Response to Referee #1

Implementations of realistic crop managements are crucial for current land surface models to better simulate crop growth simulations. This manuscript applied double-cropping and interactive irrigation in Noah-MP that better captured crop growth seasonal variations in the North China Plain. The manuscript is well written and the overall flow is clear. There were several comments need to be addressed before considering for publication.

► We appreciate the reviewer's positive feedback and helpful comments. Please find our detailed responses to each comment below.

Comments:

1. The authors mentioned incorporating crop growth is important for understanding the land-atmosphere interactions, but the manuscript did not show any land surface simulations. I suggest the authors include a result section to show how the energy fluxes and soil moisture changed with double-cropping and irrigation.

► Thanks for the constructive comments, we add Figure R1 to the revised manuscript to show the spatial and monthly changes induced by double-cropping and irrigation.

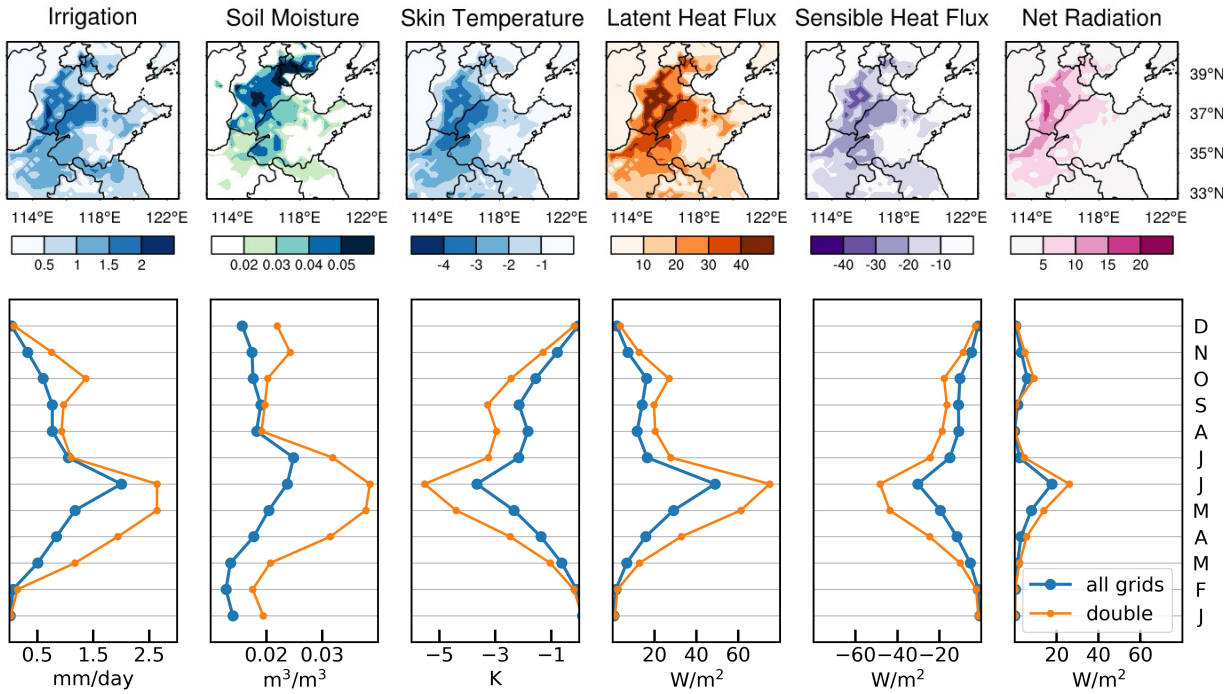

Figure R1. Irrigation-induced changes (IRRnew-CROPnew) in the climatology spatial pattern (upper panel) and mean monthly pattern (lower panel) of various variables, including irrigation, soil moisture, latent heat flux, sensible heat flux, and net radiation. The blue line represents the average value for all grids in the North China Plain (NCP), while the orange lines correspond to the double-cropping area only. (Same as Figure 6 in the revised manuscript)

Figure R1 presents the differences between the irrigation simulation (IRRnew) and the non-irrigation simulation (CROPnew). The upper panel visualizes the spatial changes, while the lower panel illustrates the monthly averaged changes for the entire NCP region (represented by the blue line) and the double-cropping region (represented by the orange line). As expected, the increased soil moisture contributes to a higher latent heat flux, with maximum increase over 40 W/m^2. Conversely, irrigation-induced evaporation cools the surface, leading to a reduction in sensible heat flux, with the sharpest decrease around 30 W/m^2. The cooler surface also reduced longwave radiation emitted from the surface, causing increases in net radiation with the greatest change about 15 W/m^2. Overall, the increase in latent heat flux surpasses the decrease in sensible heat flux, and when combined, their changes partially balance out to equal the net radiation. The most substantial changes are observed in southern Hebei province, which aligns with the irrigation fraction map (Fig. 4c). In the lower panel, all monthly patterns exhibit two peaks, with a larger peak in June and a smaller peak in September. The monthly pattern within the double-cropping area shows more pronounced changes and a more distinct two-peak structure. Furthermore, the irrigation responses of all variables display similar spatial and temporal patterns to the irrigation amount, indicating a strong correlation between irrigation application and these observed changes.

2. Although the recalibration process was described in the supplement, it still unclear whether such calibration of the double cropping scheme only at Yucheng site then applied the calibrated parameters across the whole domain? Or you perform calibration at Yucheng site and at regional scale separately?

► Thanks for the question. Yes, we conducted the calibration process initially at the Yucheng site, as demonstrated in Figure 7. Next, we applied the calibrated parameters to the entire study domain. However, to ensure the accuracy and reliability of our model, we performed validation by assessing the spatial patterns of various variables, including crop calendar, grain mass, leaf area index (LAI), and vegetation fraction (FVEG). To address any potential ambiguity, we have included a clear explanation in the revised manuscript.

3. The analysis focused on the North China Plain, but all the plots showed much large region of eastern China that seems very distractive for me. I suggest to zoom in the North China Plain for all your plots.

► Thanks for the suggestion. We have updated the Figure 7 and 8 to zoom in the NCP region. For Figure 3 and Figure 4, we think it would be better to show the whole domain so it can display the provincial differences.

4. The current flow of section 3.2 is a little bit confusing. Why only show regional crop grain yield in 2005? The validations should focus on 2005-2014. I suggest to first show the site calibration (2005) and validation (2005-2014). Then show the regional crop calendar and grain yield validation for 2005-2014.

► We appreciate the suggestion and have made the necessary adjustments. We have extended the validation period for the crop calendar to a 10-year period as recommended. However, we would like to clarify that the available observation yield data (2015+_GAEZ) is limited to the year 2015. Consequently, the validation process for grain mass is restricted to comparing the 2015 observations with the simulation average from 2005 to 2014. We acknowledge this limitation and have mentioned it in the revised manuscript.

5. Figure 8. What LAI data used in the validation?

► Thanks for the question. We used a reprocessed MODIS data from Sun Yat-sen University:

Yuan, H., Dai, Y., and Li, S.: Reprocessed MODIS Version 6 Leaf Area Index data sets for land surface and climate modelling., 2020.

We have added the information in the data availability statement.

6. Line 22-24. I don't think it is necessary to list the next phase of your research in the abstract.

► Thanks for the comment. We have deleted it accordingly, and put some implications of the study instead.

7. Line 120. The WRF model version is 4.3, but it was 4.5 in your title.

► It should be WRF4.5. We have updated it in the revised manuscript.

8. The experiment design did not mention the nesting and the domain range. The figure 1 made me think you have double-nesting domains, where the smaller rectangle is the inner domain.

► We only did one-domain simulation. The smaller rectangle just highlight the NCP region that we would like to pay more attention to. We show the whole picture since we want to apply this double-cropped irrigation to study the irrigation impact in local as well as its surrounding region, so we want to make sure the model also make reasonable performance in the whole region. We added some explicit explanation in the experiment design part to avoid misunderstanding.

Our study focused on conducting a one-domain simulation that covers the whole eastern China, with the highlighted smaller rectangle representing the NCP region of particular interest. While our primary focus was the NCP, we also aimed to assess the model's performance in the surrounding areas. Therefore, we initially presented the model performance in the whole eastern China. To prevent any potential misunderstandings, we have included explicit explanations in the experiment design section, providing further clarity on our intentions.

9. I suggest to rearrange figure 4. The color bar for irrigation fraction plot is under the targe irrigation plot. Similar problem for figure 6, you want to move the green-blue color bar up so it could underneath the maturity plots.

►Thanks for the comments. Figure 4 have been updated accordingly. But Figure 6 (or Figure 7 in revised manuscript), as the second reviewer suggested, is rearranged according to the order that they appear in the explanation. But we have include separated colorbars beneath each subplot to improve clarity. We have also explicitly stated that all "blue" subplots actually share the same color scale in the figure caption.