Drought stress found to alter the function of rainforest soil

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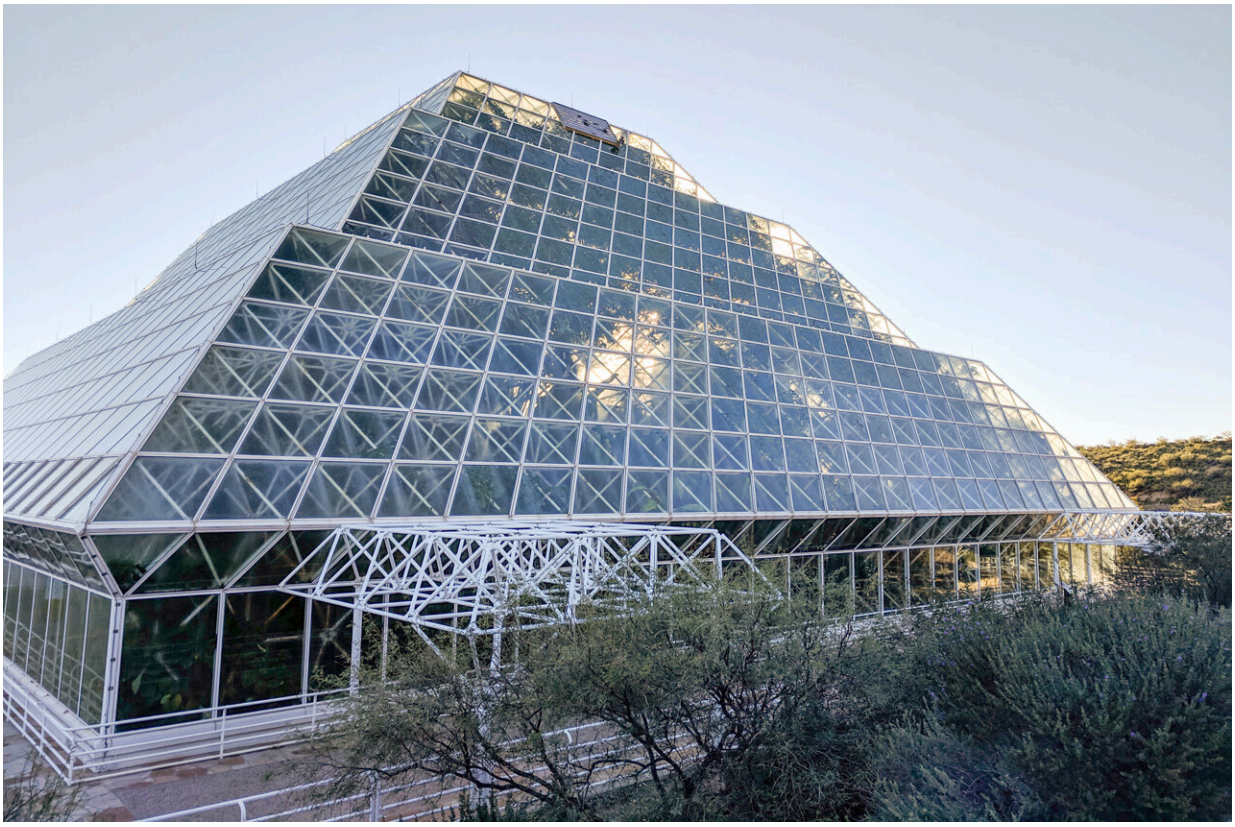

Outside view of the experimental rainforest of the Biosphere 2 in Oracle, Arizona. Credit: Laura Meredith

Prolonged drought has a significant impact on the extent to which rainforest soils can emit and consume biogenic volatile organic

compounds (VOCs). This was the finding of an international research team, including scientists from University of Freiburg and Max Planck Institute for Chemistry in Mainz, Germany, who studied the effects of drought and rewetting on soil VOC fluxes.

The associated measurement campaign was conducted from September 2019 to January 2020 at the U.S. research facility of the Biosphere 2. It was part of the project B2WALD (Biosphere 2 Water Atmosphere and Life Dynamics). B2WALD is led by Prof. Dr. Christiane Werner, Professor of Ecosystem Physiology at the University of Freiburg, and Dr. Laura Meredith, Director of the Biosphere 2 Research Center and Assistant Professor at the School of Natural Resources and the Environment at the University of Arizona in the U.S.

The soil VOC fluxes measurements were conducted by scientists from the Max Planck Institute for Chemistry, led by VOC group leader Prof. Dr. Jonathan Williams. The latest results were recently published in the journal *Nature Communications*.

Behavior of soil microbes is crucial

"The data evaluated suggests that prolonged drought stress progressively reduces the capacity of the soil to consume atmospheric VOCs and, at same time, the soil starts to be a source of VOCs. We were able to identify a soil moisture content of 19% as a critical threshold below which this shift in soil behavior occurs," says the first author Dr. Giovanni Pugliese. Position-specific 13C-pyruvate labeling experiments in the experimental rainforest attribute the effects to the activity of soil microbes, which, under drought conditions, produce decisively more atmospheric VOCs than they consume.

In response to soil rewetting after a prolonged drought period, the emission of some VOCs actually intensify. "Our measurements have

demonstrated that soil rewetting induce a rapid, albeit brief, abiotic emission peak of carbonyl compounds and a slow, but more persistent biotic emission peak of sulfur-containing compounds," Pugliese says.

Climate impacts: Observation of soil VOC fluxes enable more reliable future predictions

The measurement campaign in the experimental rainforest, which lasted several months, collected data around the clock under carefully controlled environmental conditions. The analysis of the data was able to show clear interactions between drought-impacted environmental factors and soil VOC fluxes. Particularly with regard to climate impacts such as heat and drought, it illustrates the relevance of understanding these relationships.

Williams says, "We now know that drought stress can profoundly affect the behavior of VOC fluxes to and from soil. Since current climate models predict that the Amazon rainforest region will suffer more frequent and prolonged droughts in future, we need to incorporate these newfound soil effects into atmospheric models to improve ecosystem response predictions, and simulations of future regional atmospheric chemistry and climate."

More information: Giovanni Pugliese et al, Effects of drought and recovery on soil volatile organic compound fluxes in an experimental rainforest, *Nature Communications* (2023). DOI: 10.1038/s41467-023-40661-8

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