Poster #1-31

Coupled Long-Term Experiment and Model Investigation of The Differential Response of Plants and Soil Microbes in a Changing Permafrost Tundra Ecosystem

Edward A. G. Schuur[1*], Rosvel Bracho[2], Gerardo Celis[1], Kathryn G. Crummer[2], Chris Ebert[1], Jack Hutchings[3], Caitlin Pries[4], Marguerite Mauritz[1], Elaine Pegoraro[1], César Plaza[1], Susan Natali[5], Verity Salmon[6], Christina Schaedel[1], Meghan Taylor[1], Elizabeth Webb, Charlie Koven[7], and Yiqi Luo[1].

[1]Center for Ecosystem Science and Society, Northern Arizona University, Flagstaff, AZ
[2] School of Forest Resources and Conservation, University of Florida, Gainesville, FL
[3]Department of Geology, University of Florida, Gainesville, FL
[4]Dartmouth College, Hanover, NH
[5]Woods Hole Research Center, Falmouth, MA
[6]Environmental Sciences Division, Climate Change Science Institute, Oak Ridge National Laboratory, Oak Ridge, TN
[7]Climate Sciences Department, Climate and Ecosystem Sciences Division, Lawrence Berkeley National Laboratory, Berkeley, CA

Contact: ted.schuur@nau.edu

BER Program: TES
Project: University Award
Project Website: http://www2.nau.edu/schuurlab-p/CiPEHR.html

New estimates place 1330-1580 billion tons of soil carbon in the northern circumpolar permafrost zone, more than twice as much carbon than in the atmosphere. Understanding the magnitude, rate, and form of greenhouse gas release to the atmosphere is crucial for predicting the strength and timing of this carbon cycle feedback to a warming climate. Here we report results from an ecosystem warming manipulation where we increased air and soil temperature, and degraded the surface permafrost. We used snow fences coupled with spring snow removal to increase deep soil temperatures and thaw depth (soil warming) and open top chambers to increase growing season air temperatures (air warming). The soil warming treatment has successfully warmed soils by 2-3ºC in winter, has increased growing-season depth of ground thaw by up to 50%, and has degraded an increasing amount of surface permafrost each year of the project. We have subsequently manipulated the surface water table that together with warming influences air and deep soil temperatures, permafrost, and soil moisture conditions that are primary drivers of tundra ecosystem carbon balance across the Arctic landscape. Here we report measurements of long-term carbon dioxide and methane exchange as a metric of changes in ecosystem carbon storage. Overall, soil warming had a much stronger effect on carbon exchange than air warming, and the dynamics changed non-linearly over the course of the long- term experiment. Soil warming that degraded permafrost stimulated both gross primary productivity (GPP) and ecosystem respiration (ER) such that the system was initially a net sink of C in the growing season over the first five years of the experiment. In the second phase (6-9 years), ground subsidence as a result of thaw continued to increase soil moisture and saturate the soil. While permafrost thaw as a result of the manipulation continued to progress in these years, both GPP and ER became suppressed and resulted initially in neutral growing season C exchange, and eventually net C release (source). Soil warming has altered not only the rates of C exchange but also the form of C, as measurements have now documented an increase in CH_4emissions where soils are wetter as a result of permafrost degradation. Increased flux in combination with the higher global warming potential of CH_4 contributes to the overall climate impact of permafrost thaw. This dynamic is likely to change in the future as the permafrost table is driven deeper into the ground.