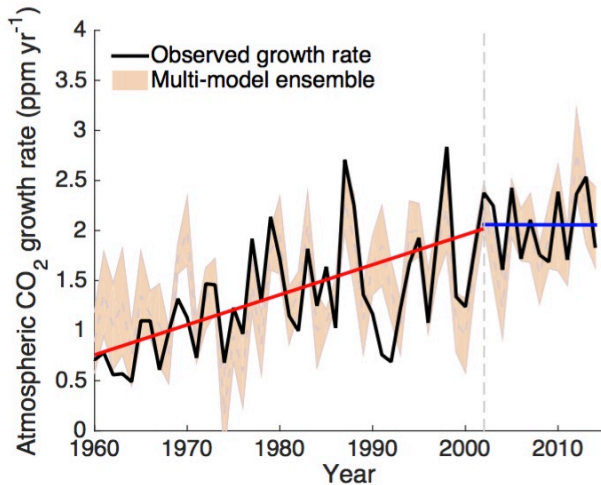


Carbon-hungry plants impede growth rate of atmospheric CO₂

8 November 2016



Changes in the growth rate of atmospheric carbon dioxide. The black line is the observed growth rate and the beige line is the modelled rate. The red line indicates a significant increasing trend in the growth rate from 1959 to 2002, and the blue line indicates no increasing trend between 2002 and 2014. Credit: Berkeley Lab

New findings suggest the rate at which CO₂ is accumulating in the atmosphere has plateaued in recent years because Earth's vegetation is grabbing more carbon from the air than in previous decades.

That's the conclusion of a new multi-institutional study led by a scientist from the Department of Energy's Lawrence Berkeley National Laboratory (Berkeley Lab). It's based on extensive ground and [atmospheric observations](#) of CO₂, [satellite measurements](#) of vegetation, and computer modeling. The research is published online Nov. 8 in the journal *Nature Communications*.

To be clear, [human activity](#) continues to emit increasing amounts of carbon, and the [atmospheric concentration](#) of CO₂, now at 400

parts per million (ppm), continues to rise. But the scientists found that between 2002 and 2014, the rate at which CO₂ increased in the [atmosphere](#) held steady at about 1.9 ppm/year. In addition, the proportion of the CO₂ emitted annually by human activity that remains in the atmosphere declined by about 20 percent. This slowdown can't keep pace with emissions, so the overall amount of human-caused CO₂ in the atmosphere increased, just not as quickly. And for that, new research suggests, we can thank plants.

"This highlights the need to identify and protect ecosystems where the [carbon sink](#) is growing rapidly," says Trevor Keenan, a research scientist in Berkeley Lab's Climate & Ecosystem Sciences Division and the corresponding author of the paper.

The scientists attribute the stalled CO₂ growth rate to an uptick in land-based photosynthetic activity, fueled by rising CO₂ levels from fossil fuel emissions. It's a snowball effect: as CO₂ levels rise in the atmosphere, photosynthetic activity flourishes and plants take in more carbon, sparking more plant growth, more photosynthesis, and more carbon uptake.

They also identified another player. Plant respiration, a process in which plants use oxygen and produce CO₂, did not increase as quickly as photosynthesis in recent years. This is because plant respiration is sensitive to temperature, and it was affected by the recent slowdown in global warming that was observed most significantly over vegetated land. So, between 2002 and 2014, plants took in more CO₂ through photosynthesis, but did not "exhale" more CO₂ into the atmosphere through respiration.

"These changes decreased the amount of anthropogenic CO₂ that stays in the atmosphere, and thus slowed the accumulation of atmospheric CO₂," says Keenan.

Their findings provide a possible answer to a climatic mystery. The growth rate of atmospheric CO₂ climbed steadily during the latter half of the 20th century, from 0.75 ppm/year in 1959 to 1.86 ppm/year in 2002. But Keenan and colleagues discovered an inflection point last year when they analyzed the latest data from the Global Carbon Project, which quantifies carbon emissions and their sources annually. Since 2002, the growth rate has remained flat.

This pause is especially surprising because it has occurred as human activity pumps more and more carbon into the atmosphere. All that CO₂ must be going somewhere, so the scientists suspected something about the carbon cycle has recently changed in a big way.

"We believed one of the planet's main carbon sinks had unexpectedly strengthened. The question was: which one?" says Keenan.

The scientists ruled out oceans as a dominant cause because most computer models agree the amount of carbon taken in by oceans has increased steadily in recent years. That left terrestrial ecosystems, which undergo a large year-to-year variability in carbon uptake, and the two biggest influences on this variability are photosynthesis and plant respiration.

To study these influences, the scientists used ten "global dynamic vegetation models" that predict how the terrestrial carbon cycle changes over time.

They also used a model that incorporates satellite measurements of vegetation cover and plant activity to predict global photosynthesis and respiration rates. They validated the model by comparing its results with data from AmeriFlux and FLUXNET, which are networks of eddy-covariance research towers that measure ecosystem carbon, water, and energy fluxes in North and South America. Berkeley Lab manages AmeriFlux for the Department of Energy.

Model projections were generated using different scenarios of atmospheric CO₂ level, temperature, soil moisture, and other processes. This enabled the researchers to evaluate the impacts of these

processes on the planet's terrestrial carbon cycle.

Taken together, the models zeroed in on rising CO₂ levels as having the biggest impact on photosynthesis and plant respiration. The result is a boost in terrestrial carbon uptake, particularly in tropical and high-latitude ecosystems. Specifically, the models suggest rising CO₂ levels caused terrestrial ecosystems to double the rate at which they take in carbon, from between one and two petagrams of carbon per year in the 1950s, to between two and four petagrams of carbon per year in the 2000s. For comparison, human activity emits between nine and ten petagrams of carbon per year (one petagram is one trillion kilograms).

The scientists conclude this increase in carbon uptake put the brakes on the growth rate of atmospheric CO₂ between 2002 and 2014.

"Unfortunately, this increase is nowhere near enough to stop climate change," says Keenan, adding that their results answer questions and pose new ones. "We've shown the increase in terrestrial carbon uptake is happening, and with a plausible explanation why. But we don't know exactly where the carbon sink is increasing the most, how long this increase will last, or what it means for the future of Earth's climate."

Provided by Lawrence Berkeley National Laboratory

APA citation: Carbon-hungry plants impede growth rate of atmospheric CO₂ (2016, November 8)
retrieved 17 April 2021 from
<https://phys.org/news/2016-11-carbon-hungry-impede-growth-atmospheric-co2.html>

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