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Improving soil moisture simulation to support Agricultural Water Resource Management using Satellite-based water cycle observations

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Efficient and sustainable irrigation systems require optimization of operational parameters such as irrigation amount which are dependent on the soil hydraulic parameters that affect the model's accuracy in simulating soil water content. However, it is a scientific challenge to provide reliable estimates of soil hydraulic parameters and irrigation estimates, given the absence of continuously operating soil moisture and rain gauge network. For agricultural water resource management, the in-situ measurements of soil moisture are currently limited to discrete measurements at specific locations, and such point-based measurements do not represent the spatial distribution at a larger scale accurately, as soil moisture is highly variable both spatially and temporally (Wang and Qu 2009). In the current study, flood irrigation scheme within the land surface model is triggered when the root-zone soil moisture deficit reaches below a threshold of 25%, 50% and 75% with respect to the maximum available water capacity (difference between field capacity and wilting point) and applied until the top layer is saturated. An additional important criterion needed to activate the irrigation scheme is to ensure that it is irrigation season by assuming that the greenness vegetation fraction (GVF) of the pixel exceed 0.40 of the climatological annual range of GVF (Ozdogan et al. 2010). The main hypothesis used in this study is that near-surface remote sensing soil moisture data contain useful information that can describe the effective hydrological conditions of the basin such that when appropriately inverted, it would provide field capacity and wilting point soil moisture, which may be representative of that basin. Thus, genetic algorithm inverse method is employed to derive the effective parameters and derive the soil moisture deficit for the root zone by coupling of AMSR-E soil moisture with the physically based hydrological model. Model performance is evaluated using MODIS–evapotranspiration (ET) and MODIS land surface temperature (LST) products. The soil moisture estimates for the root zone are also validated with the in-situ field data, for three sites (2- irrigated and 1- rainfed) located at the University of Nebraska Agricultural Research and Development Center near Mead, NE and monitored by three AmeriFlux installations (Verma et al., 2005) by evaluating the root mean square error (RMSE) and Mean Bias error (MBE).