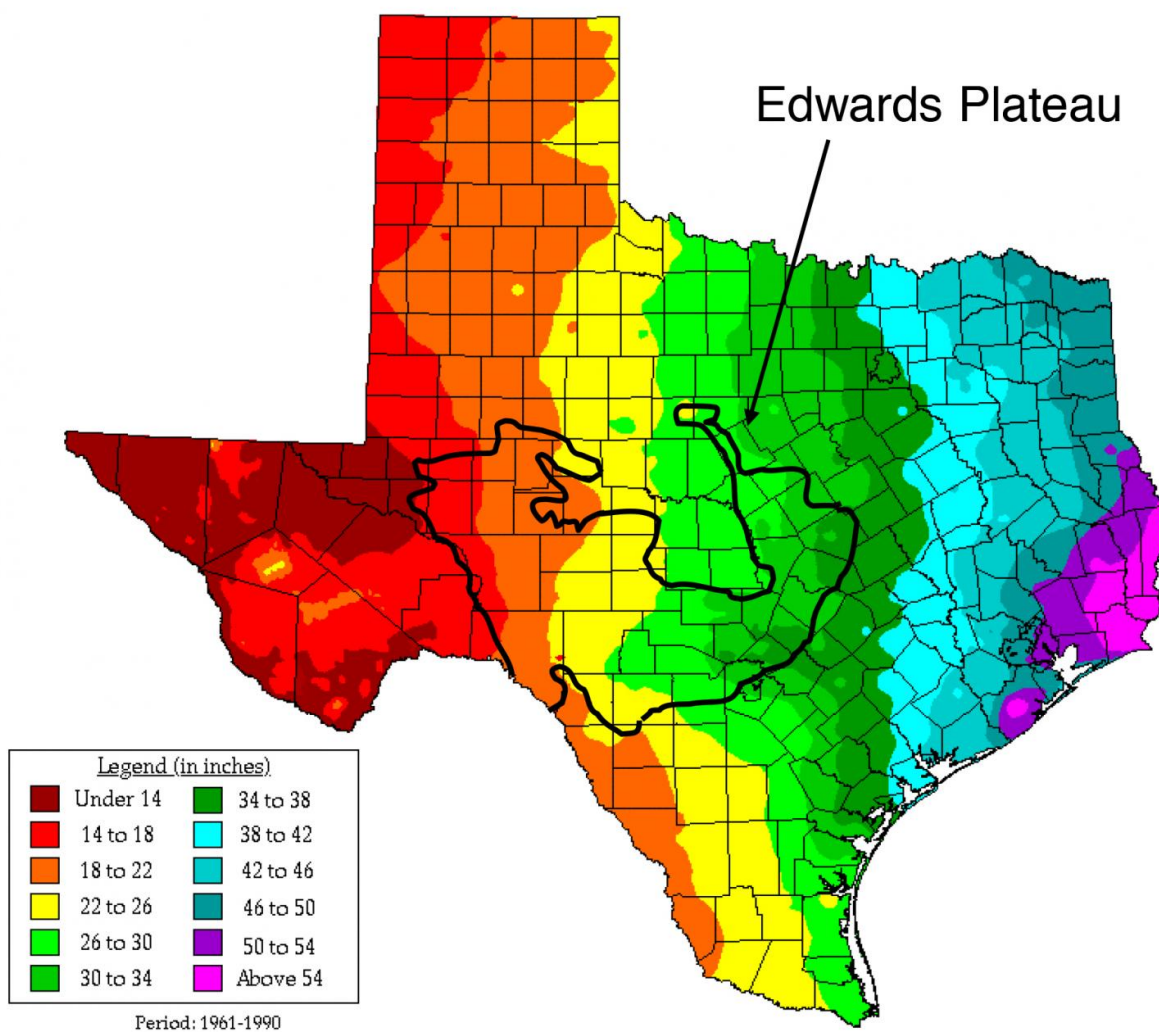


Historical rainfall levels are significant in carbon emissions from soil

May 29 2017



Researchers sampled soil at various locations along the Edwards Plateau in Texas to determine the effects of historic rainfall on soil respiration from microbes.

Microbes living in the dark green region had historic rainfall of 34-38 inches between 1961 and 1990, whereas those in the dark red region experienced under 14 inches of rain in the same period. Microbes from the wettest emit two times as much carbon as those from the driest areas. Credit: Mapping performed by Jenny Weisburg.

Scientists have known that microbes living in the ground can play a major role in producing atmospheric carbon that can accelerate climate change, but now researchers from The University of Texas at Austin have discovered that soil microbes from historically wetter sites are more sensitive to moisture and emit significantly more carbon than microbes from historically drier regions. The findings, reported today in the *Proceedings of the National Academy of Sciences*, point the way toward more accurate climate modeling and improve scientists' understanding of distinct regional differences in microbial life.

Microbes in the [soil](#) add between 44 billion and 77 billion tons of carbon to the atmosphere each year—more than all fossil fuels combined—through a process called respiration. As the planet warms, soil respiration is expected to increase, but forecasters have had trouble accurately pinpointing by how much. The new research indicates that to do a better job of predicting changes in soil respiration, forecasters need to pay attention not only to climate change but also to climate history, as [microbes](#) respond differently to shifts in their environment in wetter versus drier areas.

In regions with more rainfall historically, [soil microbes](#) were found to respire twice as much carbon to the atmosphere as microbes from drier regions. Scientists determined that this was because the microbes responded differently to change: Those from the wettest areas were four times as sensitive to shifts in moisture as their counterparts from the

driest areas.

"Current models assume that soil microbes at any site around the world exhibit the same responses to environmental change and do so instantaneously," says Christine Hawkes, a professor of integrative biology, "but we demonstrated that historical rainfall shapes the soil respiration response."

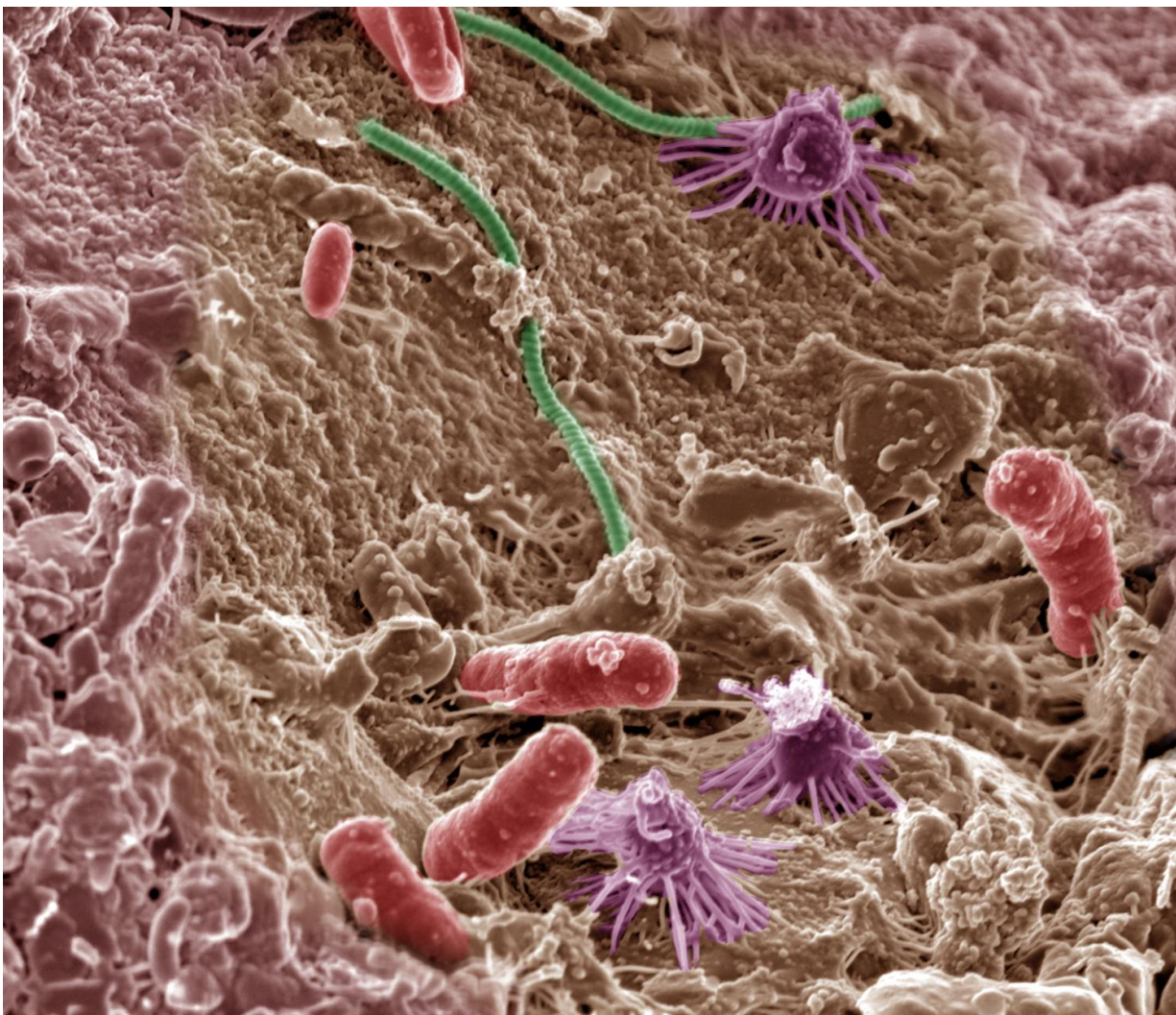


Researcher Stephanie Kivlin cores in soil plots at the Lady Bird Johnson Wildflower Center in conjunction with one of three experiments over six years that found the amount of carbon that soil microbes emit is higher in areas where there is historically more rainfall in the soil. Credit: Christine Hawkes, The University of Texas at Austin

It is unclear whether the insight into how soil microbes respond to moisture would drastically change the results of worldwide climate modeling efforts, which, so far, have taken different approaches to estimating how soil respiration responds to moisture. Incorporating the new discovery into ecosystem models, however, could help improve predictions based on local or regional differences in [soil respiration](#) and climate history.

Hawkes and the team conducted three long-term studies involving field research and lab experiments occurring over six years. In each case, the finding was the same: Historical rainfall levels proved critical for how soil microbes would respond to change, affecting the outcome just as temperature does.

"You've heard of the crisis of replication? Well, we tested this three different ways, and we couldn't get the soils to do anything different," Hawkes says. "This suggests that rainfall legacies will constrain future soil function, but we need further study to figure out by how much and for how long."



Microbes in the soil emit billions of tons of carbon into the atmosphere each year. A new study from The University of Texas at Austin finds that some microbes produce more atmospheric carbon than others, and that historic rainfall levels drive these microbes' response. Credit: Pacific Northwest National Laboratory

The research also highlights previously unknown nuances about the communities of microbes living under ground. Simple and microscopic, microbes nonetheless possess distinctive traits. Through decomposition

and [respiration](#), soil microbes affect the balance between carbon trapped under ground and emitted into the atmosphere, and this balance is not the same from one regional community to the next, the UT Austin researchers learned. They examined soil collected at various spots in Texas along the Edwards Plateau and found that microbes from the driest soil samples (living in areas with one-quarter as much water as the microbes from the wettest soils) responded with a fraction of the carbon emissions their wet-soil cousins produced. These differences persisted regardless of other soil characteristics.

"Because microbes are small and enormously diverse, we have this idea that when the environment changes, microbes can rapidly move around or shift local abundances to track that environmental change," Hawkes said. "We discovered, however, that soil microbes and their functions are highly resistant to change. Resistance to [environmental change](#) matters because it means that previous local conditions will constrain how ecosystems function when faced with a shift in [climate](#)."

More information: Historical climate controls soil respiration responses to current soil moisture, *Proceedings of the National Academy of Sciences* (2017). www.pnas.org/cgi/doi/10.1073/pnas.1620811114

Provided by University of Texas at Austin

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