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Modeling mechanisms of microbially-driven SOM transformation in soil physical fractions

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In this study we continue to develop a multiscale model of SOM transformation (soil aggregate, soil profile) in which the self-organization of soil pore space as a result of microbial growth with effects of temperature, water and oxygen was shown.

Model. The concept is further extended with separate consideration of SOM in granulo-densimetric fractions (by particles size and density). SOM transformations between granulo-densimetric fractions occur due to microbial activity, considering growth, maintenance respirations and carbon use efficiency. SOM is modelled in a particulate and adsorbed forms, each physical fraction comprises labile (hydrophilic) and stable (hydrophobic) pools. The model is age-structured and accounts for priming and autocatalysis effects. Adsorption (by mineral or black carbon particles) and physical occlusion are considered as SOM stabilization mechanisms - defining dynamic turnover rates for SOM in fractions. SOM stabilization feedback through physical occlusion mechanism is self-defined by the ratio of light to heavy fractions.

Objects. Model parametrization was based on experimental data of several long-term bare fallow experiments (LTBF network for isolation of stable SOM). Bulk SOM series for Rothamsted, Ultuna, Askov, Grignon, Versailles and Kursk experiments. We used C and $\delta^{13}C$ dynamics in granulo-densimetric fractions for Versailles experiment. And laboratory measurements of soil respiration in series of moisture and temperature for stable and labile soil pools in Versailles samples were used to calibrate temperature-moisture affects. We used mean annual temperatures and precipitations.

Results. Introducing characteristic values allowed to reveal 2 driving parameters which together with climatic data are sufficient to describe the differences in C dynamics between experimental sites. The first one is the characteristic C concentration (an overall scaling parameter that adjusts to C input). Second is the SOM stabilization parameter representing concentration of "adsorption sites" (on mineral. or black carbon particles) that affects SOM decomposition rates. Physical fractions based feedback-mechanisms of SOM stabilization (via physical occlusion and adsorption) can be responsible for dynamic SOM turnover rates of the soils. Discussed are long-term dynamics at different scenarios of climate and land use changes; possible reasons for difference in SOM loss and recovery turnover rate dynamics.