NCAR News Release

Scientists Close in on Missing Carbon Sink;
Northern Forests Less Effective Than Expected in Reducing Global Warming

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Britton Stephens. (Photo by Carlye Calvin, ©UCAR. News media terms of use*)

BOULDER—Forests in the United States and other northern mid- and upper-latitude regions are playing a smaller role in offsetting global warming than previously thought, according to a study appearing in *Science* this week. The study, which sheds light on the so-called missing carbon sink, concludes that intact tropical forests are removing an unexpectedly high proportion of carbon dioxide from the atmosphere, partially offsetting carbon entering the air through industrial emissions and deforestation.

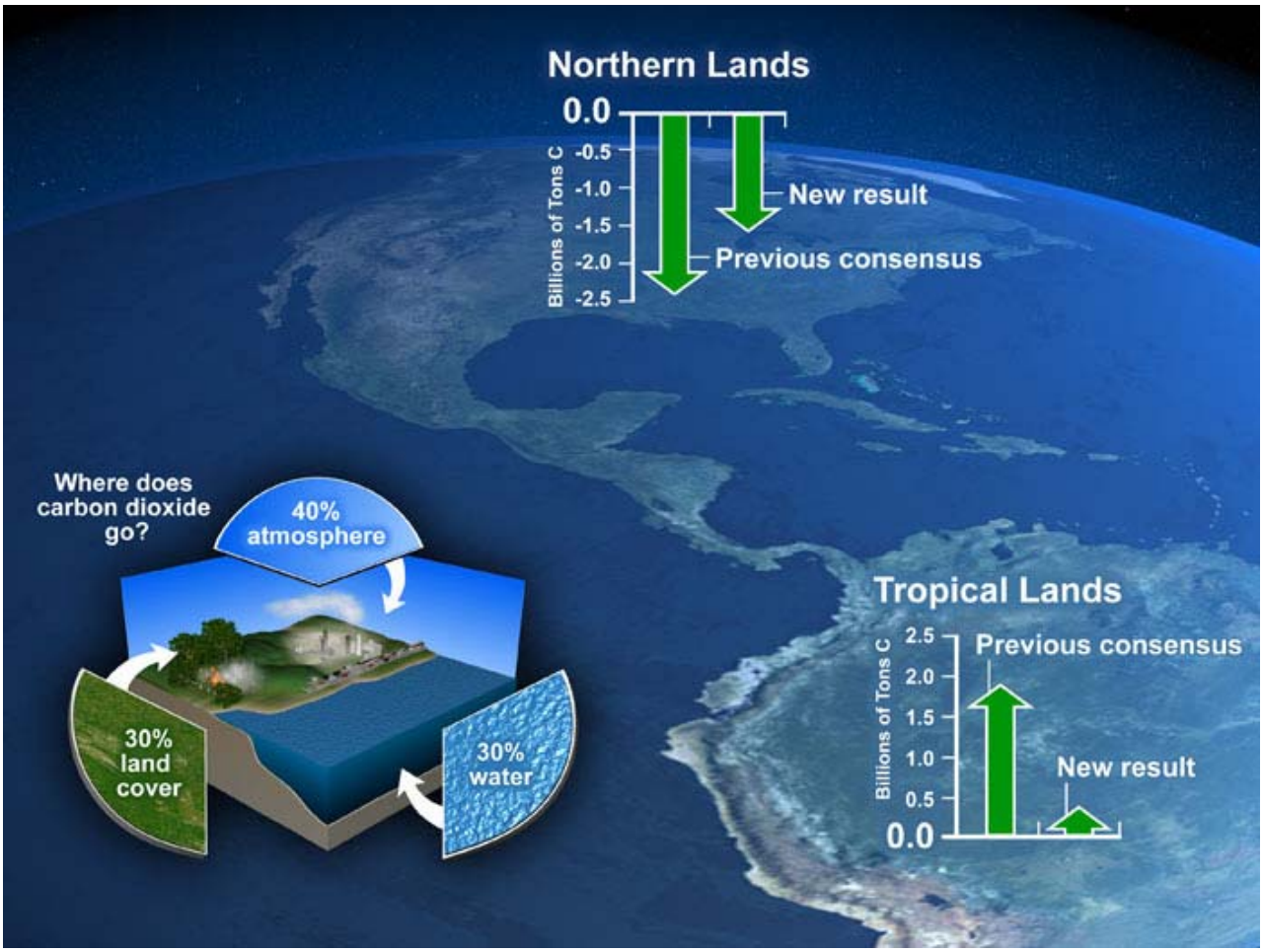
The *Science* article, "Weak northern and strong tropical land carbon uptake from vertical profiles of atmospheric CO2," was written by an international team of scientists led by Britton Stephens of the National Center for Atmospheric Research (NCAR).

To study the global carbon cycle, Stephens and his colleagues analyzed air samples that had been collected by aircraft across the globe for decades but never before synthesized. The team found that some 40 percent of the carbon dioxide assumed to be absorbed by northern forests is instead taken up in the tropics.

"Our study will provide researchers with a much better understanding of how trees and other plants respond to industrial emissions of carbon dioxide, which is a critical problem in global warming," Stephens says. "This will help us better predict climate change and identify possible strategies for mitigating it."

The missing carbon

For years, one of the biggest mysteries in climate science has been the question of what ultimately happens to the carbon emitted by motor vehicles, factories, deforestation, and other sources. Of the approximately 8 billion tons of carbon emitted each year, about 40 percent accumulates in the atmosphere and about 30 percent is absorbed by the oceans. Scientists believe that terrestrial ecosystems, especially trees, take up the remainder.



Measurements show that about 40% of the carbon dioxide emitted through fossil fuels and deforestation remains in the atmosphere, while an estimated 30% is absorbed by trees and other plants and another 30% by the oceans (see inset). Computer models have indicated that forests in the mid and upper latitudes absorb a high amount of carbon dioxide, while tropical forests emit the gas because of deforestation. But a new study led by NCAR's Britton Stephens shows that the two regions are more balanced than previously thought, with intact tropical forests playing a major role in absorbing carbon dioxide. (Illustration by Steve Deyo, ©UCAR. News media terms of use*)

To find this terrestrial carbon sink, scientists have turned to computer models that combine worldwide wind patterns with measurements of carbon dioxide taken just above ground level. The models indicate that northern forests absorb about 2.4 billion tons per year. However, ground-based studies have tracked only about half that amount, leaving scientists to speculate about a "missing carbon sink" in the north.

Stephens and his collaborators set out to test how well the models captured carbon sinks, focusing in particular on estimates produced by a recent international study into global carbon exchange known as TransCom. They turned to flasks of air collected by research aircraft over various points of the globe for the past 27 years. The air samples had been analyzed by several labs around the world, which used them to investigate various aspects of the carbon cycle, but this was the first time that a team of scientists analyzed them to obtain a picture of sources and sinks of carbon on a global level.

The research team compared the air samples to estimates of airborne carbon dioxide concentrations generated by the computer models. The scientists found that most of the models significantly underestimated the airborne concentrations of carbon dioxide in northern latitudes, especially in the summer, when plants take in more carbon. The aircraft samples show that northern forests absorb only 1.5 billion tons of carbon a year, which is almost 1 billion tons less than the estimate produced by the computer models.

The scientists also found that intact tropical ecosystems are a more important carbon sink than previously thought. The models had generally indicated that tropical ecosystems were a net source of 1.8 billion tons of carbon, largely because trees and other plants release carbon into the atmosphere as a result of widespread logging, burning, and other forms of clearing land. The new research indicates, instead, that tropical ecosystems are the net source of only about 100 million tons of carbon, even though tropical deforestation is occurring rapidly.

"Our results indicate that intact tropical forests are taking up a large amount of carbon," Stephens explains. "They are helping to offset industrial carbon emissions and the atmospheric impacts of clearing land more than we realized."

Capturing vertical movements

Most of the computer models produced incorrect estimates because, in relying on ground-level measurements, they failed to accurately simulate the movement of carbon dioxide vertically in the atmosphere. The models tended to move too much carbon dioxide toward ground level in the summer, when growing trees and other plants take in the gas, and not enough carbon dioxide up in the winter. As a result, scientists believed that there was relatively less carbon in the air above mid-latitude and upper- latitude forests, presumably because trees and other plants were absorbing high amounts.

Conversely, scientists had assumed a large amount of carbon was coming out of the tropics and moving through the atmosphere to be absorbed in other regions. But the new analysis of aircraft samples shows that this is not the case.

"With this new information from aircraft samples we see that the models were overestimating the amount of uptake in the north and underestimating uptake in the tropics," says Kevin Gurney of Purdue University, a co-author of the paper and coordinator of the TransCom study. "To figure out exactly what is happening, we need improved models and more atmospheric observations."

To view a video interview with Britton Stephens click here or on the image.

The research team comprised scientists from Colorado State University, Purdue University, and the National Oceanic and Atmospheric Administration in the United States; as well as from the Laboratory of Climate Science and the Environment (France), Tohoku University, National Institute for Environmental Studies, and Nagoya University (Japan), Central Aerological Observatory and Sukachev Institute of Forest (Russia), University of Leeds (United Kingdom), Max Planck Institute for Biogeochemistry (Germany), and CSIRO Marine and Atmospheric Research (Australia).

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About the article

Title: "Weak northern and strong tropical land carbon uptake from vertical profiles of atmospheric CO2"

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