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Testing soil organic matter hydrolysis under variable soil temperature and moisture using isothermal calorimetry

SARASWATI SARASWATI AND PHILIPPE VAN CAPPELLEN

University of Waterloo

Presenting Author: xsaraswa@uwaterloo.ca

Soil microbial communities fulfil their energy requirements by producing enzymes to decompose soil organic matter (SOM). The catabolic reactions that enable the breakdown of SOM release energy used to drive anabolic (biosynthetic) reactions in the cells. In accordance to the Second Law of thermodynamics, net microbial metabolism, that is catabolism plus anabolism, must dissipate part of the energy generated as heat. Therefore, the precise measurement of the heat flow during the microbial processing of SOM soils can underpin process-based models of SOM degradation under various biogeochemical conditions. One precise tool to measure heat flows during reactions is isothermal calorimetry. With an isothermal calorimeter, the power-time curve can be acquired with extremely high precision (±20 μW). In turn, information on both kinetics (reaction rate) and thermodynamics (reaction enthalpy, Gibbs energy, and entropy) can be inferred from the power-time curve. However, so far only a few studies have used isothermal calorimetry to study SOM degradation in different ecosystems (e.g., wetlands, forest soils, permafrost zones, etc.). As a first step, we experimentally determined the optimum soil temperatures and moisture contents that yield the greatest heat flow during the hydrolytic decomposition of artificial organic and mineral soils. In the experiment, a calorimeter was used to record the heat flows during the reaction of SOM with different hydrolase enzymes (glucosidase, glycosaminidase, sulfatase), at five temperatures (15, 20, 25, 30, and 35 ^{o}C) and two moisture contents (35% and 65%). As expected, the organic soils exhibited significantly higher heat flows than mineral soils. The optimum temperatures for decomposition were all around 25^{o}C, irrespective of the moisture content. In this presentation, we will share our preliminary experimental results and discuss some of the implications for cold region peatlands.