Ecosystems around the globe breathe differently in response to rising temperatures

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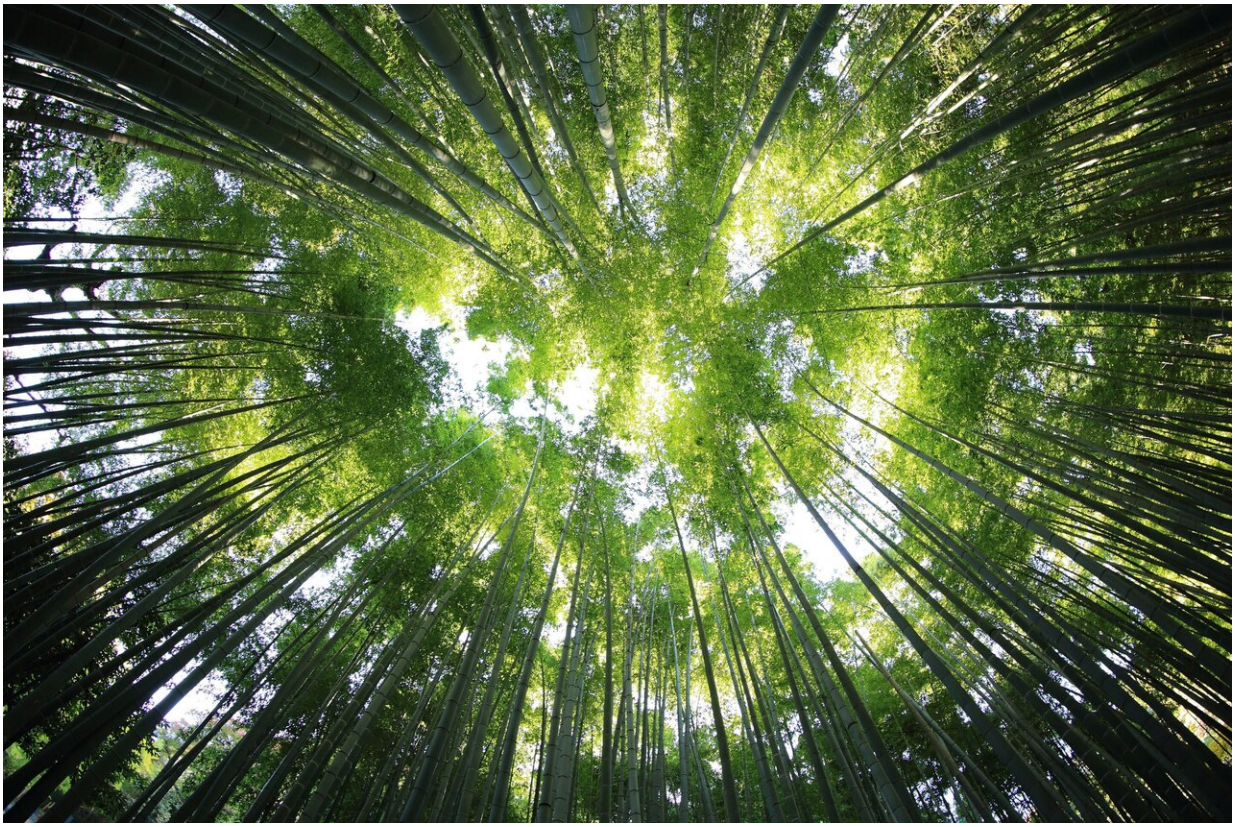

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Land stores vast amounts of carbon, but a new study led by Cranfield University's Dr. Alice Johnston suggests that how much of this carbon enters the atmosphere as temperatures rise depends on how far that land

sits from the equator.

Ecosystems on land are made up of plants, soils, animals, and microbes—all growing, reproducing, dying, and breathing in a common currency; carbon. And how much of that carbon is breathed out (also known as ecosystem respiration) compared to how much is stored (through primary production) has impacts for climate change.

A key concern is that if more carbon is respired than stored, the rate of climate change could accelerate even further. Yet, some big assumptions are made in the models used to predict climate changes—that ecosystem respiration rises with temperature at the same rate (doubles for a temperature rise of 10 °C) irrespective of the ecosystem itself. A new study "Temperature thresholds to ecosystem respiration at a global scale" published in *Nature Ecology & Evolution* from an international group of scientists led by Dr. Alice Johnston at Cranfield University and Professor Chris Venditti at University of Reading, however, suggests there are two major 'thresholds' to this relationship.

The study, funded by the Leverhulme Trust, shows that ecosystem respiration doesn't rise as strongly with temperature in warmer (Mediterranean and tropical) climates compared to mild (temperate) climates but shows an extreme rise with temperature in cold (boreal and tundra) climates. This finding contradicts several studies showing a static temperature-respiration relationship globally but agrees with observations made within different ecosystems.

First author Dr. Alice Johnston, Lecturer in Environmental Data Science at Cranfield University, said: "Ecosystems are extremely complex, and there is massive variation in how many and what type of plants, animals and microbes are present in one field compared to the next let alone across global ecosystems. Given those shifting patterns in biodiversity we would expect changes in how ecosystem respiration responds to

temperature because different species exhibit different temperature sensitivities. Our study is very simple and doesn't capture all of that variation, but it does capture three distinct differences in the ecosystem respiration pattern across 210 globally distributed sites.

"Fundamentally, our results show that temperature has a weak effect on ecosystem respiration in Mediterranean and tropical ecosystems, a well understood effect in temperate ecosystems, and an outsized effect in boreal and tundra ecosystems. On the one hand, that's a concern because huge stores of carbon in cold climates could be released with rising temperatures. On the other hand, if CO_2 fertilization in tropical regions promote primary production and rising temperatures inhibit ecosystem respiration, warmer climates could become an even more important carbon sink. Regardless, this study really indicates that we need to better understand the causes of these thresholds and the vital role that biodiversity loss could be playing. That would not only improve climate change forecasts, but further incentivise conservation efforts."

Professor Chris Venditti, Professor of Evolutionary Biology at University of Reading, added: "The impact of plant diversity on the terrestrial carbon cycle is far better known than animal diversity. In the future, we need to focus our attention on identifying general but realistic ways to integrate whole community complexity into climate models. That way, we can determine biodiversity loss or gain tipping points beyond which biosphere carbon sinks are enhanced or diminished."

More information: Alice S. A. Johnston et al. Temperature thresholds of ecosystem respiration at a global scale, *Nature Ecology & Evolution* (2021). DOI: 10.1038/s41559-021-01398-z

Provided by Cranfield University