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Modeling soil aggregates formation in rhizosphere

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We exploit experimentally supported hypothesis of aggregate waterstability relation to labile hydrophilic SOM components in its granulo-densimetric fractions. Mechanism of waterstability loss and recovery in rhizosphere is tested.

In this study we present the model of labile SOM production and its fast transformation cycle in rhizosphere as a system of nonlinear partial differential equations, solved in cylindrical coordinates centered on the root fiber. Boundary conditions include root exudate generation as a function of time. The model describes following processes: root exudates generation; exudates consumption by microorganisms; formation of microbial colonies; microbial respiration, lysis and glue(mucilage) production. Rates of these processes depend on temperature and moisture scenarios. Media viscosity and stickiness being dependent on glue concentration, define nonlinear diffusion rates and soil aggregates formation. Aggregate size and durability depend on glue spatial pattern and soil granulometric composition. Waterstability depends on the content and wettability of light fraction SOM which counteracts disrupting effects of capillary forces. Aggregate turnover rate is calculated from waterstability, durability and land use practice.

Further upscaling to bulk soil level consists in obtaining aggregate size, durability and waterstability distributions by stochastic modeling accounting for aggregate turnover rates along with root growth and root density. Where root density function depends on plant's root type.

Parameterization of microbial CO_2/lysis/glue production ratio and diffusion rates is carried out by optimizing the fit of the model result to experimental data of aggregate distributions, aggregate durability and waterstability obtained in a particular crop rotation (winter wheat - sugar beet - wheat - soybean) on a typical chernozem soil.

The above aggregation model will be used as a part of discrete long-term soil fertility dynamics model of a typical chernozem soil, providing feedbacks between soil hydrological properties and SOM transformation in granulo-densimetric fractions.