Improving Soil C Dynamic Models Through the Incorporation of Microbial Processes

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The focus of our research is to develop robust parameters and an improved conceptual understanding of microbial-facilitated decomposition of organic matter, and apply this knowledge to improve the Microbial ENzyme Decomposition (MEND) model. As part of this effort, we have been conducting a series of short to long-term (4 to 729 days) soil incubation experiments with ^{13}C labeled glucose and cellulose, to examine how land use, edaphic properties, and microbial communities influence C use and the long-term fate of C in soils. Adjacent forested and grassland soils were collected from four sites including Alfisols in Missouri near the MOFLUX facility and another site in Athens OH, Ultisols in TN, and Mollisols from IA. Initial results show an expected trend of increased C mineralization and priming with glucose additions. However, long-term incubations indicate differential C use between forest and grassland soils, where cellulose addition had no effect on grassland respiration but suppressed C mineralization in forested soils. The results of these studies of longer-term soil C incubations will allow us to better parameterize MEND and other C cycle models with respect to the relationship between C source complexity and turnover rates in various soil types. In related studies, we are also incorporating soil moisture responses into the MEND model and testing the model against field-scale data from Ultisol soils at the Dinghushan Biosphere Reserve in China. We parameterized MEND using observed heterotrophic respiration (R_H) and microbial biomass C (MBC) from a three-year field experiment in two subtropical forests: a young pine forest (PF) and an old-growth broadleaf forest (BF). The observed seasonal variability in both MBC and R_H were well fitted by the MEND model. Both MBC and R_H in the two forests were more sensitive to soil moisture than to temperature, and the R_H in BF was more susceptible to soil moisture than that in PF. The R_H increased to a larger extent in the wet season, potentially by inducing a greater active fraction of microbial biomass in BF than PF. Our results suggest that the microbial controls on soil C decomposition are different with forest types. The soil microbial community tends to decrease in abundance under a drought-prone environment in BF, and MEND simulations suggest that this effect would enhance soil C storage. Together these studies are further elucidating the factors influencing the fate of soil C and will allow us to further refine the efficacy and environmental sensitivity of the MEND model.