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News

Ships provide insight into ocean carbon

Pilot study shows how the seas soak up carbon dioxide.

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Container vessels can help to monitor carbon dioxide uptake by the oceans.Atlantic Container Lines Inc.

Ocean liners can help keep track of one of the most elusive climate variables, a pilot study suggests. Using data collected by commercial ships, scientists have accurately mapped the carbon dioxide absorbed by the North Atlantic Ocean, and found that it varies enormously from one place to another, and from year to year.

Only about half of the CO_2 emissions from human activity stay in the atmosphere, and these greatly enhance the natural greenhouse effect. The rest is absorbed — in roughly equal measure — by plants and by the oceans.

Without these powerful natural sinks, atmospheric CO_2 concentrations would be rising at more than twice the rate they actually are.

But as oceans become increasingly saturated with CO_2, some have become concerned that they may function less efficiently as carbon sinks. These worries have been fuelled by reports suggesting that the fraction of anthropogenic CO_2 emissions that stay in the atmosphere rose from 40% to 45% between 1959 and 2006[1]. However, a more recent study failed to find evidence for a trend in the airborne fraction of CO_2 emissions[2].

"This precisely illustrates the vast uncertainty surrounding this important question," says Andrew Watson, a carbon-cycle scientist at the University of East Anglia in Norwich, UK, and

leader off the carbon-mapping research, which is published in Science this week[3].

The survey is the most comprehensive assessment yet of the way that CO_2 moves from atmosphere to ocean. The results should enable a more detailed assessment of how changes in oceanic CO_2 uptake might affect planetary climate and the acidity of the oceans.

Up and down

The team equipped four container ships and one cruise liner serving North Atlantic sea routes with chemical sensors — known as equilibrators — which measure the abundance of CO_2 in the surface waters of the ocean and in the surrounding air. The data can be used to infer overall air-to-sea CO_2 transfer in the North Atlantic.

The CO_2 uptake of the region as a whole seems to change considerably from year to year, probably in response to natural climate oscillations. Uptake of CO_2 also seems to vary between locations, and annual fluxes depend strongly on seasons. This variation makes it difficult to discern any trend in the data.

"We saw no substantial decline in sink strength, but we did see very pronounced fluctuations," says Watson. "Whether the ocean CO_2 uptake is systematically weakening and, if so, what the mechanisms might be, is an open question."

The study, which is funded by the European Union (EU) and forms part of the EU's ongoing CarboOcean project, has been in the making for almost 10 years. A prototype chemical sensor was fitted onto a cargo ship in 2002, but failed to work properly. After further testing, the main study was conducted in 2005, involving around 125,000 ship-based measurements.

The scientists then compared their observations with data gathered from more sporadic coverage in adjacent years, and found that in 2005 the ocean's CO_2 uptake was higher than in other years between 2002 and 2007. In the absence of more systematic observations, other climate data had previously been used to infer a continued decline in the CO_2-absorbing capabilities of the North Atlantic since the mid-1990s.

"There is no unique way of determining something as complex as a regional carbon balance," cautions Philippe Ciais, associate director of the Laboratory for Climate Sciences and the Environment in Gif-sur-Yvette France, who coordinates the Integrated Carbon Observation System (ICOS), a planned pan-European facility for monitoring greenhouse gases. "But the good news is that you can beat uncertainty with a clever sampling strategy and relatively cheap means."

The study is a showcase for how the ICOS might work, he adds. "It will definitely guide us in designing an efficient ocean-observing system."

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2. Knorr, W. Geophys. Res. Lett. 36, L21710 (2009). | Article
3. Watson, A. J. *et al*. Science 326, 1391-1393 (2009).