocean current, the oceans below 4000 meters would stagnate.

"This would trap nutrients in the deep ocean, reducing the nutrients available to support marine life near the ocean surface," says Prof England.

Co-author Dr. Steve Rintoul of CSIRO and the Australian Antarctic Program Partnership says the model simulations show a slowing of the overturning, which then leads to rapid warming of the deep ocean.

"Direct measurements confirm that warming of the deep ocean is indeed already underway," says Dr. Rintoul. The study found melting ice around Antarctica makes the nearby ocean waters less dense, which slows the Antarctic overturning circulation. The melt of the Antarctic and Greenland ice sheets is expected to continue to accelerate as the planet warms.

"Our study shows that the melting of the ice sheets has a dramatic impact on the overturning circulation that regulates Earth's climate," says Dr. Adele Morrison, also from ACEAS and the ANU Research School of Earth Sciences.

"We are talking about the possible long-term extinction of an iconic water mass," says Prof England.

"Such profound changes to the ocean's overturning of heat, freshwater, oxygen, carbon and nutrients will have a significant adverse impact on the oceans for centuries to come."

**More information:** Matthew England et al, Abyssal ocean overturning slowdown and warming driven by Antarctic meltwater, *Nature* (2023).

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