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New way of measuring ocean carbon could better align with climate policy goals

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Claire Boteler. Credit: Dalhousie University

The ocean controls our climate. It is the largest carbon sink on the planet, absorbing 40% of human fossil fuel emissions and almost all the excess heat generated by global warming.

There is an urgent need for more data on this critical carbon-absorbing function, particularly in the North Atlantic, which accounts for roughly 30% of the total CO_2 uptake in the ocean. However, there are unique challenges in collecting and interpreting this information.

Claire Boteler, a Ph.D. candidate at Dalhousie University, is tackling these barriers head-on. As part of the Ocean Frontier Institute's Auditing the Northwest Atlantic Carbon Sink project, led by Dr. Doug Wallace and supported by OFI, Boteler has developed a novel method for analyzing ocean carbon data.

This method is not only improving our understanding of ocean carbon absorption, but it also allows scientists to spot changes more quickly.

The challenges of monitoring ocean carbon

"Ideally, we would measure ocean carbon twelve months out of the year," says Boteler. "But we often only have measurements in the spring and summer when the ocean is calm enough for scientists to collect the data."

This results in a seasonal gap. Without data to confirm the carbon levels in the winter, current analysis methods have a summer bias: they build from the assumption that the warm-weather measurements can tell us how much carbon is present in the ocean all year round and how much the ocean carbon content increases each year.

At the surface of the ocean, there is also a natural carbon cycle that takes place every year. "The variability of this cycle is so high that it's difficult to pull out any other details, such as long-term trends" Boteler says. "As a result, existing approaches for assessing anthropogenic carbon uptake use ocean carbon measurements that are collected from a depth of 200 meters or more, where there is less natural variability." However, this creates another big gap in the ocean carbon picture.

A novel approach

"In this world where machine learning methods are so popular, we wanted something that was much more transparent and easier to interpret," says Boteler.

She developed a new statistical approach to simplify the current multiyear trends into a month-by-month timespan. This helps to reduce summer bias and create a more complete picture of how carbon levels in the North Atlantic are changing over time.

Natural variations in the carbon cycle were removed using the new approach so that researchers could see the underlying features of the data and identify how human activities specifically are impacting ocean carbon levels, including within the top 200 meters.

The method also allows changes in ocean carbon content to be identified over much shorter periods of time than before, which allows for more accurate budgeting. Typically, it has been assumed that accumulation of carbon in the deep ocean is relatively constant and can be estimated from measurements made every 10 years or so.

However, anthropogenic carbon is not always increasing at a constant rate. The results show that in 2000, anthropogenic carbon below 1,000 meters suddenly changed its accumulation rate from low to a higher rate matching the waters above. This suggests low frequency variability not previously discussed.

Flash forward to today: every depth layer of the northwest Atlantic Ocean now has a detailed picture of the monthly changes of anthropogenic carbon over the last three decades. This has improved our monitoring of the carbon budget, and currently all depth layers in this region are increasing at a similar rate.

This novel approach also reduced uncertainty levels when compared to other common methods in the field.

Using this research in the fight against climate change

"In order for data to be useful, we need a method to combat the limited resolution of data available," says Boteler. "We developed an approach to pull out the most amount of detail possible at the smallest timescale currently available."

As new data is added to the model, researchers will be able to see monthly changes in ocean carbon levels and fine-scale details that may have previously gone unnoticed. "If we can do a shorter analysis that is still meaningful and accurate, the timespan of our methods will hopefully match with shorter timespan for climate policy and assessment," says Boteler.

In other words, this statistical approach gives researchers a tool to provide data the decision makers need in a timeframe short enough to be impactful.

Provided by Dalhousie University

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