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Applications of a new model of water flow in soil-plant systems

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The estimation of root water uptake and water flow in plants is crucial to quantify transpiration and hence the water exchange between land surface and atmosphere. In particular the soil water extraction by plant roots which provides the water supply of plants is a highly dynamic and non-linear process interacting with soil transport processes that are mainly determined by the natural soil variability at different scales. To better consider this root-soil interaction we extended and further developed a finite element tree crown hydro-dynamics model based on the
one-dimensional porous media equation by including in addition to the explicit three-dimensional architectural representation of the tree crown a corresponding three-dimensional characterisation of the root system. This one-dimensional xylem water flow model was then coupled to a soil water flow model derived also from the one-dimensional porous media equation.

We apply the new model to conduct sensitivity analysis of root water uptake and transpiration dynamics and compare simulation results to experimental data obtained by sap flow measurements of beech and ash trees. It is concluded that the new one-dimensional porous media approach provides a computationally efficient plant water flow and transpiration model, able to reproduce the main mechanisms of plant hydro-dynamics including root water uptake from soil.