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Organic matter quality and its temperature sensitivity during decomposition: theory and reconciliation of empirical approaches

Carlos Sierra
(csierra@bgc-jena.mpg.de)

Previous theoretical analyses based on Arrhenius kinetics and thermodynamics have shown that the temperature sensitivity of low-quality substrate is higher than that of high-quality substrate. Because soils store large amounts of low-quality carbon, understanding its response to increasing temperatures will help to predict the response of atmospheric CO_2 to climate change. However, the empirical evidence available does not provide conclusive evidence to corroborate this theoretical argument. Although there are various possible reasons for this disagreement, the theory behind this argument has not been scrutinized carefully. Based on a simple mathematical analysis it is shown in this study that low-quality substrates are less temperature sensitive when analyzed in absolute rather than in relative terms, a result that may seem counterintuitive to previous theory. However, this is a paradox intrinsic to the Arrhenius equation and it is often ignored within the 'quality-temperature' debate. In fact, different measures commonly used to analyze the temperature sensitivity of different substrates can provide apparently different and contradictory results even though they are based on the same basic principles. Distinguishing between absolute and relative measures of sensitivity is essential for understanding the sensitivity of respiration to environmental change. An analysis of the available empirical evidence on this topic shows that most studies actually agree with the Arrhenius and thermodynamics theory, with less disagreement than previously thought.