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COMPUTATIONAL EFFICIENT MODELLING OF SOIL-COUPLED 3D ROOT WATER UPTAKE FOR MULTIPLE ROOT SYSTEMS

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Summary. Numerical modelling of interacting flow processes between roots and soil is essential for understanding the influence of different root geometries and types on the hydro-system and remains a challenging task especially for multiple interacting root systems. This is mainly due to the geometric complexity, the coupled physical processes, scale differences and the required computational resources. These days, coupled 3D-soil-root models at the plant scale are available simulating the water flow along potential gradients within root as well as in soil. Although the biological, chemical and physical processes along the soil-root interface have not been fully investigated yet, current models suggest strong gradients in water potential at the soil-root interface. We develop high-precision models, which capture the main small scale features of plant-water uptake (aRoot) but run on the bulk soil scale coupled to soil water infiltration (OpenGeoSys). This requires an appropriate combination of the geometric models and time stepping schemes to solve both, the plant-water uptake and the soil water flow. The three-dimensional root architectures are embedded into bulk soil and the water flow is modeled along a network of resistances from the bulk soil along radial soil discs towards the root system up to the root collar. The non-linear dynamics of water flow within the soil surrounding the roots are covered by a 3D-Richards model. The numerical analysis of such coupled multiple-root-soil problems with a high precision involves significant computational resources and parallel computing is a way to enable the use of the necessary computer power of SMP machines or clusters. Moreover, we apply adaptive time stepping with automatic control, which assures model stability and a shorter total run-time as compared to a static and steady time-step scheme.