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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Assessment of Irrigation Physics in a Land Surface Modeling Framework using Non-Traditional and Human-Practice Datasets" *by* Patricia M. Lawston et al.

Anonymous Referee #3

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I. Summary

This manuscript examines the issue of developing and validating realistic irrigation schemes for use in land surface models (LSMs). In this study, the authors utilize observation-based datasets of irrigation intensity and green vegetation fraction (GVF) to tune the LSM irrigation amounts, which are validated against data obtained from Cosmic Ray Neutron Probes (CRNP). The main conclusion of the authors is that the timing, amount, and spatial spread of irrigation are more sensitive to the choice of irrigation scheme at smaller spatiotemporal scales than at larger, more typical scales for regional climate models. Given the balance of evidence presented and the use of a novel dataset (CRNP) for addressing this issue, it seems that the authors have arrived

at robust and meaningful conclusions that would be worthwhile additions to HESS and to the field of hydrology, in general. While I have no major qualms with the content or substance of the manuscript, I do present below some more minor comments for improving the robustness and presentation of the results.

II. General comments

A. NLDAS-2 – The authors mention several times throughout the manuscript the need for "high-quality" meteorological forcing and point out repeatedly the accuracy of the precipitation data from NLDAS-2 for their domain. While it certainly seems that NLDAS-2 provides accurate forcing over this domain (and is a high-quality dataset, in general), I echo Reviewer 2 in cautioning against drawing far-reaching conclusions about NLDAS-2 from this limited study. The entire study domain is 15 x 15 km, very small even for typical regional climate model simulations; the entire domain would fit in 4 grid cells of NLDAS-2 (1/8 degree horizontal resolution). Is there evidence that NLDAS-2 would provide equally accurate data for a different domain within the same region, or in a different region or year? If so, then I would provide a sentence or two explaining the skill of NLDAS-2 over the general region (e.g., Great Plains/Midwest) during the growing season (perhaps from the Xia study). If not, then please temper the language emphasizing the high quality of NLDAS-2 with the understanding that the spatial domain of this study is extremely limited and that NLDAS-2 may not be as accurate in other agricultural regions in North America.

III. Specific comments

A. Page 14, line 10 – "These results suggest that if this domain were one gridcell in a larger, coarser resolution domain (e.g. 15 km spatial resolution), the variation in the gridcell soil moisture (given here by the domain average) over the growing season would be representative of observations."

It would be interesting to see a supplemental model analysis with coarser-resolution grid cells (either in this paper or a future one) that validates this hypothesis. For exam-

ple, what is the spatial threshold at which large-scale forcings begin to dominate the changes in the soil moisture signal?

B. Page 15, line 9 – ". . .indicating that the model is quite insensitive to the maximum root depth change. . ."

Some common irrigated crops, such as alfalfa, have max root depths of 2+ meters. Though irrigated alfalfa is much less common in Nebraska when compared to corn and soybeans, it would be instructive to not make the above claim about the insensitivity of the model to max root depths unless other crops with much larger or smaller max root depths have been tested.

C. Page 15, line 22 – ". . .a growing number of options for irrigation intensity datasets in the coming years".

A new global irrigation dataset (the Historical Irrigation Dataset) was published through HESS rather recently (S. Siebert, M. Kummu, M. Porkka, P. Döll, N. Ramankutty, and B. R. Scanlon (2015), "A global dataset of the extent of irrigated land from 1900 to 2005," Hydrology and Earth System Sciences. DOI: 10.5194/hess-19-1521-2015). It may deserve a citation here because of its recent development and global coverage.

D. Figure 1 – Are the spotty areas of low irrigation intensity in the Tuned plot over urban areas? A brief explanation of this in the text may be warranted.

E. Figure 2 – It would be helpful to mention in the figure caption that SPoRT uses the climatological GVF in years 2009 and 2010 (as is already mentioned in the text) to avoid confusion.

F. Figure 4 – I don't believe that IRR was ever defined (in either the main text or the figure caption).

G. Figure 4 – The boundaries of Layer 4's soil depths are only mentioned here, not in the main text. Since crop roots barely extend into this layer (max root depths of 1 or 1.2 m), perhaps this further explains why there seems to be much more variability in

soil moisture between irrigation simulations in Layer 3 than in Layer 4.

H. Figure 8 – I think that the presentation of "spatial" CDFs in this figure is rather non-intuitive. To me, it would be much more intuitive to see the differences in the spatial distributions of soil moisture within the domain using a histogram, especially since each CDF is plotted for only a single time step and thus there is no "accumulation" of data over time. In this figure, since data is accumulated spatially (in two dimensions) rather than temporally (in one dimension), the shape of the CDF would be rather arbitrary and would partly depend on the order in which you spatially sample the grid cells.

I. Figure 8 – Neither the figure nor the figure caption explain what is being plotted in the figure. Units would also be appreciated (even if unitless).

IV. Technical corrections

A. Page 1, line 17 – "at the interannual scale, but become. . ." – Remove the comma.

B. Page 2, line 23 – "previous evaluation efforts, and introduces. . ." – Remove the comma.

C. Page 3, line 14 – e.g., "de Vrese et al. 2016" – Please be consistent with placing commas after "et al." in internal citations.

D. Page 4, line 1 – "with a two different. . ." – Remove "a".

E. Page 4, line 2 – "in the U.S. Central Great Plains. . ." – "Central" should be lowercase.

F. Page 4, line 5 – "Tuinenburg et al., 2014), or in. . ." – Remove the comma after "2014)"

G. Page 4, line 15 – No need for commas surrounding "such as these".

H. Page 4, line 23 – ". . .to reproduce county and water resource region irrigation water usage. . ." – Change to ". . .to reproduce irrigation water usage within counties and water resource regions. . .".

I. Page 5, line 17 – Change "c.f." to "cf.".

J. Page 5, line 19 – “reliable, area-average soil water content” – Throughout the manuscript, please change to “area-averaged” or “domain-averaged” (as in the above example) when being used as an adjective and “area average” and “domain average” when being used as a noun.

K. Page 6, line 9 – Change to “Sect. 3”.

L. Page 7, line 22 – “i.e. observationally tuned” – Change all instances of “i.e.” and “e.g.” to “i.e.,” and “e.g.,”.

M. Page 8, line 8 – “more sophisticated, but computationally expensive. . .” – Remove the comma.

N. Page 8, line 8 – “such a dynamic. . .” – Change to “such as”.

O. Page 8, line 14 – Change to “bias-corrected”.

P. Page 11, line 14 – “the SPoRT run increases latent heat flux by more than 100 W mˆ-2 more than Standard” – Change to “latent heat flux in the SPoRT run is more than 100 W mˆ-2 greater than Standard”.

Q. Page 12, line 15 – Add a space between “mm dayˆ-1” and “(not shown)”.

R. Page 12, line 25 – Add a comma after “(e.g., satellite)”.

S. Page 13, line 11 – “CRNP (irrigated) rainfed data. . .” – I would discourage this parenthetical style (it already seems to have confused other reviewers). If you must use it, I would recommend putting the parenthetical expression second, e.g., “CRNP irrigated (rainfed) data”. However, I would instead prefer this and related sentences to be written as: “by using the CRNP irrigated and rainfed data in the regression for irrigated and non-irrigated gridcells, respectively”.

T. Page 13, line 23 – Add a period after “dependent on these datasets”.

U. Page 13, line 25 – Change “exhibit” to “exhibits”.

V. Page 14, line 5 – Hyphenate “deficit based”.

W. Page 14, line 11 – Hyphenate “coarser-resolution”.

X. Page 16, line 3 – Remove the comma after “LSM framework”.

Y. Page 16, line 4 - Remove the comma after “latent heat flux”.

Z. Page 16, line 21 – Remove the comma after “soil moisture”.

AA. Page 16, line 23 – Change to “USDA Census of Agriculture”.

BB. Page 17, line 1 – Hyphenate “satellite based”.

CC. Page 17, line 2 – Add period after “(Kumar et al., 2015)”.

DD. Page 17, line 4 – Change “premiere” to “premier”.

EE. Page 17, line 23 – Capitalize “a” after Myhre, and ditto for all other instances of mixed case for author names in the reference list.

FF. Page 18, line 8 – Be consistent with italicizations: Either italicize all journal names or keep them all as plain text.

GG. Page 18, line 8 – Change “hess” to “HESS”.

HH. Page 18, line 28 – What does “Received” mean?

II. Page 19, line 3 – Be consistent with capitalization of the article titles: Either capitalize only the first word and proper nouns (standard practice) in every title or capitalize all words in every title.

JJ. Page 20, lines 5-9 – I think that these lines are in a slightly different font than the other references.

KK. Page 21, lines 2-3 – See above comment.

LL. Page 21, line 23 – What is “Artn”? Article number?

MM. Fig. 1 caption – Please define the units of irrigation intensity (even if unitless).

NN. Fig. 4 caption – Add a colon after “LSM default layers”.

OO. Fig. 4 caption – Be consistent with parenthetical notes: Delta Z is included for the middle layers but not for the top or bottom layers.

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