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Implementing small scale processes at the soil-plant interface - the role of root architectures for calculating vertical root water uptake profiles

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In soil-vegetation-atmosphere transfer (SVAT) models, root water uptake is implemented as a sink term in the 1-dimensional (vertical) Richards Equation. Commonly, vertical root water uptake profiles are related to the product of rooting density distribution and a water stress factor. This representation leads to early limitation of uptake when the densely rooted layers dry out. Although, some SVAT models compensate water stress effects by balancing reduced uptake from dryer soil layers to wetter layers, none of these models explicitly considers the process by which plants can adapt their region of uptake according to soil water availability.

Here, we present a bulk soil water model relying on precise estimates of the sink term distribution provided by the root architecture based water uptake model aRoot. In this framework the water flow is modelled along a chain of resistances from the bulk soil over a network of root segments up to the root collar. The non-linear water flow towards the root is modelled with a simplified analytical equation that covers the dynamics of the non-linear Richards model, especially close to the roots. Our overall aim is to investigate the role that root architectures plays for root water uptake in different regimes/phases as well as to define potential constraints when neglecting the root network. Therefore we will present a comparison of root water uptake behaviours for different root system realizations belonging to the same species.

We developed a simplified model, that captures small scale features of plant-water uptake but is still computationally fast. Although our model currently runs with a 3D Richards Model it is intended for later implementation in SVAT schemes and for testing hypothesis on optimal root behaviour in different environments.