Geophysical Research Abstracts,
Vol. 11, EGU2009-4357-1, 2009
EGU General Assembly 2009

A one-dimensional model of water flow in soil-plant systems

M. Janott, S. Gayler, C. Klier, and E. Priesack

Helmholtz Zentrum München, German Research Center for Environmental Health, Institute of Soil Ecology, Oberschleissheim, Germany (priesack@helmholtz-muenchen.de, ++ 49 89 3187 3376)

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 results obtained using a three-dimensional model for water flow in and between soils and roots. Using data from lysimeter experiments with young beech trees it is shown, that the model is able to correctly describe transpiration and soil water flow.

In conclusion, compared to a fully three-dimensional model the one-dimensional porous media approach provides a computationally efficient alternative, able to reproduce main mechanisms of plant hydro-dynamics including root water uptake from soil.