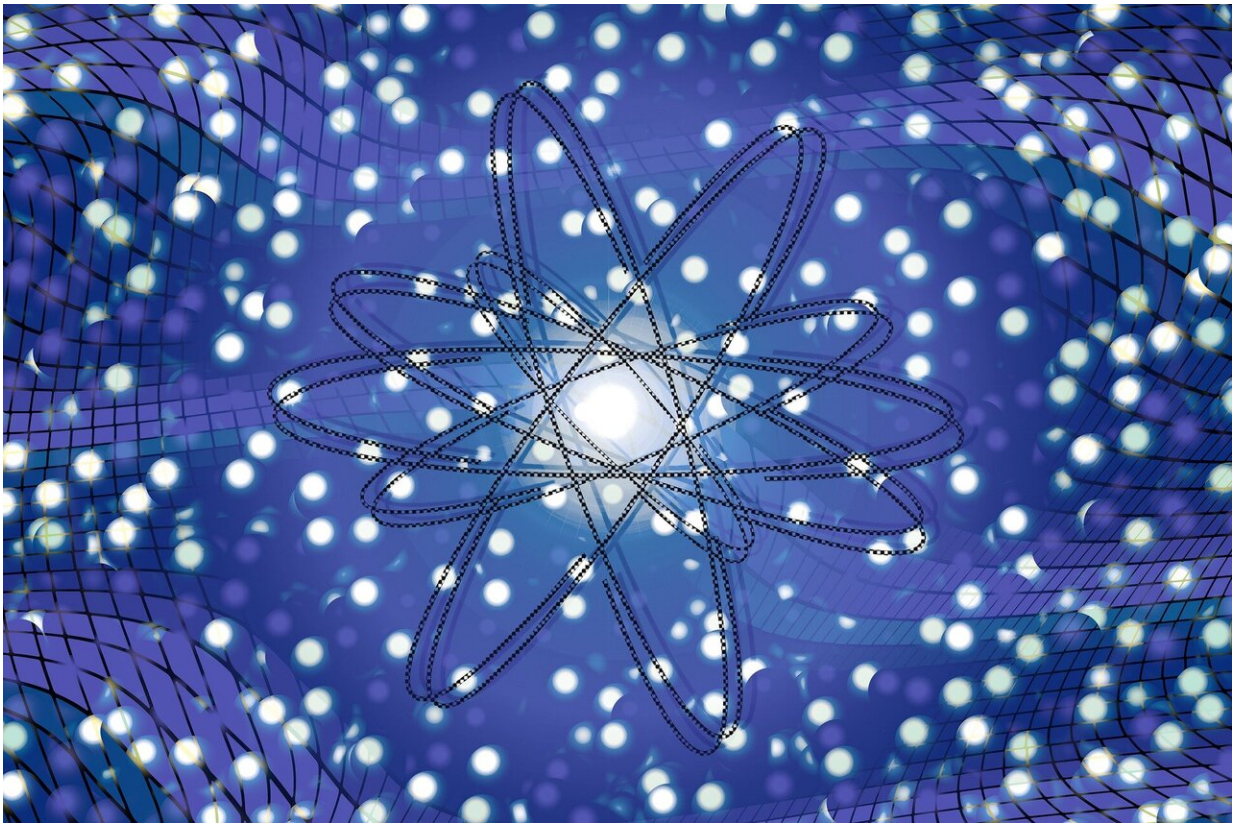


Framework to trace the path of individual carbon atoms

November 3 2020, by Anne M Stark



Credit: CC0 Public Domain

Like water molecules in a river, soil carbon atoms are always in motion.

To better understand this action, Lawrence Livermore National

Laboratory (LLNL) scientists and collaborators have created a new conceptual framework as well as a simulation model that traces the path of individual [carbon](#) atoms as they interact with the environment—undergoing biochemical transformations, moving through the [soil](#) pore space and progressing toward their final fate—[carbon dioxide](#) (CO₂). The research appears in the journal *Global Change Biology*.

Soils store more carbon than the atmosphere and biosphere combined and the balance between soil [organic carbon](#) (SOC) formation and loss will drive powerful carbon climate feedbacks over the coming century.

The most common approach to predict SOC dynamics use pool-based models, which assume classes of SOC with internally homogeneous physical and chemical properties. But new evidence shows that soil carbon turnover is not dominantly controlled by the chemistry of carbon inputs, but by how it moves through its spatially and temporally heterogeneous environment.

The new framework, called Probabilistic Representation of Organic Matter Interactions within the Soil Environment (PROMISE), uses process-based, probabilistic approaches focused on carbon flow and dynamic transformations, "fluxes" as opposed to discrete pools.

Climate change results from a disturbance of the global carbon cycle, and soils play a pivotal role in regulating the Earth's climate system. Soils are a huge reservoir—but are under threat—due to intensifying agriculture, permafrost thaw, atmospheric warming, etc.

"In reality, SOC exists in a state of constant flux with new inputs of plant-derived carbon offset by continuous SOC losses through decomposition," said LLNL scientist Jennifer Pett-Ridge, a co-author of the paper. "Even small shifts in the magnitudes of these changes impact

the strength of the terrestrial carbon sink. We need to shift soil management toward approaches that conserve the carbon we have, add more, and ideally slow down the processes that lead to SOC loss."

The PROMISE concept considers how SOC cycling rates are governed by the random processes that influence the proximity between microbial decomposers and organic matter, with emphasis on their physical location in the soil matrix. The team showed how the application of this new model traces the fate of individual carbon atoms as they interact with their environment, undergoing biochemical transformations and moving through the soil pore space.

"We think of carbon as always being in motion, like [water molecules](#) in a river. Sometimes they get stuck (like in an eddy at the edge of a river), but eventually they dislodge and move on toward their final fate—mineralization to CO₂," Pett-Ridge said. "In our [simulation model](#), we can trace the fate of individual carbon atoms as they interact with their environment—like a particle moving down a river, getting stuck and then released back into the main flow—in a dynamic continuum."

The PROMISE framework reshapes the dialogue around issues related to SOC management in a fluctuating world. The team said they want the framework to spur the development of new analytical tools and model structures across disciplines—including soil ecologists, biogeochemists, ecosystem modelers and mathematical biologists—that will illuminate physical controls on the flow of carbon between plant, soil and atmospheric pools.

"Ecosystems function because energy transfer does not stand still," Pett-Ridge said. "By grappling with the dynamic nature of soil carbon, we can more effectively manage this critical resource in a changing world."

More information: Bonnie G. Waring et al. From pools to flow: The

PROMISE framework for new insights on soil carbon cycling in a changing world, *Global Change Biology* (2020). [DOI: 10.1111/gcb.15365](https://doi.org/10.1111/gcb.15365)

Provided by Lawrence Livermore National Laboratory

Citation: Framework to trace the path of individual carbon atoms (2020, November 3) retrieved 7 May 2024 from <https://phys.org/news/2020-11-framework-path-individual-carbon-atoms.html>

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.