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Towards the consideration of soil-root resistances in root water uptake models with macroscopic representations of hydraulic root architecture

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Plant water uptake from soil is an important component of terrestrial water cycle with strong links to the carbon cycle and the land surface energy budget. To simulate the relation between soil water content, root distribution, and root water uptake, models should represent the hydraulics of the soil-root system and describe the flow from the soil towards root segments and within the 3D root system architecture according to hydraulic principles. We have recently demonstrated how macroscopic relations that describe the lumped water uptake by all root segments in a certain soil volume, e.g. in a thin horizontal soil layer in which soil water potentials are uniform, can be derived from the hydraulic properties of the 3D root architecture. The flow equations within the root system can be scaled up exactly and the total root water uptake from a soil volume depends on only two macroscopic characteristics of the root system: the root system conductance, K_{rs}, and the uptake distribution from the soil when soil water potentials in the soil are uniform, **SUF**. When a simple root hydraulic architecture was assumed, these two characteristics were sufficient to describe root water uptake from profiles with a non-uniform water distribution. This simplification gave accurate results when root characteristics were calculated directly from the root hydraulic architecture. In a next step, we investigate how the resistance to flow in the soil surrounding the root can be considered in a macroscopic root water uptake model. We specifically investigate whether the macroscopic representation of the flow in the root architecture, which predicts an effective xylem water potential at a certain soil depth, can be coupled with a model that describes the transfer from the soil to the root using a simplified representation of the root distribution in a certain soil layer, i.e. assuming a uniform root distribution.