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Modeling soil organic matter reallocation in soil enhanced by fungal growth

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Soil, as a huge carbon reservoir having a large interface with the atmosphere, has a major role in understanding global carbon cycle. Yet, its structure gives rise to an extremely complex ecosystem in which chemical fluxes are difficult to describe. Amongst microbial organisms that inhabit soil, fungi represent an entire kingdom of life that has developed its own strategy to adapt its environment. They are thus known to have a particular importance for the reallocation of carbon (and other elements) as they are able to build a mycelium structure that can spread over several meters and through which nutrients can be translocated.

This study, based on simulations, is dedicated to enlighten the role of fungal colonization to generate an ecosystem in which coexists disperse biological hotspots. The simulation environment is reconstructed from thresholded computed tomography images of soil samples. Soil organic matter acting as a resource for fungi is assumed to occur first in a particulate solid state (POM). It is degraded into dissolved organic carbon (DOC) through enzymatic activity of fungi. Fungal uptake converts DOC into an internal resource that diffuses through the mycelium and helps it for further colonization. The fungal model is an adaptation of a previously developed model. In addition to internal resource, it accounts for two states of biomass: non-insulated and insulated. One is converted into the other by insulation which is the analog of an ageing process. Being insulated, the interaction rates of the biomass with the environment (degradation and uptake) become slower and the ability to diffuse in the pore space is lost. This aims at producing a more stable state of the mycelium when all resource has been consumed.

Spatially simulations reveal a transient state in POM-fungi interaction characterized by a large spread of DOC in the pore space. It is then followed by an enhanced fungal growth toward these areas. Finally a steady state occurs in which DOC is produced and consumed in a close vicinity of the POM reducing its availability for other micro-organisms.