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Hydraulic properties comparison in the calibration of CropSyst, SWAP and MACRO models in simulating soil water content for 3 years

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The quantification of the water balance components within soil-crop-climate system is strictly required to derive proper management conditions for plant growth and environmental protection.
Numerical models are currently accepted as helpful tools to gain into the processes occurring in the soil-crop-climate system and to extrapolate data. A large number of available models solves, at field scale, the water balance components by the well known Richard's equation. Despite their common basis of the representation of water flow in the unsaturated zone, it is possible that with the same pedological, climatic and agronomic management conditions, apparently similar hydrological models give different answers. Therefore, to test the capability of a model to represent reality, model simulation must be compared with experimental data and with simulations by other models.
The objective of the present study was to evaluate and compare the performances of three well known models (SWAP, MACRO and CropSyst based on the solution of the Richard's equation). Main attention was focussed on the effects of the calibration of the three models on the soil hydraulic properties parameterization.
The performance of SWAP, MACRO and CropSyst is compared using field data collected from a structured fine soil (Vertic Calciustepts located in Cerese, Mantova, Italy) cropped to maize.
The models are tested and compared on the basis of their ability to predict in situ the measured soil water content at different depths during the years 2002-2004. Water contents was measured with a TDR equipment at 5 depth, where possible with daily frequency. All three models produce acceptable predictions, as evidence by an average root mean square error (RMSE) within $\pm$ 0.031 and an average coefficient of residual mass (CRM) within $\pm$ 0.66. The SWAP and CropSyst models produces the better performance, but in absolute none of the models is consistently more accurate than the others. In any case the different behavior between the models can be attributed primarily to differences in how the models manage numerical solutions close to the bottom an upper boundaries and on the hydraulic properties parameterization. In particular, the CropSyst model has shown some limitations in following soil water dynamic for the numerical constraints in the parameterization of the Campbell's equation.

Keywords: Models comparison, SWAP, MACRO, CropSyst