Modelling plant growth and rhizodeposition based on the distribution of sugars within the plant

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A modelling approach for simulating rhizodeposition and root growth based on the distribution of sugars within roots

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Abstract

Rhizodeposition, i.e. the release of any organic material by the roots, has been recognized as a major process that favors plant growth (*e.g.* by shaping microbial activity in the rhizosphere) and controls the short-term dynamics of carbon in the soil. So far, our understanding of such effects has been hindered by the lack of reliable estimations of the amount and composition of the various organic materials (e.g. exudates, mucilage, sloughed cells, volatile organic compounds) released by the roots over their lifetime. This is due to the technical challenges associated to the measurement of rhizodeposition fluxes, but also to the absence of any mechanistic plant models that explicitly integrate such fluxes as part of plant's metabolism. *RhizoDep* is a new functional-structural plant model (FSPM) that simulates the development of a 3D root system together with physiological processes such as root respiration and rhizodeposition. The overarching principle of this modelling approach is that virtually all processes are regulated by the concentrations of sugars allocated between different pools (e.g. phloem, cortical cytosol, reserve) in each root segment in a dynamic way. *RhizoDep* is thus able to simulate both temporal and spatial variations of rhizodeposition within the whole root system over plant's life, depending on the total amount of photoassimilates allocated from the shoots to the roots. By coupling this root model to plant or crop models able to control C inputs to the root system, on one hand, and to models that simulate soil organic matter dynamics, on the other hand, it has now become possible to recreate a plausible representation of the whole carbon cycle in soil-plant-atmosphere systems, and how it may be affected by different environmental conditions.