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Southern Ocean already losing ability to absorb CO_2

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One of the world's largest carbon sinks has stopped soaking up the carbon dioxide that humans are pumping into the atmosphere, according to a new study.

Global warming has caused the Southern Ocean to become windier, churning up the waters so that they are unable to absorb CO_2 at the rate we produce it, the researchers say.

The implications are far-reaching, and once more imply that the Intergovernmental Panel on Climate Change's projections are conservative: temperatures are likely to rise higher than predicted.

Corinne Le Quéré at the University of East Anglia in the UK, and colleagues say their study suggests that climate feedback loops – whereby more CO_2 in the atmosphere causes warming which in turn releases even more CO_2 from the oceans – are happening between 20 and 40 years before they were expected.

Cold storage

"This is serious," says Le Quéré. "All climate models predict that this kind of feedback will continue and intensify during this century."

The Earth's carbon sinks absorb about half of all human-produced carbon emissions. The Southern Ocean is one of the biggest sinks, absorbing 15% of CO_2 emissions. The gas dissolves into the ocean's surface waters and is stored at cool depths where it is retained far longer than it would be at the warmer surface.

But since 1958, the Southern Ocean has become windier, mixing up the ocean waters and bringing the cool, carbon-laden waters up to the surface, where they release their gas into the atmosphere.

Le Quéré's team found that this is effectively saturating the Southern Ocean reservoir, so that it is unable to absorb CO_2 as quickly as it is being emitted by human activities.

24 years of stability

The researchers spent 24 years monitoring CO_2 around the globe as it is pumped into the atmosphere and absorbed by natural sinks. They obtained much of their data from a network of 40 air samplers positioned around the globe, 11 of which are in and around the Southern Ocean.

"We found that the Southern Ocean reservoir has not changed in 24 years," Le Quéré told **New Scientist**. "This is surprising, because during same time CO_2 emissions increased by 40%. As the sources of CO_2 go up we would expect the reservoir to increase too."

Ice cores studies of the climate and atmosphere over the past 800,000 years have shown that higher temperatures have sucked carbon dioxide out of ocean reservoirs during previous warming periods. But climate models have suggested that this effect would not be seen for at least 20 years.

"To me, it is quite scary that we can detect this impact of climate change already," says Le Quéré. By

releasing more CO_2 into the atmosphere, people are participating in a "large and dangerous experiment", she says.

Ozone depletion

The increase in wind is caused by human-assisted depletion in ozone, which cools the upper atmosphere - the cool air then descends, creating air currents. Global warming also increases windiness by exacerbating the pressure differences that fuel them.

"Since the beginning of the industrial revolution the world's oceans have absorbed about a quarter of the 500 gigatonnes of carbon emitted into the atmosphere by humans. The possibility that in a warmer world the Southern Ocean - the strongest ocean sink - is weakening is a cause for concern," says Chris Rapley, director of the British Antarctic Survey.

Another study, published alongside Le Quéré's in the journal *Science*, also shows a weakening of the ocean sink.

Claudia Benitez-Nelson at the University of South Carolina, US, and colleagues looked at how the swirling ocean phenomena, known as eddies, affect the biological mechanisms that store carbon in the oceans. These mechanisms, which involve the absorption of CO_2 by photosynthesising plankton, are responsible for an important portion of the ocean reservoirs.

Eddies are water swirls up to 200 kilometres across that suck nutrients up from the deep and feed large plankton blooms in the surface waters. It had been thought that the blooms replenish the ocean sink, because a portion of plankton drops to the bottom of the ocean when it dies, dragging the carbon it has absorbed from the atmosphere with it.

But Benitez-Nelson found that in warm waters, bacteria and tiny floating animals, such as krill, at the centre of the eddies feed on the plant plankton, thereby recycling their carbon and preventing it from being stored on the ocean bed.

Journal references *Science* (DOI: 10.1126/science.1136188 and 10.1126/science.1136221)

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