How two scientists are balancing the planet's natural carbon budget

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An expansive view of Colorado’s East River watershed. Credit: Brian Saccardi

A pair of researchers at the University of Massachusetts Amherst recently published the results of a study that is the first to take a process-based modeling approach to understand how much CO_2 rivers and streams contribute to the atmosphere. The team focused on the East River watershed in Colorado's Rocky Mountains, and found that their new approach is far more accurate than traditional approaches, which overestimated CO_2 emissions by up to a factor of 12. An early online version of the research was recently published by *Global Biogeochemical Cycles.*

Scientists refer to the total CO_2 circulating through the earth and the atmosphere as the carbon budget. This budget includes both anthropogenic sources of CO_2, such as those that come from burning fossil fuels, as well as more natural sources of CO_2 that are part of the planet's regular carbon cycle. "In the era of global climate change," says Brian Saccardi, graduate student in geosciences at UMass Amherst and lead author of the new research, "we need to know what the baseline levels of CO_2 are, where they come from and how those physical process of carbon emission work." Without such a baseline, it makes it difficult to know how the earth is changing as CO_2 levels increase.

Streams and rivers are one of the many venues that naturally emit CO_2—scientists have long known this, but it's been a very difficult number to pin down. In part, this is because CO_2 emissions fluctuate rapidly and it has proved impracticable to physically monitor all of the earth's river networks. And so scientists typically rely on statistical models to estimate how much CO_2 streams and rivers emit. The problem, Saccardi explains, is that the models don't account for the full complexity of how CO_2 moves from groundwater into the stream or river, what happens to it once there and how much gets emitted to the atmosphere.

"This is the first time we're accounting for the physical processes themselves," says Matthew Winnick, professor of geosciences at UMass Amherst and the paper's co-author. "We need to know how each step of the movement of CO_2 works, so we know how they will react to climate change."

Saccardi and Winnick designed, tested and validated a "process-based" model that relies on the laws of physics as well as empirical measurements to arrive at its estimates. The pair took 121 measurements of streams in the remote East River watershed in Colorado, against which they could test their new model. And the results were clear: According to the research, their model is far more accurate than the standard approaches.

Though Saccardi and Winnick are quick to point out that their conclusions apply to the East River watershed only, they have future plans to apply their process-based model more widely and suspect that their new method may help to radically reevaluate the earth's natural carbon budget.

More information: Brian Saccardi et al, Improving Predictions of Stream CO 2 Concentrations and Fluxes using a Stream Network Model: a Case Study in the East River Watershed, CO, USA, *Global Biogeochemical Cycles* (2021). DOI: 10.1029/2021GB006972

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