Hydrol. Earth Syst. Sci. Discuss., 6, C1602–C1606, 2009
www.hydrol-earth-syst-sci-discuss.net/6/C1602/2009/

Hydrology and Earth System Sciences Discussions

Interactive comment on "Calibration of a crop model to irrigated water use using a genetic algorithm" *by* T. Bulatewicz et al.

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Received and published: 21 July 2009

Comment 1

"As emphasized in the title of this paper, this paper applies genetic algorithms to calibrate EPIC. But in the text of this paper, I did not see any review of previous calibration work that has used evolutionary algorithms to calibrate EPIC or similar crop models (EPIC, APEX, SWAT, and ALMANAC) that are developed at Texas AM University and USDA ARS at temple. Please go to https://www.card.iastate.edu/swat_articles/, and summarize previous work. There are many evolutionary algorithms available. What is the major reason that inspires the authors to use Genetic Algorithms (GA)?"

Response

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Interactive Discussion

Discussion Paper

There are indeed other evolutionary algorithms available. The competing older algorithms include evolutionary strategies and evolutionary programming, and are very similar to genetic algorithms. The most popular recent approaches are particle swarm optimization and bacterial foraging optimization. In the authors' opinion, genetic algorithms are significantly more popular than the other competing approaches for practical applications. We have cited related work and included reasons for our choice of GA in the manuscript.

Changes to the Manuscript

Replace first line of section 5 with:

"The genetic algorithm (GA) (Goldberg, 1989), an optimization procedure based on Darwinian evolution, was applied to maximize H. GA possess a number of desirable features that make them an attractive optimization method for this study. They are quite robust in the presence of local optima and both theoretical studies as well as simulations with real-world problems suggest that they are quite effective in obtaining very good solutions. In addition, the vast existing literature on the topic allows one to choose from a variety of operators to suit the needs of a particular optimization problem.

For these reasons, GA have been widely employed for parameter estimation of models such as EPIC. Zhang et al. (2009) found GA to perform well compared to other optimization algorithms in the calibration of the SWAT model. Multi-objective GA have been used in the calibration of this model (Bekele and Nicklow, 2007; Whittaker 2007) as well. GA have also been used to calibrate runoff models such as HBV (Seibert, 2000) and TOPSIS (Cheng et al., 2006) as well as crop (Dai et al., 2008) and crop-related models such as SWAP (He et al. 2007)."

Comment 2

"The basic settings of EPIC needs to be addressed in section 2. For example, what are the PET and soil erosion methods used in this paper."

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Response
We agree that these settings should be included in the paper.

Changes to the Manuscript
Add to page 2371, line 10:
"EPIC can be divided into nine subroutines of which hydrology and plant growth were of interest for our simulations (Williams, 1990). The hydrology subroutine is composed of surface runoff, percolation, lateral sub-surface movement and evaporation. These processes in our simulations were controlled by the parameters used to describe the soil groups. Slope, and NRCS runoff curves, soil water content and rainfall amounts determine runoff. Percolation and lateral sub-surface movement is controlled by the soil layer data. Potential evaporation was estimated using the Penman-Monteith method.

Plant growth is determined on a daily time step based on intercepted solar radiation. Daily plant growth is estimated as a function of intercepted solar energy and plant leaf area. Daily dry matter is accumulated for the growing season that is controlled by heat units or environmental conditions (typically freeze events for summer crops) and yield is estimated using a total biomass to grain ratio, which is referred to as a harvest index. Species-specific parameters distinguish between crops."

Comment 3
"In Table 1, the authors list the parameters that have been selected for calibration. There is no Curve number, Soil erodibility factor, Nitrogen uptake, and other parameters that control and water and nutrients movement. The authors may need to justify their selection."

Response
Soil related factors such as runoff numbers were dependent upon the soil group. Fertility was assumed to be non-limiting as the focus of this paper was crop water use with an emphasis on future drainage. Although it could be argued that N and P can influence crop growth, the assumption has to be that in a water-centered research

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framework, they should not limit plant growth.

Changes to the Manuscript

"Add to page 2371, line 16:

Variables that control plant growth and canopy development (and subsequent water use) were selected for optimizations. These were WA, TB, TG, DLAI, RLAD, and RBMD (Table 1). Variables that affected irrigation timing (IRI, BIR, ARMN, and ARMX) were also optimized. Other factors that might affect hydrology (soil runoff curve and slope) were inputs based on the soil groups and growth related parameters such as fertilizer uptake were not altered as plant nutrition was not of interest and simulations were managed in a manner that nutrient stress did not affect plant growth and canopy development."

Comment 4

"From lines 10-25 on page 2372, the authors said that there are a total of 779 wells in the county, and they discarded 23 wells. For the 11-years period, there should be (779-23)*11 = 8316 well-year combination. But in line 22 on the same page, they said they used 4931 well-year combination. Some explanation should be added to address this difference."

Response

You are correct that this was not properly explained in the manuscript.

Changes to the Manuscript

Add to page 2372, line 22:

"Of the possible 8316 well-years in the simulation period (756 wells over 11 years), 4931 of them were used in the calibration. The WIMAS data reported that the other 3385 well-years either did not grow a crop or grew a crop that was not one of the four included in the this study (or multiple crops were grown)."

Comment 5

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"From section 4, I think that the parameters (10 parameters listed in Table 1) are spatially aggregated but not spatially distributed. Is this correct? The authors need to clearly state this in section 4."

Response
This was not clearly stated in the text and has been added.

Changes to the Manuscript
Add to page 2374, line 5:
"The parameter values obtained through the estimation procedure were not estimated for individual fields, as the values were assumed to be representative across the study region, which is relatively homogeneous in terms of soils, water availability, farming practices/technology, etc."

Comment 6
"A discussion on how to transfer the results obtained in this study to stake holders and decision maker may strengthen this paper."

Response
We agree that this is not clearly stated in the manuscript.

Changes to the Manuscript
Add to page 2386, line 18:
"The particular team assembled for this paper crosses the spectrum of hydrologists, agronomists, economists, and computer scientists, and the results are being shared and translated by disciplinary specialists to interested collaborators, stakeholders and agencies with which the team is working. Examples include applications of the calibrated model in both irrigation studies and in the assessment of the economic impacts of water policy on farmers in western Kansas as part of an integrated model."

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 6, 2367, 2009.