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Optimizing available water capacity using microwave satellite data for improving irrigation management

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This work addresses the improvement of available water capacity by developing a technique for estimating soil hydraulic parameters through the utilization of satellite-retrieved near surface soil moisture. The prototype involves the usage of Monte Carlo analysis to assimilate historical remote sensing soil moisture data available from the Advanced Microwave Scanning Radiometer (AMSR-E) within the hydrological model. The main hypothesis used in this study is that near-surface soil moisture data contain useful information that can describe the effective hydrological conditions of the basin such that when appropriately In the method followed in this study the hydraulic parameters are derived directly from information on the soil moisture state at the AMSR-E footprint scale and the available water capacity is derived for the root zone by coupling of AMSR-E soil moisture with the physically-based hydrological model. The available capacity water, which refers to difference between the field capacity and wilting point of the soil and represent the soil moisture content at 0.33 bar and 15 bar respectively is estimated from the soil hydraulic parameters using the van Genuchten equation. The initial ranges of soil hydraulic parameters are taken in correspondence with the values available from the literature based on Soil Survey Geographic (SSURGO) database within the particular AMSR-E footprint. Using the Monte Carlo simulation, the ranges are narrowed in the region where simulation shows a good match between predicted and near-surface soil moisture from AMSR-E. In this study, the uncertainties in accurately determining the parameters of the nonlinear soil water retention function for large-scale hydrological modeling is the focus of the development of the Bayesian framework. Thus, the model forecasting has been combined with the observational information to optimize the model state and the soil hydraulic parameters simultaneously. The optimization process is divided into two steps during one time interval: the state variable is optimized through the state filter and the optimal parameter values are then transferred for retrieving soil moisture. However, soil moisture from sensors such as AMSR-E can only be retrieved for the top few centimeters of soil. So, for the present study, a homogeneous soil system has been considered. By assimilating this information into the model, the accuracy of model structure in relating surface moisture dynamics to deeper soil profiles can be ascertained. To evaluate the performance of the system in helping improve simulation accuracy and whether they can be used to obtain soil moisture profiles at poorly gauged catchments alongwith the available water capacity, the root mean square error (RMSE) and Mean Bias error (MBE) are used to measure the performance of the soil moisture simulations. The optimized parameters as compared to the pedo-transfer based parameters were found to reduce the RMSE from 0.14 to 0.04 and 0.15 to 0.07 in surface layer and root zone respectively.