Reviewer #1

Comment R1.1:

The results presented indicate the improvement in accuracy due to the introduction of crop phenology such as emergence and harvest, rather than that of an irrigation scheme.

Response R1.1:

We agree. The introduction of crop phenology processes such as emergence and harvest has a marked impact on the results, even without activating irrigation.

We propose to change the title of the paper from

"Implementation and validation of a new irrigation scheme in the ISBA land surface model"

to

"Implementation and validation of a new crop and irrigation scheme in the ISBA land surface model".

Throughout the manuscript,

"new irrigation …"

was replaced by

"new crop and irrigation …".

Comment R1.2:

Even with the introduction of crop phenology and an irrigation scheme, there is still a large difference from observations, especially in seasonal changes. The major reason for this difference may be that appropriate validation data are not used rather than model problems. For example, the observational LAI change shown in Figure 4 is odd for a crop LAI change (the model LAI change is more plausible). To solve this problem, it would be appropriate to compare the model output with the site-scale LAI and GPP observed on the farm.

Response R1.2:

We agree.

Corn is the dominant crop type in the considered irrigated area in Nebraska (Zhang et al. 2020). While the satellite LAI observations present a peak at the end of July, the modelled LAI is plateauing in August (Fig. 4). Corn LAI observations at the field scale for various agricultural management conditions are showed in Boedhram et al. (2001). These data show that the modelled LAI plateau in August at LAI values of about 3.5 m2m-2 is realistic.

In Table 4, we included Boedhram et al. (2001) LAI data for fertilized irrigated corn in 1994 and 1995.

"Corn is the dominant crop type in the considered irrigated area in Nebraska (Zhang et al. 2020). While the satellite LAI observations present a peak at the end of July, the modelled LAI is plateauing in August (Fig. 4). Corn LAI observations at the field scale for various agricultural management conditions are showed in Boedhram et al. (2001). These data show that the modelled LAI plateau in August at LAI values of about 3.5 m2m-2 is realistic."

will be added to Section 3.1.

Table 4 – Simulated mean LAI peak characteristics over Nebraska for the 1999-2018 time period for crops (see Fig. 4) and all vegetation types (see Fig. 5), together with satellite and in situ observations.

Vegetation types	LAI source	Peak LAI (m^2 m^{-2})	Peak LAI date
Crops	Satellite observations	4.9 (±0.8)	31 July
	Boedhram et al. 2001 (*)	3.6 to 4.0	12 July to 19 August 1994
	Boedhram et al. 2001 (*)	3.5	2 August to 23 August 1995
	ISBA_ref	3.6 (±0.2)	2 July
	ISBA_pheno	3.5 (±0.2)	26 August
	ISBA_pheno_irr	3.7 (±0.1)	28 August
All	Satellite observations	3.8 (±1.5)	31 July
	ISBA_ref	3.3 (±0.3)	1 July
	ISBA_pheno	3.1 (±0.3)	16 July
	ISBA_pheno_irr	3.1 (±0.3)	16 July

(*)Boedhram et al. (2001) data are for fertilized irrigated corn in 1994 and 1995.

References:

Boedhram, N., T. J. Arkebauer, and W. D. Batchelor: Season-long characterization of vertical distribution of leaf area in corn, Agron. J., 93, 1235–1242, https://doi.org/10.2134/agronj2001.1235, 2001.

Zhang, Z., M. Barlage, F. Chen, Y. Li, W. Helgason, X. Xu, X. Liu, and Z. Li: Joint modeling of crop and irrigation in the central United States using the Noah-MP land surface model. Journal of Advances in Modeling Earth Systems, 12, e2020MS002159, https://doi.org/10.1029/2020MS002159, 2020.

Comment R1.3:

L66–69: Irrigation schemes have been integrated into several large scale LSMs such as CLM. More intensive literature review on the topic is needed.

Response R1.3:

Yes. We will introduce recent references in the Introduction describing the implementation over the USA of a representation of crop and irrigation into land surface models: Zhang et al. for Noah-MP, and Felfelani et al. (2020) for CLM.

References:

Felfelani, F., D. M. Lawrence, and Y. Pokhrel: Representing intercell lateral groundwater flow and aquifer pumping in the community land model, Water Resources Research, 56, e2020WR027531, https://doi.org/10.1029/2020WR027531, 2020.

Zhang, Z., M. Barlage, F. Chen, Y. Li, W. Helgason, X. Xu, X. Liu, and Z. Li: Joint modeling of crop and irrigation in the central United States using the Noah-MP land surface model. Journal of Advances in Modeling Earth Systems, 12, e2020MS002159, https://doi.org/10.1029/2020MS002159, 2020.

Comment R1.4:

L90: Brief description on the SURFEX is needed here.

Response R1.4:

The following sentence was added:

“SURFEX integrates different models describing ocean and terrestrial surfaces. Over land, specific models are used to represent water bodies, cities, and the soil-plant system. The latter is modelled by the ISBA LSM.”

Comment R1.5:

L139–140: Describe lon. and lat. of the two places in the same way.

Response R1.5:

“40.83°N, 96.76°W”

was replaced by

“40.83°N - 96.76°W” .

Comment R1.6:

L158: Is simulated LST soil surface temperature under the canopy? Can satellite measure it?

Response R1.6:

In the version of the model used in this study, a single composite soil-vegetation energy budget is used and the thermal effect of crop residues is not represented. This means that over vegetated areas, the simulated LST can differ from the vegetation temperature as seen from space.

This will be added to the manuscript.

Comment R1.7:

L195: What is difference between the irrigation amount and the irrigation rate?

Response R1.7:

"A number of irrigation variables need to be simulated such as the irrigation amount, the irrigation rate"
was replaced by

"A number of irrigation parameters need to be assigned such as the irrigation amount, the irrigation interval".

Comment R1.8:

L216: through?

Response R1.8:

Yes, thanks for noting this.

Comment R1.9:

Section 2.4: It is better to place this section at the beginning of Section 2 for easier Understanding.

Response R1.9:

We agree. Section 2.4 will be moved to the beginning of Section 2 together with Sections 2.2 and 2.3. Section 2.1 will be placed at the end of Section 2.

Comment R1.10:

L314: Clarify ISBA_ref does not include crop phenology.

Response R1.10:

““ISBA_ref” without any irrigation (the benchmark)”

was replaced by

““ISBA_ref” without irrigation nor crop phenology (the benchmark)”

Comment R1.11:

Section 2: The detail of crop phenology and LAI development should be described.

Response R1.11:

A specific subsection on crop phenology will be added. It will be indicated that in ISBA_ref, phenology is entirely driven by photosynthesis and that no growing degree-day model is used. The only phenology parameter is a minimum LAI value of 0.3 m^2m^{-2} for low vegetation. In this study, two more parameters are used: emergence and harvest dates (Table 2). After the harvest and before the emergence, the simulated LAI is maintained at the minimum LAI value of 0.3 m^2m^{-2}.

Comment R1.12:

Section 3.1: Simply compare irrigation water amount between observations and simulations, and show the correlation and significance.

Response R1.12:

A direct comparison would not have been statistical significant because complete USGS observations were available only for 6 years during the considered time period.