Numerical modelling of evapotranspiration processes in flatland areas

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The evapotranspiration (*ET*) is the combination of two separate processes whereby soil water is lost: surface evaporation and vegetation transpiration. Evapotranspiration has a great importance in the water cycle, specially in flatland areas where water flux is mainly vertical and has a remarkable influence in floods and droughts. Unfortunately, the estimation of *ET* is one of the most difficult tasks in hydrogeology and soil sciences due to complex interactions amongst the components of land-plant-atmosphere system.

In this work we present a new methodology to estimate actual evapotranspiration ET_A from reference evapotranspiration ET_0 by numerical modelling of water flow and physical-biological processes in the unsaturated zone. This estimation is performed by computing the water stress coefficient k_S.

The water stress coefficient k_S describes the effect of water stress on *ET* and this coefficient ranges from 0 to 1. To estimate k_S we model soil evaporation, root water uptake by plants and water flow in both the saturated and unsaturated zones of the soil.

Groundwater flow is described by the highly non-linear Richards equation in conjunction with the van Genuchten constitutive model and appropriate boundary conditions. Evaporation from soil surface is modelled as a Neumann boundary condition and root uptake is simulated by adding a sink term in Richards equation. Both the top boundary condition and the sink term are assumed to be functions of ET_0 and the Leaf Area Index (*LAI*).

Richards equation with the proposed boundary conditions is solved using a hybridized mixed finite element method for space discretization combined with a backward Euler scheme in time. Non-linear terms of Richards equation are linearized using the modified Picard iteration scheme.

In order to evaluate the performance of the proposed method, we estimate ET_A in an experimental plot located in Buenos Aires (Argentina) for the period 2003-2004. To compute ET_0 we use the FAO Penman-Monteith equation with daily resolution. The available meteorological data include air temperature, wind speed, sun shine hours, relative humidity and precipitation. *LAI* values and soil properties are obtained form the literature. Numerical results show that the numerical model is a useful tool for evaluating and predicting evapotranspiration under non-standard conditions.