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Uncertainty of future Southern Ocean CO₂ uptake cut in half

The Southern Ocean dominates the oceanic uptake of human-made CO₂. But how much carbon dioxide can it actually absorb in the future? This long-standing question remained unresolved as projections of different generation of climate models repeatedly showed a wide range of future Southern Ocean CO₂ sink estimates. Climate scientists from Bern have now been able to reduce this large uncertainty by about 50 percent.

Anyone researching the global carbon cycle has to deal with unimaginably large numbers. The Southern Ocean – the world's largest ocean sink region for human-made CO₂ – is projected to absorb a total of about 244 billion tons of human-made carbon from the atmosphere over the period from 1850 to 2100 under a high CO₂ emissions scenario. But the uptake could possibly be only 204 or up to 309 billion tons. That's how much the projections of the current generation of climate models vary. The reason for this large uncertainty is the complex circulation of the Southern Ocean, which is difficult to correctly represent in climate models.

"Research has been trying to solve this problem for a long time. Now we have succeeded in reducing the great uncertainty by about 50 percent," says Jens Terhaar of the Oeschger Centre for Climate Change Research at the University of Bern.

Together with Thomas Frölicher and Fortunat Joos, who are also researchers at the Oeschger Centre, Terhaar has just presented in the scientific journal "Sciences Advances" a new method for constraining the Southern Ocean's CO₂ sink. The link between the uptake of human-made CO₂ and the salinity of the surface waters is key to this. "The discovery that these two factors are closely related helped us to better constrain the future Southern Ocean CO₂ sink " explains Thomas Frölicher.

Towards achieving the Paris climate target

A better constraint Southern Ocean carbon sink is a prerequisite to understand future climate change. The ocean absorbs at least one fifth of human-made CO₂ emissions, and as such slows down global warming. By far the largest part of this uptake, about 40 percent, occurs in the Southern Ocean.

The new calculations from Bern not only reduce uncertainties in CO₂ uptake and thus allow more accurate projections, but also show that by the end of the 21st century the Southern Ocean will absorb around 15 percent more CO₂ than previously thought. This is only a tiny bit of help on the extremely challenging path to achieving the Paris temperature goal of 1.5 degree. "The reduction of human-made CO₂ emissions resulting from the combustion of fossil fuels remains extremely urgent if

we are to achieve the goals of the Paris climate agreement," clarifies Fortunat Joos.

Better model predictions possible

In their study, the three climate scientists show why the salinity content of the ocean surface waters is a good indicator of how much human-made CO₂ is transported into the ocean interior. Models that simulate low salinity in the Southern Ocean surface waters have too light waters and therefore transport less water and CO₂ into the ocean interior. As a result, they also absorb less CO₂ from the atmosphere. Models with higher salinity, on the other hand, show higher absorption of CO₂ from the atmosphere. The salinity of the Southern Ocean surface waters, determined through observations, allowed the researchers from Bern to narrow down the uncertainty in the various model projections.

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Oeschger Centre for Climate Change Research

The Oeschger Centre for Climate Change Research (OCCR) is one of the strategic centers of the University of Bern. It brings together researchers from 14 institutes and four faculties. The OCCR conducts interdisciplinary research right on the frontline of climate change research. The Oeschger Centre was founded in 2007 and bears the name of Hans Oeschger (1927-1998), a pioneer of modern climate research, who worked in Bern.

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