Geophysical Research Abstracts
Vol. 13, EGU2011-7060, 2011
EGU General Assembly 2011

Temperature response (Q10) of heterotrophic CO2 production in response to varying simple carbon sources and microbial metabolic status

Bjorn Erhagen, Ulrik Ilstedt, and Mats B Nilsson
Department of Forest Ecology and Management, Swedish University of Agriculture Science

How the decomposition of soil organic material will respond to increased temperature in the atmosphere is very important, if we want reliable predictions on how the feedback from climate change will affect the biosphere-atmosphere CO2 exchange. The balance between litter input and heterotrophic respiration, i.e. decomposition of organic material, controls the long-term storage of soil organic carbon. Because of the large quantity of carbon stored in the soil (∼2400Pg) compared to the amount of CO2 currently in the atmosphere (approximately 750 Pg) even small changes in the soil carbon pool may affect the concentration of CO2 in the atmosphere and thereby potentially also the climate. According to kinetic theory the effect of temperature on organic matter degradation should be inversely related to the organic matter carbon quality, i.e. increased temperature sensitivity with decreasing organic matter quality. Another potential, but less recognized, source of variation might be metabolic status of the saprotrophic soil microbial community. Depending on the stoikiometry of the carbon and nutrient sources for the microorganisms the relative proportions of catabolic (respiratory) and anabolic (biomass synthesis) activities will differ. This relationship between anabolic and catabolic reaction is often expressed as carbon use efficiency (CUE) describing to what proportion the utilized carbon source is converted into microbial biomass.

To further advance the understanding of the intrinsic controls on the temperature sensitivity of soil organic matter decomposition we used high-resolution laboratory soil incubations at 4, 9, 14 and 19 oC and additions of pure defined carbon sources, representing the major constituents of plant and microbial biomass. We used both monomers and polymers representing different quality with respect to degradability. The temperature sensitivity (Q10) differed ($p<0.05$) both with respect to the added carbon source and with respect to microbial physiological status. The results from addition of pure substrates revealed a positive relationship between substrate quality (expressed as the rate of CO2 production at 14oC) and the temperature response i.e. substrate with low quality had low temperature response. These results contradict the kinetic theory predicting increased temperature sensitivity with decreased organic matter quality. The structure of the glucose polymer affected the Q10 response. Addition of crystalline cellulose resulted in hardly any response in increased respiration and no Q10 response was obtained. The CUE for carbon monomers had no temperature dependence for any of the added substrate in the temperature range of 4 -19 °C, and the CUE ranged between 60-75 %. A possible reason to the relatively high CUE is that CUE was calculated as the ratio between not respired C at the time of maximal respiration rate and added C, i.e. also carbon transformed to microbial storage compounds might be included in the microbial biomass carbon. The independence of CUE to temperature, as found in this study, is in contrast to (2008) how found a decreased CUE with increased temperature. The importance of solving these seemingly conflicting results on the effect of temperature on CUE for large-scale carbon modeling is stressed in the modeling study by Allison et al (2010). Using a soil-carbon enzymatic model they got substantially different results with respect to carbon accumulation dependent on if the CUE was temperature dependent or not.

Allison, S.D., Wallenstein, M.D., Bradford, M.A., 2010. Soil-carbon response to warming dependent on microbial physiology. Nature Geoscience 3, 336-340.
Steinweg, J.M., Plante, A.F., Conant, R.T., Paul, E.A., Tanaka, D.L., 2008. Patterns of substrate utilization during long-term incubations at different temperatures. Soil Biology & Biochemistry 40, 2722-2728.