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Seasonal dynamics of soil microbial carbon use efficiency

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The efficient incorporation of carbon (C) into microbial biomass (high C-use-efficiency; CUE) is more and more considered to be a crucial first step in soil C sequestration. Microbial CUE strongly depends on substrate quality, availability of N and environmental factors such as temperature and moisture. However, the response of CUE to seasonal changes of these factors in temperate systems and their interactions is largely unknown.
In a first step to address these questions, we ran the soil C model MIMICS with seasonally different drivers (temperature, inputs of easily available C, uptake of nitrogen (N) and litter fall input). We created seasonal patterns for these factors, based on literature and existing model simulations for a deciduous hardwood forest. We used a base version of MIMICS with constant (non-seasonally-variable) temperature, evenly distributed input of easily available C, leaf litter and loss of N out of the system (simulating plant N uptake). We then manipulated each of these factors individually to better reflect seasonal dynamics in situ. Temperature was adjusted to follow a bell-shaped curve over the course of a year, with lows of -5°C in winter to highs of 20°C in summer. Input of easily available C (simulating root exudation) and N loss followed a similarly shaped curve with highs in summer and lows in winter. The input of leaf litter was realized as a single event in fall. In a final simulation, all individually adjusted factors were combined. Preliminary results showed that seasonal changes of easily available C inputs and N loss had little effect on CUE. Litter fall had a negative effect on CUE in fall. Because the model, in its current form, does include temperature sensitivity of enzyme dynamics, but not directly of CUE, higher temperature in summer did not lead to the expected decrease in CUE. Future iterations of MIMICS will include different scenarios to represent the influence of temperature on microbial dynamics.
In the next step we will test our modelling results in a deciduous forest in which we established litter removal plots. We will sample these plots and corresponding control plots with litter input bi-monthly and measure CUE along with measurements of soil organic matter and microbial parameters.
Our preliminary results show that CUE in temperate forest systems might vary seasonally. In respect to C sequestration in soils, this could indicate that there are better and worse times for soil microbes to efficiently build stable soil organic matter.