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A prototype model linking soil structure dynamics with soil processes

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Soil structure regulates all important processes in soil such as water, air and solute movement, microbiological activity, carbon and nutrient cycling, root growth as well as water and nutrient uptake by plants. Some models can account for the effects of soil structure on transport and turnover processes, but the structure in these models is treated as static. In reality, soil structure is dynamic at time scales ranging from seconds (e.g. compaction, tillage) to minutes (e.g. soil surface sealing), seasons (e.g. root growth, earthworm activity) and even decades (e.g. organic matter cycling). A lack of model tools that dynamically link soil structure with function has hampered an improved understanding of how changes in land use, soil management and climate affect the ecosystem services provided by soil. Here, we present a prototype soil-plant model incorporating dynamic links between soil properties and soil processes. The current version of the model describes the effects of key biological processes (i.e. plant root growth/decay, macro-faunal activity and organic matter turnover) on soil porosity, pore size distribution and hydrological processes. We illustrate the approach with scenario simulations of long-term soil structure degradation under a permanent grass cover in a drying climate. Future model developments will involve the inclusion of physical/mechanical processes affecting structure in cultivated soils.