Geophysical Research Abstracts
Vol. 17, EGU2015-9297, 2015
EGU General Assembly 2015

Temperature effect on mineralization of SOM, plant litter and priming: modified by soil type?

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The purpose of this study was to provide improved temperature response functions to be used in models of soil organic carbon (SOC) and litter mineralization, with focus on the winter period. Our working hypothesis were: 1) decomposition of SOM and plant residue occurs also at temperature close to the freezing point; 2) the effect of temperature on SOC decomposition is stronger in clayey than in sandy soil; 3) decomposition and response to temperature of added plant litter is not affected by soil type.

A silty clay loam (27% clay, 3% sand) and a sandy loam (6% clay, 51% sand) with similar weather and cultivation history were pre-incubated at about 15° C for about 4.5 months. Clover leaves labelled with 13C were added to half of the samples, and soil with and without clover was incubated for 142 days at 0, 4, 8.5 or 15 °C. Mineralization of SOC and clover leaves was observed also at 0° C. In the absence of added plant material, SOC decomposition followed a first order reaction which was twice as fast in the sandy soil as in the clay soil. The decomposition rate of clover leaves was also higher in the sandy soil than in the clay soil. However, the influence of temperature on SOC and on clover decomposition was the same in both soils. In presence of plant material, there was a positive priming effect on SOC, which initially correlated with decomposition of plant litter. There was a progressively lower priming effect at higher temperatures, particularly in the sandy soil, that could be understood as substrates exhaustion in a restricted volume of influence around the added clover leaves.

We provide parameterised Arrhenius and alternative modifying linear temperature functions together with decay rates at reference temperature, which can be used for predicting decay rates of SOC per se and of the labile pool of clover leaves. We also show the superiority of these functions compared to the use of Q10 as temperature factor. Further, we suggest approaches for modelling the priming effect caused by plant litter.

Reference: Frøseth RB, Bleken MA(2015) Effect of low temperature and soil type on the decomposition rate of soil organic carbon and clover leaves, and related priming effect. Soil Biology and Biochemistry 80:156-166.