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WATSFAR: numerical simulation of soil WATer and Solute fluxes using a FAst and Robust method

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To simulate the evolution of hydro- and agro-systems, numerous spatialised models are based on a multi-local approach and improvement of simulation accuracy by data-assimilation techniques are now used in many application field. The latest acquisition techniques provide a large amount of experimental data, which increase the efficiency of parameters estimation and inverse modelling approaches. In turn simulations are often run on large temporal and spatial domains which requires a large number of model runs. Eventually, despite the regular increase in computing capacities, the development of fast and robust methods describing the evolution of saturated–unsaturated soil water and solute fluxes is still a challenge.

Ross (2003, Agron J; 95:1352–1361) proposed a method, solving 1D Richards' and convection-diffusion equation, that fulfil these characteristics. The method is based on a non iterative approach which reduces the numerical divergence risks and allows the use of coarser spatial and temporal discretisations, while assuring a satisfying accuracy of the results. Crevoisier et al. (2009, Adv Wat Res; 32:936–947) proposed some technical improvements and validated this method on a wider range of agro- pedo- climatic situations.

In this poster, we present the simulation code WATSFAR which generalises the Ross method to other mathematical representations of soil water retention curve (i.e. standard and modified van Genuchten model) and includes a dual permeability context (preferential fluxes) for both water and solute transfers. The situations tested are those known to be the less favourable when using standard numerical methods: fine textured and extremely dry soils, intense rainfall and solute fluxes, soils near saturation, ...

The results of WATSFAR have been compared with the standard finite element model Hydrus. The analysis of these comparisons highlights two main advantages for WATSFAR, i) robustness: even on fine textured soil or high water and solute fluxes - where Hydrus simulations may fail to converge - no numerical problem appears, and ii) accuracy of simulations even for loose spatial domain discretisations, which can only be obtained by Hydrus with fine discretisations.