Study helps assess impact of temperature on belowground soil decomposition

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The Earth's soils store four times more carbon than the atmosphere and small changes in soil carbon storage can have a big effect on atmospheric greenhouse gas concentrations. A new paper in the journal *Nature Climate Change* concludes that climate warming does not accelerate soil organic carbon decomposition or affect soil carbon storage, despite increases in ecosystem productivity.

The research, led by U.S. Forest Service Research Ecologist Dr. Christian Giardina, with the agency's Institute of Pacific Islands Forestry, Pacific Southwest Research Station, with co-authors Drs. Creighton Litton and Susan Crow (University of Hawai`i at Manoa), and Dr. Greg Asner (Carnegie Institution for Science), shows that soil carbon storage was constant across a highly constrained 5 degrees Celsius gradient of mean annual temperature in tropical montane wet forest in Hawai`i.

The scientists also showed an increase in productivity across the gradient, both above and belowground, and an increase in the decomposition rate of fresh litter and a decline in coarse woody debris with warming. From these results, they concluded that long-term warming in tropical montane forests will accelerate carbon cycling, but is unlikely to cause net losses of soil carbon.

"Given our findings, we expect that warming alone, that is in the absence of other changes such as drying or increased fire, will not accelerate the loss of carbon from mineral soils," says Giardina. "This means that tropical soils will not become a net source of CO2 to the atmosphere."

The effects of warming on soil carbon storage are poorly quantified because it is difficult to assess how temperature change impacts processes below the soil surface. However, the temperature gradient used in this study provides an ideal study system for measuring ecosystem responses to warming over long periods of time. The scientists were careful to find a gradient of temperature change where potentially confounding factors were held constant, including vegetation composition, disturbance history, geology, and soil type and moisture. This allowed them to isolate the effects of changing temperature on ecosystem carbon storage and flux.

The scientists propose that where ecosystem carbon is unprotected, such

as at the surface in plant debris, its decomposition and storage will respond strongly to warming. However, when carbon is protected in the soil, decomposer organisms have reduced access to that carbon and so decomposition or storage show little temperature sensitivity. And while climate warming will continue with the addition of greenhouse gases into the atmosphere due to human activities (fossil fuel combustion, land-use clearing), previous assumptions about a positive soil carbon cycling feedback to future warming may be incorrect.

While soil carbon storage and turnover was insensitive to warming, the decomposition of coarse wood and plant growth did increase, which means that the capacity of tropical ecosystems to retain carbon will depend on the balance of changes within each ecosystem.

More information: Giardina, Christian P.; Litton, Creighton M.; Crow, Susan E.; Asner Gregory P. 2014. Warming-related increases in soil CO2 efflux are explained by increased below-ground carbon flux. *Nature Climate Change* 4, 822–827.
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