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Comparison of approaches for simulating moisture regulations in enzyme decomposition soil carbon models

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The effect of moisture content on soil carbon dynamics has been historically simulated by using empirical functions that scale the net reaction rates in models. These functions fit will to data from studies in the laboratory in which soils are under stable conditions at various moisture levels, but they fail to capture the variability in moisture responses across soils and especially are unable to reproduce interaction effects that occur when simultaneously varying other driving factors, such as temperature.
Results are shown from a comparison of model approaches using empirical moisture modifiers, on the one hand, and diffusion based fluxes, on the other. The effects of these approaches are evaluated in the framework of two distinct types of models: conventional first-order decomposition and more mechanistic enzyme-decomposition soil C model. The combination of these different approaches results in qualitatively different responses of soil C to variations in various drivers, e.g. moisture and temperature. The impact of moisture effects depends not only on empirical vs diffusion approaches, but also strongly on the underlying decomposition kinetics. Effects are also highly dependent on the temporal scale of simulations. Clearly, model results become more complex as more mechanistic processes are included, with the potential of explaining the variability of natural systems, but results also increase in uncertainty when adding non-linear processes that have not yet seen proper validation.