"A MULTISCALE MODEL FOR WATER AND NUTRIENT UPTAKE BY PLANT ROOTS : FROM SINGLE ROOT TO ROOT SYSTEM SCALE"

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Aims: Water and nutrient transfer to plant roots is a multiscale problem determined by processes within the µm to the m scale. A spatially distributed mechanistic description of these processes would require a sub mm discretization with high computational demand for an entire full grown root system that extends over the meter scale. .

Methods: A coupled multiscale model for water and nutrient uptake from a single root to the root system scale has been developed . We used the 1-D radially axisymmetric model of Barber and Cushman (1981) to describe nutrient transport to a single root segment. Transport to the entire root system is represented by a network of connected cylindrical models around the roots. This network of cylinders was coupled to a 3-D regular grid that was used to solve the flow and transport equations Flemisch et al. (2011) in the soil at the root system scale.

Results: Cumulative nutrient uptake simulated by the coupled multiscale model compared well with the approximate analytical solution of Roose et al. (2001) and with simulations using a spatially highly resolved 3-D mesh while reducing computational costs.

Conclusions: The multiscale coupling approach allows simulating water and nutrient transport at the root system scale with minimal computational cost and good accuracy. This approach also accounts for the effect of root architecture and soil conditions (e.g. water content) on nutrient uptake.

References:

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