Modeling Climate Sensitivity of Above and Below Ground Processes at MOFLUX

Rose Z. Abramoff,[1]* Jeffrey D. Wood[2], Lianhong Gu,[1] Matt E. Craig,[1] Anthony P. Walker,[1] Melanie A. Mayes[1]

[1]Environmental Sciences Division & Climate Change Science Institute, Oak Ridge National Laboratory, Oak Ridge, TN;
[2]University of Missouri, Columbia, MO;

Contact: (abramoffrz@ornl.gov)
Project Lead Principal Investigator (PI): Paul J. Hanson
BER Program: ESS
Project: ORNL Terrestrial Ecosystem Science SFA
Project Website: https://tes-sfa.ornl.gov/

When considering belowground ecosystem responses to climate change, the soil is often treated as a monolith, i.e., considering root and soil microbial respiration together as the total soil respiration flux. However, plant roots and soil microorganisms represent fundamentally different components of belowground ecosystems with different potential sensitivities to drought, temperature extremes, and diurnal, seasonal, and inter-annual changes in productivity.

Together plant roots and soil microorganisms dominate ecosystem carbon (C) losses via respiration but are also responsible for soil C formation and stabilization. Therefore, the future balance of C that is allocated to and remains in soil depends on the relative climate sensitivity of plant productivity and belowground allocation, root respiration, and microbial respiration. We are exploring the climate sensitivity of belowground processes across multiple temporal scales (i.e., diurnal, seasonal, inter-annual), using long-term measurements from the Missouri Ozark AmeriFlux (MOFLUX) site. This heavily instrumented *Quercus-Carya* (oak-hickory) forest is located in the Ozark Border Region of Central Missouri, which experiences seasonal soil water deficits because of high precipitation variability, evapotranspiration, and vapor pressure deficit. The MOFLUX site has measured hourly soil respiration using 8 or 16 automated chambers since 2004, with a subset of chambers over plots where roots were excluded since 2017.

We are identifying quantitative frameworks to partition climate and plant allocation effects on autotrophic and heterotrophic respiration across temporal scales, including statistical and process-based models. The main objective is to decompose the real-time and time-lagged effects of photosynthesis, temperature, and soil moisture on belowground activity. We particularly aim to understand effects of seasonal drought on plant root and microbial activity by exploring mathematical relationships that reflect different hypotheses about the roles of matric potential, diffusion, and oxygen limitation. Modeling frameworks where the structure and key parameters are constrained using long-term measurements can be used to project C responses and their uncertainty to future climate.