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Monitoring and Modeling transient root development as a sink distribution in the combined Penman Monteith and Richards equations

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Plant water loss, regulated by stomata and driven by atmospheric demand cannot exceed potential evapotranspiration or the maximum supply through the roots. Along the SPAC (soil-plant atmosphere continuum) roots are the weakest link. . We attempt here to predict rooting depth combined with rooting mass and water uptake using Penman Monteith equation in which canopy and aerodynamic resistances are obtained by numerical iteration of measured canopy minus air temperature radiation and humidity data.
The objective of this study was to improve the root-sink term for water extraction and thus improve predictions of transpiration and soil water distribution. The sink function is based on a mathematical model that was developed to describe the time course of roots growth and its spatial distribution , using maize as the model system. Logistic growth curve was constructed from field data to obtain three fitting parameters: 1. The mass of root(M/L3) shortly after planting. This is taken as the initial condition for the development of the roots. 2. The carrying capacity of roots, i.e. the maximal root density allowed within a given soil volume. (M/L3) 3. The time constant at which the exponential root growth rate (r) is stopped and changed to logistic curve. The process of rooting development is described by a governing ordinary differential equation using the above 3 parameters. Richards' equation was used to account for the effect of roots water uptake intensity (transpiration) combined with root's growth rate in unsaturated soil. An empirical sink-term is applied to simulate the roots water uptake when rooting depth is a time-dependent variable changing from the day of planting to maturity . Also transient root mass distribution function is introduced which is similar to the root water uptake function.
The Richards equation is discretized on the finite-difference grid and solved numerically by means of the Runge-Kutta method. The soil water profiles with and without roots water uptake are obtained and compared.