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Study recalibrates trees' carbon uptake

Finding, based on using heavy oxygen as a photosynthetic yardstick, could alter climate projections.

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ENLARGE

IF TREES INHALE FASTER . . .

Apparent earlier underestimate of how quickly trees and other plants take in carbon for photosynthesis could have climate implications.

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Photosynthesis appears to be somewhat speedier than conventional wisdom had suggested, a new study finds. If true, this could mean that computer projections are at risk of overestimating the potential for forests to sop up carbon dioxide, a major greenhouse gas.

The new study did not measure photosynthesis directly. It instead deduced photosynthetic rates from subtle variations in the molecular weight of carbon dioxide molecules in air. Samples had been collected from across the globe during a 30 year period.

Some CO_2 molecules tip the scales more than usual because one of their oxygen atoms has a molecular weight of 18, not 16. (The heavies pack an extra pair of neutrons.) The likelihood that an oxygen atom in CO_2 will be an O^{18} will depend on the proportion of heavy oxygen in a region's water, explains biogeochemist Lisa Welp of the Scripps Institution of Oceanography in La Jolla, Calif. That ratio can vary by soil moisture and weather conditions, she explains.

As plants breathe CO_2 into their leaves, that CO_2 will exchange its oxygen atoms with those in water, Welp notes. A substantial amount of that CO_2 will eventually be released back into the air, now bearing an O^{18}-to-O^{16} ratio reflective of the plant's water.

In the September 29 *Nature*, Welp — and colleagues on three continents — report finding a subtle change in the proportion of CO_2 molecules hosting heavy oxygen. This anomaly appeared to start in the tropics and then quickly spread across the planet. The pattern then repeats, almost in waves.

Each wave lasted about 18 months. And the start of a new wave every four years or so generally coincided with the emergence of a prolonged spell of unusually warm ocean temperatures in the Equatorial Pacific — a climatic event known as an El Niño. Explains Welp, "We find that water's oxygen isotopes get heavier during El Niños in the tropics."
Using the average ratio of heavy-to-normal oxygen in CO_2 (linked to an El Nino event that could be timed), Welp's group now had a means to evaluate how long it takes plants to transfer an anomalous oxygen signature into atmospheric CO_2 — and then wash it away again once an El Niño ended. With this information, the researchers attempted to validate a fairly well accepted estimate of the global rate of carbon taken up by photosynthesis in plants each year —120 petagrams (peta being 10^{15}).

Their assessment found the 120-petagram figure looked short — by about 25 to 45 percent. As to how such a revision in the rate of carbon cycling through plants might alter estimates of future long-term carbon sequestration by forests, Welp emphasizes: "We don't know yet. It's way too early to tell."

But Matthias Cuntz, a biogeochemist with the UFZ-Helmholtz Centre for Environmental Research in Leipzig, Germany, argues that in fact, carbon-storage implications of the new numbers are not that hard to fathom.

The global value for carbon sequestered long term in plant tissue each year is fairly well established at about 1.6 billion tons, he says. That's almost 2 percent of the 120 petagram estimate. So if the carbon throughput is revised upward by 25 to 45 percent, then the amount of carbon being sequestered long term must be substantially less than 2 percent, Cuntz says – perhaps "only about 1 percent."

In a commentary accompanying the new *Nature* paper, Cuntz likens the old 120-petagram figure to a "gold standard" for the annual rate at which land plants take in carbon for photosynthesis. If Welp's team is right, he now argues, it has just put "a dent" in that gold standard.

The new estimates in the *Nature* paper do, however, rest on a lot of assumptions – albeit smart ones, Cuntz explains in his commentary. So the rather unexpected result that Welp and her colleagues report will certainly need confirmation.

But if the new numbers hold up, he told me, it could mean that current computer climate models rely on overly optimistic estimates about how efficiently trees can sequester carbon. “If you change photosynthesis a little, like this,” he says, “it could lead to huge differences [in projections of how climate might change in the future].”

Indeed, it would argue that reining in global warming will prove much harder than biologists had led us to expect.

SUGGESTED READING :

S. Perkins. Worldwide slowdown in plant carbon uptake. Science News online, August 19, 2010. Available online:

S. Perkins. Falling behind: North American terrain absorbs carbon dioxide too slowly. Science News, Vol. 172, December 1, 2007, p. 341. Available online:

S. Perkins. Can banking carbon cool the greenhouse? Stockpiling carbon dioxide in plants and soil may be effective only for the short term, if at all. Science News, Vol. 158, December 16, 2000, p. 396. Available online:

CITATIONS & REFERENCES :

L.R. Welp, et al. Interannual variability in the oxygen isotopes of atmospheric CO2. Nature, Vol. 477, September 29, 2011, p. 579. doi: 10.1038/nature10421Abstract:

National Oceanic and Atmospheric Administration. What is an El Niño?