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Carbon use efficiency and biomass turnover of soil microbial communities as affected by climate, geology, vegetation and land-use across a European transect

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Microbial carbon use efficiency (CUE) is defined as the amount of organic C allocated to microbial growth relative to organic C taken up, and is a critical parameter driving soil C release and long-term C sequestration in soils. Except for microbial CUE, microbial biomass turnover rates can also influence soil organic C sequestration through the amount of microbial necromass produced. Hence, studying microbial CUE together with microbial turnover will improve our understanding of soil C cycling and help to advance process-based modeling. Microbial CUE and microbial turnover rates are thought to vary with nutrient availability, substrate quality, soil temperature, soil moisture and possibly microbial community structure. However, these major controls on microbial CUE have rarely been investigated together; additionally, microbial turnover rates were rarely measured directly. The commonly used approaches for estimating microbial CUE are based on tracing 13C-labeled substrates into microbial biomass and respiratory CO_2, which have been recognized to overestimate microbial CUE of native soils. Recently, a substrate-independent method for measuring microbial CUE and microbial biomass turnover rates has been established in our laboratory, which is based on the measurement of (i) the incorporation rates of 18O from labelled water into newly formed microbial dsDNA and (ii) basal respiration rates. This method overcomes some drawbacks of the formerly used methods and has been shown to yield realistic estimates of soil microbial CUE and microbial turnover rates.

In this work, we aimed to elucidate the effects of climate, geology, vegetation and land-use on microbial CUE and microbial turnover rates based on the novel 18O approach. We sampled mineral and organic soils from three land-use types (croplands, pastures and forests) across a European continental transect from 96 sites ranging from southern Spain to northern Norway. Soils were sieved and incubated at 20 °C and 40% water-holding capacity for two weeks in the laboratory before measurements of microbial processes. Edaphic parameters such as soil texture, soil pH, nutrient availability (cation-exchange capacity, base saturation, N, P availability) and soil organic matter content are currently measured, and climatic, geological and vegetation information have been retrieved from global databases. First results showed no climatic and land-use effects but strong inverse nutrient effects (P versus N availability) on microbial CUE and microbial turnover rates. We also found that microbial CUE was most strongly correlated to microbial growth normalized to microbial biomass but not to microbial respiration. We will present further results and discuss the effects of soil physicochemistry, and resource composition and stoichiometry on soil microbial respiration, growth, CUE and biomass turnover, and set those in relation to microbial community composition.