ORNL researchers improve soil carbon cycling models

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A new carbon cycling model developed at the U.S. Department of Energy's (DOE) Oak Ridge National Laboratory better accounts for the carbon dioxide-releasing activity of microbes in the ground, improving scientists' understanding of the role soil will play in future climate change.

Predicting climate change depends heavily on the cycling of carbon dioxide, which is found in four main reservoirs: the atmosphere, biosphere, oceans and soil. ORNL's model was designed to replace traditional soil carbon cycling models.

"Soil is a big reservoir of carbon," said co-author Melanie Mayes of ORNL's Environmental Sciences Division. "And most of the soil carbon cycling models in use today are so vastly simplified that they ignore the fact that decomposition is actually performed by microbes."

In a paper published in Ecological Applications, the journal of the Ecological Society of America, ORNL researchers integrated data from scientific literature on carbon degradation in soil to form the Microbial-Enzyme-mediated Decomposition, or MEND, model that improves upon previous models.

"Our MEND model does a better job of representing the mechanisms of soil carbon decomposition than existing models," Mayes said.

ORNL's comprehensive model accounts for how the different forms of

carbon in soil, or "pools," react with extracellular enzymes excreted into the soil by microbes, allowing scientists to understand how quickly carbon is moving through soils.

The model simulates the carbon cycle, beginning after a decaying plant or animal releases carbon-rich materials into the soil. The organic material is degraded by enzymatic reactions, releasing dissolved carbon molecules that can be absorbed by microbes for growth or metabolism. These processes ultimately result in the release of carbon dioxide.

ORNL's MEND model is the first model able to track degradation by accounting for most of the relevant processes and by estimating the parameters based on a comprehensive literature review. This model, which is based on the physiological functions of microbes, accounts for how temperature affects the ability of microbes to emit carbon dioxide. Soil can either store or release carbon depending on how rapidly carbon-rich materials in the soil are decomposed.

"What we think will happen is that as temperature goes up, microbial physiology will change, altering their ability to break down carbon chains and release carbon dioxide into the atmosphere," Mayes said. "If our models don't account for this process, then our ability to predict future climate change will be less realistic."

For the next six to eight months, ORNL's team will run laboratory-scale experiments to ensure that the MEND model accurately represents the decomposition of carbon compounds in soils. Eventually, team members hope to incorporate their model into the publicly available supercomputing program called the Community Land Model, a module used in the Community Earth System Model that helps researchers predict future climate change.