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Water flow and solute transport in the soil-plant-atmosphere continuum: Upscaling from rhizosphere to root zone

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Root water and nutrient uptake are among the most important processes considered in numerical models simulating water content and fluxes in the subsurface, as they control plant growth and production as well as water flow and nutrient transport out of the root zone. Root water uptake may lead to salt accumulation at the root-soil interface, resulting in rhizophere salt concentrations much higher than in the bulk soil. This salt accumulation is caused by soluble salt transport towards the roots by mass flow through the soil, followed by preferential adsorption of specific nutrients by active uptake, thereby excluding most other salts at the root-soil interface or in the root apoplast. The salinity buildup can lead to large osmotic pressure gradients across the roots thereby effectively reducing root water uptake.
The initial results from rhizoslides (capillary paper growth system) show that sodium concentration is decreasing with distance from the root, compared with the bulk that remained more stable. When transpiration rate was decreased under high salinity levels, sodium concentration was more homogenous compared with low salinity levels. Additionally, sodium and gadolinium distributions were measured nondestructively around tomato roots using magnetic resonance imaging (MRI). This technique could also observe the root structure and water content around single roots. Results from the MRI confirm the solutes concentration pattern around roots and its relation to their initial concentration.
We conclude that local water potentials at the soil-root interface differ from bulk potentials. These relative differences increase with decreasing root density, decreasing initial salt concentration and increasing transpiration rate. Furthermore, since climate may significantly influence plant response to salinity a dynamic climate-coupled salinity reduction functions are critical in while using macroscopic numerical models.