Pore- to Core-Scale Research to Inform Ecosystem-Scale Soil C Biogeochemistry

VL Bailey, B Bond-Lamberty, C Liu

The spatial separation of soil organic carbon (SOC), microbes, and extracellular activity is an important mechanism of SOC protection in soils and is difficult to represent in predictive models at ecosystem scales. **Our overarching science objective is to develop the mechanistic understanding of how SOC in protected locations is metabolized as a result of pore-scale changes in its bioavailability, and to test that understanding using ecosystem models.** We address this objective by integrating modeling, observations, and experiments, using new tools to strengthen team collaboration, and increase transparency and reproducibility, and making our data openly available. Our research, based on experiments using intact and manipulated soil cores from hydrologically dynamic research sites in central Florida and interior Alaska, indicates that the physical protection of SOC breaks down when pedogenic soil structure deteriorates or pores connect hydrologically. Pore- and continuum-scale flow and reactive transport models have been developed to simulate the physical protection of SOC, to evaluate how pore-scale water saturation and hydrological connection in heterogeneous soils affect microbial respiration of SOC, and to establish macroscopic effective relationship between SOC respiration rate and moisture content in soils. Because the soil structural controls on these pore-scale mechanisms strongly correlate to soil texture, we are also evaluating the power of soil texture indicators in global databases for predicting carbon turnover and respiration at much larger scales. By linking experimental data and mechanism-based models with an analysis of ecosystem-scale models, we hope to inform new mechanistic models of C transformation and transport in soils, improve the predictive power of larger-scale models, and address important Terrestrial Ecosystem Science Program goals.