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The use of the SCEM-UA optimization algorithm in the calibration of the physically based hydrological model SWAP

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In the agricultural seasons 2010 and 2011, an intensive monitoring activity aimed at quantifying fluxes and storage of water in a maize agroecosystem of the Po Valley plain (Northern Italy) was carried out. In the experimental site, instruments for the measurement of water fluxes with the eddy covariance technique were installed. Additionally, in order to measure the terms of the H_2O budget also investigating their variability at the field scale, six Intensive Monitoring Plots (IMPs in the following) were identified in the field and instrumentation for the continuous monitoring of water status of the soil (moisture, water potential, groundwater table depth) was installed in each of them. In the two seasons, also periodic campaigns for the determination of biometric parameters of the crop, hydrological parameters of the soil, fluxes of water from maize leaves and from soil were conducted. The experimental field was characterized by a shallow groundwater table depth (0.6 to 1.5 m). In 2010 it was watered by border irrigation, while in 2011 no irrigation events were applied.
Monitored data were used to carry out simulations with the physically based hydrological model SWAP (Soil Water Atmosphere Plant model, Kroes and Van Dam, 2003), with the aim of assessing the relative contribution of the various water fluxes (rainfall, irrigation, capillary rise) to maize water requirements. In particular, the SWAP model was implemented using the basis of observational data collected for the two IMPs showing the main differences in terms of soil types, vegetation growth and, limited to 2010, irrigation supply. The two selected IMPs were located at the ends of a transect placed perpendicularly to the irrigation channel.
While many parameters and water fluxes necessary for the SWAP implementation and validation were measured directly, it was impossible to detect with sufficient accuracy the saturated hydraulic conductivity at different depths for the two IMPs during the two years of experimentation as well as the exact irrigation amount in each IMPs in 2010. These variables were estimated using an automatic calibration procedure based on the optimization algorithm SCEM-UA (Shuffled Complex Evolution Metropolis, Vrugt et al, 2003), one of the most powerful algorithms for the search of the global optimum currently available. SCEM-UA is available as a set of MATLAB functions (i.e. a toolbox) and has been designed to optimize models working within the MATLAB environment. The need to optimize a stand-alone executable code (SWAP.exe), whose parameters are controlled by means of a text file, required the development of an interface between SWAP and SCEM-UA.
The calibration procedure as well as the simulation results will be presented and discussed.