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The Role of Soil Structure in Fungal Dynamics and Breakdown of Organic Matter: a Modelling Approach

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There is also overwhelming evidence that physical protection within aggregates can play a significant role in organic matter dynamics. Yet current models of soil organic matter dynamics divide soil organic matter into conceptual pools with distinct turnover times, assuming that a combination of biochemical and physical properties control decay without explicit description. Albeit robust in their application, such models are not capable to account for changes in soil structure or microbial populations, or accurately predict the effect of wetness or priming. We demonstrate how recent advancements in our understanding of soil microhabitats can be used to propose a new class of soil C models that explicitly accounts for microbial dynamics, physical processes and are spatially explicit to embrace the microscopic heterogeneity in soils.

Exemplified for fungi, we will demonstrate how such a model can provide contrasting results to existing approaches. The model comprises two C-pools, particulate organic matter which through enzyme activity is converted into dissolved organic matter. The fungal and carbon dynamics occur within a 3D soil structure obtained by X-ray CT. In addition Lattice Boltzmann modelling is used to predict the water distribution within soil structures. The model is parameterised through a combination of literature data and parameter estimation (Cazelles et al., 2012).

We show that CO_2 is affected not only by the amount of Carbon in the soil but also by microbial dynamics, soil structure and the spatial distribution of OM. The same amount of OM can result in substantially different respiration rates, with surprisingly more CO_2 with increased clustering of OM. We can explain this from the colony dynamics, production of enzymes and interaction with OM in a 3D structure. We also show that with increasing soil C content soil the respiration increases non linearly, with a rapid increase above a critical threshold.