EGU22-9499, updated on 12 Aug 2022
https://doi.org/10.5194/egusphere-egu22-9499
EGU General Assembly 2022

Comparing the performances of Pedotransfer Functions with Hydrus 1D Inverse Parameters Estimation in a deep cultivated sahelian soil

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Knowledge about soil water balance and ecosystem water partitioning is crucial for managing soils in semi-arid areas like the Sahel, but hydraulic parameters are hardly available to run either parsimonious or detailed process models. This study aims at bridging this parameterization gap in a typical deep (> 2m) loamy sand soil from the groundnut basin in Senegal[1]. Five approaches of soil hydraulic parameterization with a range of different complexity were compared: (1) the lookup table of Carsel and Parrish (1988) that use only the soil texture class known as “Class PTFs”, (2) Rosetta PTFs from only topsoil characterization, (3) Rosetta PTFs with a detailed multilayer soil characterization, and inverse estimation from soil moisture using Hydrus-1D, considering the soil column either as (4) a single soil material and (5) with three-layered soil material. We compared the predicted (i) soil water content (SWC) with high-frequency measurements from 15 cm down to 200 cm deep and (ii) actual evapotranspiration (ET) with Eddy Covariance (EC) data during four consecutive growing seasons under a rotation of pearl millet and peanut crops. The simplest methods (1 & 2) resulted in a significant bias of the predicted SWC, with, however, some predictive ability of Method 2 to simulate the general trends of Swc, especially under peanut crops. Method 3 behaved reasonably with average RMSE for SWC, varying between 0.029 and 0.023 cm^{-3} cm^{-3}. Method 4 further improved the predictions with RMSE ranging from 0.013 to 0.020 cm^{-3} cm^{-3}. The best agreement was found under peanut using Method 5 (RMSE ≤ 0.013 cm^3 cm^{-3}). Methods 3, 4 or 5 behaved satisfactorily for predicting ET whatever the crop, e.g. Method 4 (RMSE= 0.05 cm day-1, NSE= 0.9 and R^2= 0.93) for pearl millet.

We showed that inverse modelling should be preferred over using PTFs when studying water fluxes and evapotranspiration in cultivated Sahelian soils.

[1] Faidherbia-Flux (FLUXNET: SN-Nkr): https://lped.info/wikiObsSN/?Faidherbia-Flux