

Effects of temperature on microbial efficiency and community composition in soils from different land uses in a boreal climate

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Soil organic matter plays an important role in the global carbon cycle, as it is the largest carbon pool in terrestrial ecosystems. Because it stores two to three times the amount of carbon in the atmosphere, even small alterations of the carbon cycle may have significant impact on the global climate. The fate of soil organic carbon in an ecosystem is determined during its decomposition by microbial metabolic activity. Specifically, the efficiency of microbial metabolism regulates whether carbon remains in soils or if it is lost into the atmosphere. Energy requirements and supply are the driving force for microbial metabolism. During microbial decomposition, parts of soil organic matter are converted into biochemical energy, which is used for maintenance, growth and reproduction. Additionally, waste products, such as heat energy and CO₂, are dissipated from the soil system. We used the ratio of energy dissipation to energy utilization as an indicator for microbial inefficiency, i.e. soil microbial communities which minimize energy dissipation have an efficient metabolism. Recent research suggests that microbial efficiency is temperature dependent, but this property is often neglected in soil organic matter models. Here we investigate effects of temperature on microbial efficiency and community composition in soils from different land uses. Such empirical data may help in refining climate change modelling.

In August 2012, soil samples were taken from long-term research sites with different land use managements (forest, arable, grassland and ley farming systems). These sites are closely situated to the city of Umeå in Northern Sweden (63°49'N; 20°15'E) with boreal climate. In the laboratory, we amended the soil samples with different complex substrates and incubated them at three constant temperatures (5, 12.5 or 20 °C). We determined heat flows using isothermal calorimetry and CO₂ respiration by infrared gas analysis over a 42 h incubation period upon substrate additions. Isothermal calorimetry measures heat flow from samples at constant temperature and provides complementary information to CO₂ respiration for investigating the terrestrial carbon cycle. In addition, we analysed remaining substrates in soil extracts throughout the incubation period in order to correct microbial efficiency indices by taking into account substrate not utilized in microbial metabolism.

We will present our findings illustrating variations in microbial efficiency and respiration in soil ecosystems exposed to different temperatures and land uses. Our findings will be linked to the microbial community composition determined via phospholipid fatty acid analysis. Results will be discussed in relation to their potential to enhance our understanding of terrestrial carbon cycling.