## Scaling from small-scale experiments to the Critical Zone to explain ecosystem patterns of soil organic C dynamics

Illumination of the mechanisms governing ecosystem-scale processes (equivalent to the scale of the critical zone, CZ) often requires controlled, mechanistic laboratory studies. However, scaling phenomena observed in small, reductionist systems up to the scale of the CZ in both space and time is challenging. For example, historically agricultural plots at the Calhoun CZ observatory likely experienced reduced inputs of organic matter (OM) deep within the profile for >150 y. Many of those same plots also experienced erosional loss of the original surface horizon. As a result, forests re-growing on former agricultural land are supported by previously deeper horizons whose OM stocks are small compared to soil profiles in intact, old-growth hardwood stands. Given the importance of soil OM mineralization for ecosystem productivity, these large-scale features of the landscape likely influence contemporary ecosystem function. However, the fundamental microbial mechanisms linking depth-related variation in soil OM characteristics to modern forest C balances remain unclear. We are working across scales to address these issues by conducting microcosm studies of isolated soil bacteria, mesocosm studies of soil organic matter (SOM) decay and mineralization, and ecosystem studies of altered soil profiles in both upland and lower landscape positions. Using stoichiometric characteristics of eroded and intact soil profiles as guides, we are varying the ratios of resources available to bacteria growing at a known rate and quantifying C flow into their biomass vs. $CO_2$. We compare these rate responses to resource ratios with those observed during decay and mineralization of incubating SOM from multiple depths which exhibit similar, natural variation in resource ratios. Preliminary results from this on-going project suggest that by working across scales and incrementally increasing the complexity of our experimental systems, we can elucidate some of the fundamental, small-scale mechanisms driving ecosystem processes observed across far greater temporal and spatial scales.