Land-use alters the temperature response of microbial carbon-use efficiency

T. BÖLSCHER[1]*, G.I. ÅGREN [1], A.M. HERRMANN [1]

[1]Swedish University of Agricultural Sciences, 750 07 Uppsala, Sweden (*correspondence: tobiasboelscher@gmail.com)

Decomposition of soil organic matter is a major flux in the global carbon (C) cycle and small changes in this vast flux may seriously modify global climate. A key property during decomposition is the microbial community's carbon-use efficiency (CUE). It is defined as the fraction of microbial utilized C that is allocated to biosynthesis, with the remaining being respired. Therefore, CUE regulates C sequestration and experimental evidence suggests that it decreases with warming [1]. Yet, most soil C models consider CUE as a constant property. We hypothesized that (i) the temperature response of CUE differs across land-uses and (ii) that such dissimilarities significantly affects projections of soil C stocks under future temperature conditions.

To test our hypotheses, we applied a microbial thermodynamics approach [2] using isothermal calorimetry and incorporated our findings in the Q-model [3]. Soils from arable, grassland, ley-farming, and forest sites situated in a boreal climate were amended with two C substrates differing in molecular complexity. All soils were then incubated at various temperatures ranging from 5 to 20 °C. CUEs were calculated from cumulative heat production and residual substrate [2] when 15 % of the added substrate was utilized.

In the arable soil, CUE remained constant over the temperature range between 5 and 20 °C. In contrast, CUEs in ley farming, grassland and forest soils were constant in the temperature interval 5 to 12.5 °C, but decreased non-linear beyond 12.5 °C. For both substrate amendements, the decrease in CUE was most pronounced in forest soil. Such land-use specific temperature response funcations have not been observed previously. Implementing this hitherto unrecognized phenomenon into the Q model revealed considerably different responses of soil C stocks to changes in climate conditions across land-uses. Our findings emphasize the need to understand temperature responses of microbial CUE for projecting soil C dynamics.

[1] Frey *et al.* (2013) *Nat. Clim. Change* **3**, 395-398. [2] Bölscher *et al.* (2016) *Biol. Fertil. Soils* **52**, 547-559. [3] Ågren & Bosatta (1998) *Theoretical Ecosystem Ecology – Understanding Element Cycling*. Cambridge Univ. Press.