Temperature and moisture dependence of organic matter decomposition in soils from different environments, with special reference to the contribution of light- and heavy-fraction C

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Abstract

In this study, we explore the possibility of constructing SOM simulation models based on experimentally measurable pools of SOM and seek to determine parameters to be taken into account when comparing the behaviors of SOM under different ecological environments. To achieve this, we conducted a comparative analysis of the physical fractions of SOM (LF and HF) and parameters that were biologically determined by incubation experiment for steppe soils from Ukraine and Kazakhstan and forest soils from Japan. The analyzed parameters include potentially mineralizable organic C (C_0) and the rate constant of decomposition and its temperature/moisture dependence. In analyzing the resulting data, we used two different approaches to simulating the observed C mineralization patterns. The first approach supposes first-order kinetics for C mineralization in each sample, with one fixed pool of SOM (C_0) that is decomposed under k values that vary with temperature and moisture conditions. This was followed by a comparative statistical analysis of the parameters and physicochemical properties or amounts of LF and HF. The second approach supposes, for the analysis of the entirety

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of each steppe or forest soil sample, a universal relationship between the rates of C mineralization at the initial stage of the incubation, i.e., the 7th day (CR_7), the amounts of C in the LF (LFC) and HF (HFC), and their respective rate constants k_1 and k_2 that vary with temperature and moisture conditions. The general trends of the parameters obtained by the two approaches are similar in that the possible effect of pH and differences in the nature of the LF from the respective environments were considered to be important factors in the SOM decomposition process. Although the first approach, based on long-term incubation, is commonly used to determine the temperature/moisture dependence of SOM decomposition, the second approach successfully incorporates the physical fractions of SOM (i.e., LFC and HFC) as measurable pools in simulating the SOM decomposition rate during the early stages of incubation (7th day) for each ecosystem. Despite several remaining problems, the integration of the measurable fractions into SOM-simulation models is worthwhile because it substantially increases the possibility of validating these models when comparing actual and simulated changes in SOM in different ecosystems.