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Using continuous quality theory in simulating global soil carbon dynamics for future climate projections.

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Biochemical conceptual interpretation of the soil organic matter transformations is common for the coupled climate-carbon cycle models. Here the continuous quality theory (Q-theory, Ågren and Bosatta, 1996) is used instead. We have investigated the interactive effects between soil carbon and projected climatic changes using the INMCM climate-C cycle model coupled to the Q model describing soil organic matter dynamics. *ROMUL,* a model based on the concept that soil organic matter transformation occurs in a succession of discrete steps, is used to compare the results obtained with Q-theory.

In the *Q model* soil organic matter is characterised by a distribution $\rho_c(q,t)$ over a continuous variable quality, q, which describes its ease of decomposition. We have used an equation formulated in Ågren and Bosatta (1996) for $\rho_c(q,t)$, in which decomposition is described by two terms: one for the mineralisation of organic matter and one that can be compared to the "advection" of C towards lower qualities (humification). The microbial utilisation rate of the soil organic matter is temperature- and quality-dependent. The thermodynamic equation from Bosatta and Ågren (1999) describes temperature dependency with an Arrhenius-type formulation, but such that utilization of lower qualities is more temperature-sensitive. Numerical solution of the Q model was implemented using an explicit total variation diminishing (TVD) scheme.

The CO_2- fertilization effect is incorporated in the carbon cycle model and higher productivity of terrestrial plants in the higher CO_2atmosphere compensates for the loss of soil C resulting from increased soil temperature. According to the Q and ROMUL models, soils accumulate more C, 60 Pg and 104 Pg globally, respectively. Despite fundamental differences in formulation of the temperature dependence of the organic matter decomposition the Q and ROMUL models' predictions of global soil respiration in a warmer climate are nearly identical, indicating that differences in the temperature sensitivity of the decomposition of substrates of differing lability may not be critical factors. Air temperature predictions obtained by the INMCM climate-C cycle model coupled either to the Q or ROMUL model were also nearly identical. Sensitivity study has demonstrated that in the Q model soil C decreases when the humification rate and temperature is increased, because more soil C is allocated to lower qualities that are more sensitive to temperature changes. However, when litter inputs are also increased (as it is in global predictions due to CO2 fertilization effect on plant productivity) the higher humification rate also increases the input of litter to the lower qualities and this more than outweighs the increased temperature sensitivity.