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Uncertainty in the determination of soil hydraulic parameters and its influence on the performance of two hydrological models of different complexity.

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Measurements of soil hydraulic properties is often a limiting factor in unsaturated zone modelling, especially at the larger scales. Investigations for the hydraulic characterization of soils are troublesome and the accuracy of the results obtained by the different methodologies is still under discussion. Therefore it is licit to wonder whether, in the simulation of water dynamics in the unsaturated zone, the uncertainty in the determination of the soil hydraulic parameters could be so high to become more important than the modelling approach selected for the simulation.
In order to explore this issue, in this research the data collected in an intensive monitoring activity conducted in 2006 during the cropping season of a 10 ha maize field located in Northern Italy (Landriano – PV), were used to: i) compare different methods for determining soil hydraulic parameters and ii) evaluate the effect of the uncertainty in these parameters on different outputs (i.e. evapotranspiration, water content in the root zone, fluxes through the bottom boundary of the root zone) of two hydrological models of different complexity: SWAP, a widely used model of soil moisture dynamics in unsaturated soils based on Richards equation, and ALHyMUS, a conceptual model of the same dynamics based on a reservoir cascade scheme. Five are the direct and indirect methods executed to determine soil hydraulic parameters for each horizon of the experimental profile, two based on a parameter optimization to fit: a) the laboratory measured retention and hydraulic conductivity data and b) the field measured retention and hydraulic conductivity data; and three based on the application of widely used Pedo-Transfer Functions to the measurements of texture and organic matter: c) Rawls and Brakensiek (1989); d) HYPRES (Wösten et al., 1999); and e) ROSETTA (Schaap et al., 2001). Simulations were run using meteorological, irrigation and crop data measured at the experimental site for the time period June - October 2006. Results confirm the existence of a wide range of variation of the soil hydraulic parameter values evaluated with the different methods, remarkably in the case of the saturated hydraulic conductivity Ksat and the shape parameter alpha of the V-G curve (Van Genuchten, 1980). This is reflected in a variability which is, as expected, different for each model's output. This variability, in the case of the water content in the root zone and of the fluxes at the bottom of the root zone is found to be often larger than the difference between the same output simulated by the two models. Finally, it is shown that a good agreement in soil moisture patterns may occur even if evapotranspiration and percolation fluxes are significantly different, therefore multiple output variables shall be considered to test the performances of methods and models.