Microbial dormancy in terrestrial ecosystem models

Melanie Mayes (mayesma@ornl.gov) - ORNL (PI), Gangsheng Wang (ORNL); Sindhu Jagadamma (ORNL); Chris Schadt (ORNL) (Co-PIs).

Climate feedbacks from soils can result from environmental change followed by response of plant and microbial communities, and/or associated changes in nutrient cycling. Explicit consideration of microbial life history traits and functions may be necessary to predict climate feedbacks due to changes in the physiology and community composition of microbes and their associated effect on carbon cycling. Existing dormancy models were not theoretically sound and were inappropriate when scaled in ecosystem models. Here, we developed a new Microbial-ENzyme-mediated Decomposition (MEND) model by incorporating microbial dormancy and the ability to track multiple isotopes of carbon. We tested two versions of MEND, i.e., MEND with dormancy and MEND without dormancy, against long-term (270 d) lab incubations of four soils with isotopically-labeled substrates. Although MEND without dormancy fitted well multiple observations (total CO₂ and 14C respiration, and dissolved organic carbon), this apparently good fit was achieved at the cost of significantly underestimating the total microbial biomass. MEND with dormancy improved estimates of microbial biomass by 20-71% over MEND without dormancy. We observed that the intrinsic microbial carbon use efficiency decreased with increasing temperature by approximately 0.01 per degree Celsius (95% confidence interval: 0.005-0.016 per degree Celsius). Further development of C-N coupled MEND with dormancy illustrated that the C:N ratios in soil organic matter (SOM), dissolved organic matter (DOM) could be well constrained and regulated by microbial stoichiometry. The MEND structure is being tested on the PFLOTRAN-CLM platform to improve representation of CLM subsurface biogeochemistry processes. These efforts should provide essential support to future field- and global-scale simulations and enable more confident predictions of feedbacks between environmental change and carbon cycling.