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Microbial growth rather than respiration drives seasonal dynamics of soil microbial carbon use efficiency

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Microbial carbon use efficiency (CUE), i.e. the allocation of carbon taken up by microbes into growth, is more and more recognized as an important variable in ecosystem models to adequately predict belowground carbon cycling and serves as a proxy for soil C sequestration. An efficient microbial biomass production (high CUE) could potentially be the first step for incorporation of C into stable organo-mineral associations and soil aggregates. External factors such as temperature, C and nutrient availability are known to affect CUE. It has long been assumed that these effects will mainly be brought on by changes in microbial respiration. High C availability relative to nitrogen for instance is expected to lead to overflow respiration, which would in turn reduce CUE.
In our study we measured microbial CUE at in situ temperatures in an agricultural soil and a forest soil every 6-7 weeks, starting in March 2018. From late winter (March) to summer (July), CUE increased from 0.14±0.02 to 0.66±0.02 in agricultural soils and from 0.17±0.02 to 0.50±0.03 in forest soils. These changes correspond to increases in respiration rates from 200±22 ng C h-1 g-1 dry soil to 406±21 ng C h-1 g-1 dry soil and from 502±42 ng C h-1 g-1 dry soil to 1334±74 ng C h-1 g-1 dry soil in agricultural and forest soils, respectively. This roughly doubling of respiration rates was outweighed by a more than ten-fold increase in microbial growth during the same time period from 33±7.2 ng C h-1 g-1 dry soil to 786±26 ng C h-1 g-1 dry soil and from 103±16 ng C h-1 g-1 dry soil to 1352±179 ng C h-1 g-1 dry soil in agricultural and forest soils, respectively.
Our results thus demonstrate that seasonal changes in CUE are driven by a strong response of growth, rather than respiration. We will discuss our results with regard to temperature and C and nutrient availability, as potential drivers of CUE increase from winter to summer.