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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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Comment 1

"Page 2 (2369) line 4: All the stake holders consulted are corporate entities viz., "governmental agencies, administrative units and private sector enterprises". None of them are farmers on the field. Hence, they cannot have on filed knowledge and all their impressions are second hand, based on what little they could glean from their field workers. Thus the entire exercise remains mostly academic."

Response

It was our intent that "private sector enterprises" would include farmers. We have clarified this in the text.

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Changes to the Manuscript
Page 2369, line 3:
"governmental agencies, administrative units, and private sector enterprises"
Change to:
"governmental agencies, administrative units, private sector enterprises, and farmers"

Comment 2
"Page 2 (2370) line 1: It is stated that computational requirement mandated prototyping of many facilities required. But it can seldom be a case on field that the field practices can be safely jacketed into set prototypes. The soils differ, soil moisture content differs, precipitation is not uniform and application of water to the crops differs from field to field. Hence prototyping necessarily differs from the actual field practices."
Response
In this sentence, our use of the word "facilities" is ambiguous. Our intended meaning of the word is in reference to the computational facilities necessary for decision support systems (e.g. databases and software systems). We have clarified this in the text.

The use of crop models for a priori evaluations of crop management practices is common. In most cases, specific fields are not the focus when selecting input variables to represent soil physical properties and management decisions (planting date, seeding rate, fertilizer rates). In these scenarios, accepted regional norms or predominant soil types are used. Tan and Shibasaki (2003) provide an example of using EPIC in this capacity. [Tan, G., and R. Shibasaki. 2003. Global estimation of crop productivity and the impacts of global warming by GIS and EPIC integration. Ecol. Modeling 168:357-370.]
Changes to Manuscript
Page 2370, line 1:
"prototyping of many facilities"

HESSD
6, C1007–C1016, 2009

Change to:
“prototyping of many computational facilities”

Comment 3
“Table 2: The range, the EPIC model can handle is 10 to 30 C of optimal temperature for plant growth (TB). But the TB values of all the 4 crops considered are 5, 5, 7 and 5 C beyond the range of the model. Similar is the case of TG, minimum temperature of plant growth, the range of the model not covering the maximum values of 3 out of the 4 crops. Thus the very capability of the EPIC model is inherently inadequate to handle the max and min temperatures of plant growth, which is a serious lacuna.”
Response
The EPIC User Manual offers what it terms a “typical range” for each of the model parameters and does not indicate that these are limits or that the model results are invalid if these ranges are exceeded. We have clarified this in the text.
Changes to Manuscript
Add to Page 2371, line 10:
“Although some of the chosen parameter ranges exceed the typical ranges stated in the EPIC documentation, these typical ranges do not reflect the limits that the model is capable of simulating.

Comment 4
“Page 3 (2371) lines 2023: What KDWR reports is the total yearly irrigated water volume. The total annual volume cannot cover the intricacies of intra-seasonal variations of the crop requirements depending on various causative factors such as precipitation, soil moisture content, sunshine hours etc. This inadequacy is further aggravated by the three deficiencies, the authors themselves pointed out in lines 1-8

HESSD
6, C1007–C1016, 2009

(Page 3, 2372). Moreover, by clubbing together the water usage for two different soil groups (lines 15-23), the inherent variations for the two soil groups are smoothened out."

Response

This model is supported by high quality water-use data as mandated by Kansas water law, whereby farmers who irrigate must report information such as annual water use from meter measurements. While we agree that this data has limitations (as described in the text), we believe that it may be usable for parameter estimation.

The data include per-well water use, and each well is associated with a field of a given soil type, so the water usage across the different soil groups is not combined as each field is simulated individually. We have clarified this in the text.

Changes to Manuscript

Regarding the latter point, Add to Page 2372, line 20:
"Thus, each simulation of the crop production associated with a well utilizes one of the five sources of weather data and one of the two soil groups."

Comment 5

"Table 1: Most of the parameters considered are the values of the extremities (max or min) and practically normal values were not at all considered. The extreme values invariably present a lop-sided picture greatly different from the normal of any instant."

Response

The model requires that a variety of parameters be provided for its simulation of crop growth, and some of these parameters are the minimum and maximum values of various quantities. For example, the model requires the inputs of minimum and maximum volume of water per irrigation application, but it does not require the input of a practically normal value for this quantity, as such a value is calculated as part of the simulation. As mentioned in response to comment 2, the EPIC model is well

HESSD
6, C1007–C1016, 2009

established for crop production and its water uses.

Changes to Manuscript

None.

Comment 6

"Page 7 (2379) lines 21-23: The parameters considered were "total amounts of water on a country wide basis" and "average well capacity for all wells considered". Such aggregation and averaging inherently deviates from the performance of individual cases – crops or wells."

Response

The reference to "total amounts of water on a countywide basis" was not a parameter of the model, but rather one of the statistics we report in Table 8. Similarly, the "average well capacity" was not a parameter of the model, but was calculated strictly as a guide for identifying a possible baseline irrigation depth reported on page 2379, line 24.

Changes to Manuscript

None.

Comment 7

"Page 7 (2379) line 26: It is clearly stated that "EPIC outputs are not particularly sensitive to IRI in the range of 4-10 days". The capability of the EPIC model remains low, not to be sensitive to an irrigation interval of even 10 days."

Response

The primary motivation of this study is to evaluate the suitability of the EPIC model for crop simulation for decision support systems, and it is thus important to identify any limitations of the model that may present. As you have observed, an explicit

HESSD

6, C1007–C1016, 2009

statement of this motivation is missing from the text, so we have added it to help readers understand how to interpret the findings.

Changes to Manuscript

Add to Page 2369, line 27:

"This study evaluates the suitability of the EPIC model for providing crop simulation to decision support systems at the regional scale. In this work we chose a county size as this represents a standard land unit size for aggregation of information reported about crop production (yields, etc.), information that was needed for this study. We are also evaluating extending these methods to larger scales such as the Ogallala Aquifer portion of Kansas."

Comment 8

"Page 7 (2380): In line 17 and from Table 6, the optimum value of WA obtained by the analysis is 33.4. From lines 25-26, the corresponding value in literature cited is from 16 to 28 which is far below the obtained value."

Response

You are correct that the identified value for WA for sorghum is higher than values reported in the literature (although similar to values used in other crop models). Differences between measured values for WA and those used in simulation models are not unusual as explained on page 2381, line 11.

Changes to Manuscript

None.

General Response to Comments 9-12

Our estimated values were higher than those reported from field research, but were not different than those used in other models such as CropSyst, another biomass-Harvest

HESSD

6, C1007–C1016, 2009

Index model. In most cases, values used in crop models have been selected or identified through calibration processes such as the one we employed and most if not all had the goal of reducing differences between measured biomass or grain yield and simulated or estimated biomass or grain yield. The goal of these calibration procedures is not to necessarily to mimic measured values at every level, but to minimize errors in the values of interest, most often crop yield, water use or nutrient use. Our goals were similar in that we wanted to reduced the errors between measured and simulated crop yield and water use so as to use the resulting values to produce more accurate results in future simulations.

Comment 9

"Page 7 (2380): In line 17 and from Table 5, WA value for alfalfa arrived is 29.2 against the range in cited literature of 12 to 15 and 17.2."

Response

You are correct that the identified value for WA for alfalfa is higher than values reported in the literature (although similar to values used in other crop models). Differences between measured values for WA and those used in simulation models are not unusual as explained on page 2381, line 11. (see our general response to comments 9-12)

Changes to Manuscript

None.

Comment 10

"Page 7 (2380): In line 17 and from Table 7, WA value arrived at is 31.2 against the range in cited literature of 20 to 25."

Response

You are correct that the identified value for WA for soybean is higher than values

HESSD

6, C1007–C1016, 2009

reported in the literature (although similar to values used in other crop models). Differences between measured values for WA and those used in simulation models are not unusual as explained on page 2381, line 11. (see our general response to comments 9-12)

Changes to Manuscript

None.

Comment 11

"Similarly TB values arrived at are far above the ranges cited from the literature."

Response

For corn, the identified TB value is within the range of values used in other models and is 2.2 degrees higher than is cited in research trials.

For sorghum, the identified TB value is 0.5 degrees higher than values reported in the literature.

For alfalfa, the identified TB value is 3.4 degrees higher than cited in the literature, although it is only 0.4 degrees higher than values used in other models.

For soybean, the identified TB value is 1.6 degrees higher than values reported in one study, and within the range of values reported in another study.

Although differences exist, we do not believe that the estimated values for TB are unreasonable. (see our general response to comments 9-12)

Changes to Manuscript

None.

Comment 12

"TG for alfalfa arrived at is 0.5 C against the range in literature of 5 to 10.7 C. Such a very low minimum temperature requires proper justification."

HESSD

6, C1007–C1016, 2009

Response
It is unclear in the text that the 10.7 on page 2382, line 18 refers to the TG estimate for soybean and is not a literature citation for alfalfa TG. We have clarified this in the text. Thus, the estimated value for TG of 0.5 is 4.5 C lower than the 5 C cited in the literature, which we do not believe to be unreasonable. (see our general response to comments 9-12)
Changes to Manuscript
Page 2382, line 18:
"Our TG of 10.7 C is"
Change to:
"Our TG of 10.7 C for soybean is"

Comment 13
"Table 10: RMSE of the values of water for all the 4 crops is too high to be acceptable."
Response
Please note that the reported RMSE's are calculated from the results of all 250 parameter sets. The RMSE's for the best parameter set that was identified in the study are lower. For example, the RMSE's for the complete corn data are 1.08 t/ha for yield and 53.5 mm-ha for water. When normalized to the means, the approximate coefficient of variation of each is as follows, which are within the acceptable range commonly found in the agronomy water resources literature:

Yield: 1.08/11.4 * 100 = 9.47%
Water: 53.5/332.2 * 100 = 16.1%

Also, please note that the RMSE is a measure of well-level error (akin to the well-level relative errors reported in Table 8) which are higher than the county-level relative errors. Although the well-level errors (both relative and RMSE) may be

HESSD
6, C1007–C1016, 2009

considered high, the county-level errors are low. The goal of the optimization was to minimize the error over the aggregate and we would expect to see a better match between individual fields had the optimization been formulated as such.

Changes to Manuscript

Add to page 2385, line 20:

"These RMSE of water use and the well-level relative error (Table 8) both reflect the accuracy of the simulations at the field scale. When aggregated to the county scale, there is a significant reduction in the error (compare well- and county-level relative error of water use in Table 8)."

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