The global land surface may absorb less carbon dioxide than previously thought

UC Irvine researchers develop a new carbon budget with a weaker land sink.
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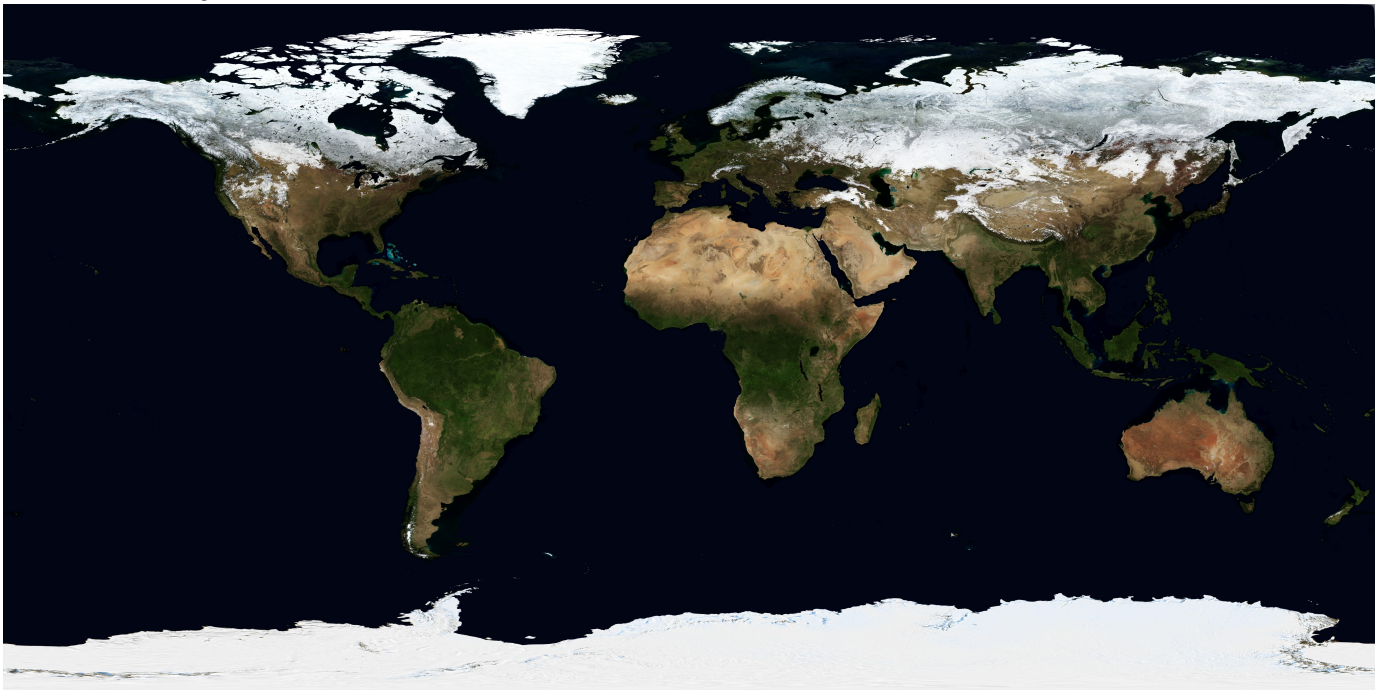

The findings stand to dramatically reshape the way scientists understand where human-emitted carbon dioxide truly goes.

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NASA

Research Spotlight

Human activities release vast amounts of carbon dioxide (CO_2) into the atmosphere, but scientists are still working to pin down exactly where all of it goes. While the amount that remains in the air and dissolves into the oceans is relatively well

understood, the role of land ecosystems has been far more challenging to quantify.

In a new study published in *Science Advances*, a team led by researchers from the University of California, Irvine, analyzed multiple datasets of vegetation biomass and found that land absorbs much less carbon than reported in previous assessments by the Intergovernmental Panel on Climate Change (IPCC) and others. Earlier estimates suggested that plants took up about 1.6 petagrams of CO_2 annually over the past two decades, while the team's analysis indicates that the actual value of this carbon sink is only about half that amount.

One of the main challenges has been measuring global plant biomass and tracking how it changes from year to year. According to UC Irvine Professor James Randerson, lead author of the study, recent breakthroughs in satellite remote sensing and machine learning now make it possible to measure these changes with far greater accuracy.

"In the past, the land's role in the carbon budget was often calculated indirectly," Randerson said. "Now, advances in remote sensing and machine learning provide us with a way to measure much of it directly."

To develop a balanced global carbon budget with a weaker land sink, the authors propose adjustments to other components of the system. Their analysis indicates that oceans likely absorb about 8% more carbon than previously reported, while fossil fuel emissions are about 6% lower than earlier estimates. With these revisions, the new budget aligns with the satellite-based measurements of plant biomass more closely with independent, long-standing constraints on the carbon cycle, including trends in atmospheric oxygen and the distribution of atmospheric CO_2 between the Northern and Southern Hemispheres.

"If there is a small amount of 'ghost carbon' in the system from overreporting of fossil fuel emissions, it has likely inflated estimates of the land sink in previous work that relied on estimating this term by difference," said Randerson.

The authors note that while national fossil fuel reporting is generally reliable and largely free from political influence, past pressures to project strong economic growth may have introduced a slight positive bias in global emissions estimates.

"Key takeaways from the study are the need for greater rigor in fossil fuel accounting and the importance of advancing independent, satellite-based methods

to track changes in land carbon," Randerson said.

Citation: James T. Randerson *et al.*, The weak land carbon sink hypothesis. *Sci. Adv.* 11, eadr5489 (2025). DOI:10.1126/sciadv.adr5489

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