Geophysical Research Abstracts
Vol. 12, EGU2010-8473, 2010
EGU General Assembly 2010


# Water uptake by a maize root system – An explicit numerical 3-dimensional simulation.

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Water is one of the most important resources for plant growth and function. An accurate modelling of the unsaturated flow is not only substantial to predict water uptake but also important to describe nutrient movement regarding water saturation and transport.

In this work we present a model for water uptake. The model includes the simultaneous flow of water inside the soil and inside the root network. Water saturation in the soil volume is described by the Richards equation. Water flow inside the roots' xylem is calculated using the Poiseuille law for water flow in a cylindrical tube. The water saturation in the soil as well as water uptake of the root system is calculated numerically in three dimensions. We study water uptake of a maize plant in a confined pot under different supply scenarios.

The main improvement of our approach is that the root surfaces act as spatial boundaries of the soil volume. Therefore water influx into the root is described by a surface flux instead of a volume flux, which is commonly given by an effective sink term. For the numerical computation we use the following software: The 3-dimensional maize root architecture is created by a root growth model based on L-Systems (Leitner et al 2009). A mesh of the surrounding soil volume is created using the meshing software DistMesh (Persson & Strang 2004). Using this mesh the partial differential equations are solved with the finite element method using Comsol Multiphysics 3.5a. Modelling results are related to accepted water uptake models from literature (Clausnitzer & Hopmans 1994, Roose & Fowler 2004, Javaux et al 2007).

This new approach has several advantages. By considering the individual roots it is possible to analyse the influence of overlapping depletion zones due to inter root competition. Furthermore, such simulations can be used to estimate the influence of simplifying assumptions that are made in the development of e[U+FB00]ective models. The model can be easily combined with a nutrient uptake model. In this way the proposed method will be capable of analysing nutrient uptake considering inter root competition as well as the solubilising effect of combined root exudation.

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