Jun 27th, 3:40 PM - 5:00 PM

Multiobjective optimization approach to compare evapotranspiration methods in the Cotton2K agroecosystem model

Kelly R. Thorp
USDA-ARS, kelly.thorp@ars.usda.gov

Gary W. Marek
USDA-ARS, gary.marek@ars.usda.gov

Kendall C. DeJonge
USDA-ARS, kendall.dejonge@ars.usda.gov

iEMSs International Congress on Environmental Modelling and Software

9th International Congress on Environmental Modelling and Software
Fort Collins, Colorado, USA, Mazdak Arabi, Olaf David, Jack Carlson, Daniel P. Ames (Eds.)
https://scholarsarchive.byu.edu/iemssconference/2018/

Multiobjective Optimization Approach to Compare Evapotranspiration Methods in the Cotton2K Agroecosystem Model

Kelly R. Thorp[1], Gary W. Marek[2], Kendall C. DeJonge[3]
[1]USDA-ARS-ALARC, Maricopa, AZ, kelly.thorp@ars.usda.gov
[2]USDA-ARS-CPRL, Bushland, TX, gary.marek@ars.usda.gov
3USDA-ARS-CARR, Fort Collins, CO, kendall.dejonge@ars.usda.gov

Abstract: Efforts to improve agroecosystem models require methods for unbiased comparisons among different simulation algorithms. With particular focus on evapotranspiration (ET) calculations in the Cotton2K model, the objectives of this study were to develop a novel methodology for evaluating model parameterization options and to compare model performance using three ET algorithms. The analysis used data from cotton field studies that tested fully irrigated, deficit irrigated, and dryland cotton production in 2000, 2001, and 2008 at Bushland, Texas. Measurements of ET were available from large weighing lysimeters at the Bushland field site. Other measured data included leaf area index, plant component dry matter, canopy height, counts of bolls and mainstem nodes, water content in 10 soil layers, and cotton fiber and seed yield. A Fortran-based version of Cotton2K was updated to include recently standardized ET methods, in addition to two native Penman approaches that required either daily or hourly weather input data. Using high performance computing, a Sobol global sensitivity analysis was conducted to evaluate 72 model input parameters with respect to 22 model outputs. Several model outputs were often highly influenced by cotton variety parameters that control the effect of plant density on growth, leaf growth at prefruiting nodes, prefruit node development, and probability of boll abscission. A multiobjective optimization approach based on calculation of Pareto optimal parameter sets was developed to identify feasible parameterization options for further model evaluation. Statistical tests demonstrated that the three ET methods led to differences in simulation accuracy for ET, soil water contents, and several plant growth metrics ($p < 0.05$). However, no ET method could consistently outperform the other two methods when considering the simulation outputs collectively. Regardless of the ET method used, Cotton2K tended to underestimate ET as compared to measurements from lysimetry, and simulations of two important plant metrics, leaf area index and seed cotton yield, were not simulated with root mean squared errors better than 66% and 38%, respectively. The simulation approach was useful for unbiased comparison of three ET methods in Cotton2K and suggested that techniques for simulating surface soil water flux and for linking water use with crop growth need improvement.

***Keywords**:* cotton; evapotranspiration; irrigation; multiobjective; Pareto