Dear Sir or Madam:

Thank for your time of reviewing our manuscript. We appreciate all your comments which largely improved the manuscript. The detailed replies are in blue. We hope these responses could fully address your comments.

Best wishes,

Yaqiong Lu and Xianyu Yang

Anonymous Referee #2

General comments

The authors demonstrate the impact of using anomaly forcing in the Community Land Model 4.5 on crop yield projections, as compared to using 3-hourly forcing data, for three scenarios: 1.5 °C warming, 2.0 °C warming, and RCP4.5. This is an important and timely piece of work, given that high resolution output data is not always easily available from climate models for use in driving crop components of land-surface mod- els.

The paper is well written and includes all relevant information for reproducing the key results. I have a few specific comments below to be addressed before publication.

Specific comments

Line 28 "Our approach can be adopted by other land surface models to expand their capabilities for utilizing monthly climate data" Could you elaborate on this by adding a paragraph to the discussions section to discuss the applicability of this method and these results to other models?

We added some discussions of the applicability of this method to other land surface models at line 385-388:

Our approach can be adopted by other land surface models to expand their capabilities for utilizing monthly climate data. The source code of the anomaly forcing CLM is available at post4.5crop_slevis/models/lnd/clm/src/cpl/ lnd_import_export.F90. The Fortran code could be transplanted to other land surface models which use NetCDF format atmospheric forcing.

Line 59: "biogeochemical compset is active" is jargon specific to CLM – could you replace with a more general phrase? (or add a sentence to explain what a "compset" is)

We use component which is easier for understanding.

Line 59: could you indicate what "CLM-CN" and "CLM-BGC" include? (can be very brief e.g. what the "CN" and "BGC" stand for)

We added descriptions at line 58-61:

"The crop model in CLM runs when the soil biogeochemical component is active, and it was tested with the CLM-CN in version 4.0 and tested with CLM-BGC in version 4.5, where CLM-CN and CLM-BGC are officially supported soil biogeochemical components in CLM4.0 and CLM4.5 respectively."

Line 74: add references for CRUNCEP, QIAN

We added references for CRUNCEP, QIAN at line 76:

"e.g., CRUNCEP (Viovy, 2018), QIAN (Qian et al., 2006)"

Viovy, N.: CRUNCEP Version 7 - Atmospheric Forcing Data for the Community Land Model. https://doi.org/10.5065/PZ8F-F017, Research Data Archive at the National Center for Atmospheric Research, Computational and Information Systems Laboratory, 2018.

Qian, T., Dai, A., Ternberth, K. E., and Olseon, K. W.: Simulation of Global Land Surface Conditions from 1948 to 2004. Part I: Forcing Data and Evaluations, Journal of Hydrometeorology, 7, 953-975, 2006.

Line 96: The phrase "has been in function" is not clear, so should be reworded. E.g. could replace with "has been functional" or "has been available".

We modified the phrase to has been available.

Table 1: Define abbreviations CAM and MOAR. Line 141: Change "multiplies" to "multiplied by" Line 149: Change "equation2" to "equation 2"

Here CAM is the Community Atmosphere Model, MOAR is the abbreviation of Mother Of All Runs. In the text, we modified CAM to Community Atmosphere Model and MOAR to the standard CLM forcing to avoid confusion. We also changed "multiplies" to "multiplied by" and "equation2" to "equation 2".

Line 153-155: Need to explicitly define the quantities used in these equations. Also, are the underscores intentional, or should they be subscripts instead? Consider whether the notation for each variable could be simplified (e.g. is it necessary to include the letters "var", or is this implicit?).

We simplified the terms and defined the quantities at line 155-159:

$$af_{i,j,m} = fut_{i,j,m} - hist_{i,j,m} \qquad (1)$$

$$af_{i,j,m} = fut_{i,j,m}/hist_{i,j,m} \qquad (2)$$

Where $af_{i,j,m}$is anomaly forcing signal at a location i and j in a month m, $fut_{i,j,m}$ is the averaged future value and $hist_{i,j,m}$ is the averaged historical value at a location i and j in a month m.

Replace all occurrences of "CO2" with "CO_2" e.g. lines 164, 166.

We replaced all CO2 with CO_2

Line 180: replace "R2" with "R^2".

Done.

Line 189: replace "as" with "to"

Done

Line 194: explain "bottom atmosphere temperatures". Is this the air temperature of the lowest atmospheric level simulated by CESM? What height or pressure level is this?

Yes, the bottom atmosphere temperature is the air temperature of the lowest atmospheric level. In our simulation, the bottom atmosphere temperature are simulated by CESM. CESM uses a hybrid terrain follow sigma coordinate at the bottom surface. The sigma vertical coordinate defined as the ratio of the pressure at a given point in the atmosphere to the pressure on the surface of the earth underneath it. The lowest sigma level in the CESM simulation we used is 0.9925. So the pressure of the lowest layer is 992.5 hPa if the surface pressure is 1000 hPa. The actual height of the lowest atmospheric level varies across gridcells.

Line 205-6: "we set the maximum precipitation anomaly ratio to 5 to avoid unrealistically extreme precipitation levels". Can you add an explanation of why is this necessary i.e. what are causing these extreme precipitation levels, with references.

Ratio 5 was suggested by NCAR scientists David Lawrence and Sean Swenson, who are core developers of CLM and wrote the initial anomaly forcing code in CLM. Most of unrealistic extreme precipitation ratio are actually due to the nearly zero historical precipitation (the denominator). The cap for the precipitation anomaly ratio is use to avoid such situation.

Figure 2 caption: Change "1pt5, 2pt0" to "1.5 $^{\circ}$C, 2.0 $^{\circ}$C"

We modified the caption of Figure 2.

Line 237-9: "For irrigated crops, such overestimations in the northern US and Europe disappear (Figure 3g-i) because sufficient irrigation was added to the irrigated soil col- umn; as long as there is plant water stress which removed water availability impacts on crop yields." Can you clarify this sentence, since at the moment it seems counter- intuitive (did you mean something like: "because sufficient irrigation was added to the irrigated soil column to prevent plant water stress, which removed water availability impacts on crop yields"?).

For the rainfed crops, the anomaly forcing CLM had higher soil moisture at planting due to higher snow cover so the crop yield was higher in the anomaly forcing CLM. But for the irrigated crops, the standard CLM also received plenty of water from irrigation, so the water stress disappeard in standard CLM.

We clarified this sentence at line 241-243:

"For irrigated crops, such overestimations in the northern US and Europe disappear (Figure 3g-i) because sufficient irrigation was added to the irrigated soil column in the standard CLM, which removed the plant water stress that was seen for rainfed crops."

Fig 3 caption: "the historical crop map in 2005". Can you add the reference?

We added the url for the data in Figure 3 caption: MAPSPAM 2005; https://www.mapspam.info/

Lines 267-272: Is this the first time these "standard CLM" yield projections have been published? If yes, could you add a discussion, including a comparison to other yield projections in the literature for these scenarios. If not, could you add references.

The crop yield projections have been published in Ren et al., 2018. We added the citation at line 268: "in the standard CLM (Ren et al., 2018)"

Ren, X., Lu, Y., O'Neill, B. C., and Weitzel, M.: Economic and biophysical impacts on agriculture under 1.5 °C and 2 °C warming, Environ Res Lett, 13, 2018.

Line 368: give reference for UN FAO yields

We added the url for UNFAO crop yield statistics at line 372: http://www.fao.org/statistics/en/