

This study introduces the new improvements of a land surface model (LSM) ISBA regarding agricultural management. The authors explicitly explain the key mechanisms and associated parameterizations of the new scheme. And the performances of the new version is validated over an irrigated area in Nebraska, US. By comparing simulated eco-hydrological components to observations, the authors demonstrate the advantages of the new scheme in reproducing crop dynamics as well as hydrological processes.

Indeed, simulating crops and irrigation in LSMs is challenging, because it must obey associated biophysical mechanisms and adapt to the complexity of diverse cultivations. It is impressive that the authors made a significant contribution and provided a comprehensive validation from various perspectives. I can see a lot of implications based on this work. Its contribution to the model development is worth being published in GMD. However, although the manuscript has improved a lot after a major revision, I think a substantial revision is still required before acceptance.

Major comments:

1. Although the title mentions a new crop scheme, I didn't see a explicit introduction to it in the main text. Moreover, there is no independent validation of the new crop scheme (i.e., correlation coefficients and RMSD between ISBA_pheno and ISBA_ref). Moreover, it is trivial to mention SURFEX_v8.1. I suggest to enrich the contents for the new crop scheme only (details see some comments below) and remove SURFEX_v8.1 from the title.

2. The manuscript is too long for readers to get the key innovations.

1) Sect 2.1: It is not necessary to introduce the details of the SURFEX platform. And please try to introduce something directly. For example, it is not necessary to mention ECOCLIMAP-II when this study used ECOCLIMAP-SG. Moreover, this sentence should appear in the section of experiment setting up.

2) There are a lot of overlaps between section 2.2 and 2.2.1. And it is still unclear for me the key differences between the old and the new scheme. Please first simply introduce the key processes implemented by the former crop and irrigation schemes without any details (i.e., parameters, formula of SWI, etc) and emphasis the key limitations of them which will be solved by the new scheme.

3) Sect 2.2.2: Although the aggregation rule is new, its key aim is to reduce the computing burden. Thus I suggest to simply introduce the aggregation process here and move the details to the supplementary materials. Moreover, the last paragraph talks about the water supply (unlimited) for irrigation. It may belong to Sect. 2.3.

4) If authors underline the difference of metrics values rather than their spatial patterns, some figures can be simplified (optional). a. Figure 6, 8, and 9: This three can be assembled together by combining their top panels together and a box plot (or a violin plot) aside instead of two associated images. b. Figure 7, 10, and 12: They can be assembled together by making three subplots with time series of boxes or violins.

5) Supplement S5 is not needed.

3. Two issues regarding validation must be dug out. Firstly, irrigation amount is highly influenced by precipitation, which however is poorly reproduced in all reanalysis data. I'm not surprise that the fairly performance of ERA5 precipitation (Fig. S4), which may lead to vast bias between simulated irrigation and census data. Thus, I suggest to show how simulated irrigation amount is improved by the new scheme in comparison to that based on the old scheme rather than to demonstrate the fit between simulation and census data.

Secondly, there are significant mismatches among ET products. Although assimilated with a lot of observations, the ET from GLEAM is a model output, not observations. The model have a very coarse representation of plant functional types, and irrigation processes is not taken into account (at least for v3.2b). So I don't think it is suitable to call it 'observations' (e.g., in Figure 9). Furthermore, it is not suitable to validate the simulated ET by GLEAM. Nothing can be demonstrated if the simulation is compared to an unreliable product. I suggest to remove this part. Other parts are sufficient to demonstrate the advances of the new scheme.

4. Line 49-50: There is still a large uncertain in terms of ET-precipitation feedback. It could either positive (rain prefers wet soil) or negative feedback (rain prefers dry soil), which relies on

numerous factors (e.g., surface heterogeneity, atmospheric boundary conditions, wind speed/direction, spatial scales, etc). So I suggest to underline the contribution of irrigation to ET-precipitation feedback but avoid mentioning where the precipitation may occur.

5. Line 67-70: It is not true. See some new works including specific crop types, cultivation schedules, as well as multiple irrigation techniques.

Leng, G.Y., Leung, L.R., Huang, M.Y., 2017. Significant impacts of irrigation water sources and methods on modeling irrigation effects in the <scp>ACME</scp> <scp>L</scp> and Model. J. Adv. Model. Earth Syst. 9, 1665–1683. <https://doi.org/10.1002/2016MS000885>

Yin, Z., Wang, X.H., Otlé, C., Zhou, F., Guimberteau, M., Polcher, J., Peng, S.S., Piao, S.L., Li, L., Bo, Y., Chen, X.L., Zhou, X.D., Kim, H., Ciais, P., 2020. Improvement of the Irrigation Scheme in the ORCHIDEE Land Surface Model and Impacts of Irrigation on Regional Water Budgets Over China. J. Adv. Model. Earth Syst. 12, 1–20. <https://doi.org/10.1029/2019MS001770>

6. Line 400-402: This is a literature at 2001. I guess both seed selection and fertilization contributes to the LAI increase. Figure 5b shows that the observed LAI in 2002 coincides with Boedhram et al. (2001). Is there an increasing trend of LAI?

Minor comments:

1. Line 36-37: It is not necessary to mention a specific region. The previous sentence already well describe the key drivers of increasing water demand.

2. Line 40: 'controlling' -> 'mitigating'.

3. Line 100: 'the' -> 'a'.

4. Line 104: Modify it to 'by driven by atmospheric forcing ..'

5. Line 149: Modify it to 'tends to optimize water withdrawal according to water extracting abilities of crops at different stages.'

6. Line 151: Modify it to 'sum of irrigated water will be validated by the ...'

7. Line 161-162: This sentence is abrupt. Consider to remove it.

8. Line 163-164: Please avoid hand-waving if there is little information about flood and drip irrigation in the manuscript.

9. Line 165: Seems Figure 1 doesn't appear in the previous content. Consider to change the order between Figure 1 and Figure 2.

10: Line 169: 'that' -> 'whether'.

11: Line 173-174: Remove this sentence.

12: Line 188: 'with no' -> 'without'.

13: Line 1001: blue dots?

14: Line 1029: For the correlation coefficient, it will be good enough if the p-value < 0.05.