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Carbon use efficiency (CUE) and biomass turnover of soil microbial communities as affected by bedrock, land management and soil temperature and moisture

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Soil microbial carbon use efficiency (CUE), defined as the proportion of organic C taken up that is allocated to microbial growth, represents an important synthetic representation of microbial community C metabolism that describes the flux partitioning between microbial respiration and growth. Therefore, studying microbial CUE is critical for the understanding of soil C cycling. Microbial CUE is thought to vary with environmental conditions (e.g. temperature and soil moisture). Microbial CUE is thought to decrease with increasing temperature and declining soil moisture, as the latter may trigger stress responses (e.g. the synthesis of stress metabolites), which may consequently lower microbial community CUE. However, these effects on microbial CUE have not been adequately measured so far due to methodological restrictions. The most widely used methods for microbial CUE estimation are based on tracing ^{13}C-labeled substrates into microbial biomass and respiratory CO_2, approaches that are known to overestimate microbial CUE of native organic matter in soil. Recently, a novel substrate-independent approach based on the measurement of (i) respiration rates and (ii) the incorporation rates of ^{18}O from labelled water into newly formed microbial DNA has been developed in our laboratory for measuring microbial CUE. This approach overcomes the shortcomings of previously used methods and has already been shown to yield realistic estimations of soil microbial CUE. This approach can also be applied to concurrently measure microbial biomass turnover rates, which also influence the sequestration of soil organic C. Microbial turnover rates are also thought to be impacted by environmental factors, but rarely have been directly measured so far.

Here, we aimed at determining the short-term effects of environmental factors (soil temperature and soil moisture) on microbial CUE and microbial biomass turnover rates based on the novel ^{18}O approach. Soils from three land-use types (arable fields, pasture and forest) sampled from two geologies (silicate versus limestone) in the same region in Austria were incubated at three temperatures (5, 15 and 25 $^{\circ}$C) for 1 day and at three moisture levels (30, 60, 90% water-holding capacity) for 7 days in the laboratory, respectively. We will present the results and discuss major effects of environmental factors as well as of land management and geology on microbial growth, respiration, microbial CUE and microbial biomass turnover, and set those in relation to microbial community composition.