Poster #9-25

Resolving Conflicting Physical and Biochemical Feedbacks to Climate in Response to Long-Term Warming

Kristen M. DeAngelis,[1*], Xiao-Jun Allen Liu[1*], Grace Pold[1], Luiz A. Domeignoz-Horta[1], Bhoopesh Mishra[2], Kenneth M. Kemner[3], Serita D. Frey[4], and Jerry M. Melillo[5]

1 University of Massachusetts, Amherst, MA;
2 Illinois Institute of Technology, Chicago,, IL;
3 Argonne National Laboratory, Argonne, IL;
4 University of New Hampshire, Durham, NH;
5 Marine Biological Laboratory, Woods Hole, MA

Contact: deangelis@microbio.umass.edu

BER Program: TES
Project: University Award

Microorganisms regulate soil carbon (C) cycling, and several mechanisms mediate the warming effects on microbial physiology and climate feedbacks to the atmosphere. Microbial growth strategy, substrate complexity, and physical protection all contribute to microbial C processing and soil organic matter loss or stabilization. In a 27-year experiment at Harvard Forest, soils have been continuously heated 5ºC above ambient temperatures, with unheated plots as controls. Chronic warming reduced microbial C-use efficiency and mass-specific growth, while warming increased turnover rate in microaggregates (<250 μm) and macroaggregates (250-2000 μm) extracted from the top 10 cm of the mineral soil. Microbial efficiency declined with substrate complexity, consistent with previous results. C-use efficiency was more temperature sensitive in warmed soils, in microaggregates compared to macroaggregates, and with complex substrates. Warmed soil aggregates had reduced C and nitrogen content, enzyme production, and increased the proportion of mineral-associated organic matter. Structural equation modeling showed that soil warming regulated growth efficiency directly and indirectly by altering soil structure, substrate availability, and microbial physiology. Scanning Transmission X-ray Microscopy and X-ray Raman Scattering results show that physically protected C inside soil aggregates is not as weathered as inter-aggregate C budget. Analyses done with the trait-based model MIMICS (Microbial-Mineral Carbon Stabilization Model) suggest that long-term warming effects of soil C more closely resemble observed values when physical protection of soil organic matter is a function of microbial biomass and clay content, compared to clay content alone. Our findings show essential roles of the mechanism-related factors in mediating microbial thermal strategy and physiology in response to climate warming, suggesting the need to include these mechanisms in earth system models to improve predictions of soil C feedbacks to the climate system.