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 #1

This manuscript presented the first evaluation of the anomaly forcing mode for crop yield simulation with CLM4.5 in CESM. The authors created anomaly forcing datasets for three climate scenarios (1.5 ˚C warming, 2.0 ˚C warming, and RCP4.5) and con- duct global CLM crop simulations using the compset of CLM45BGCCROP at a spatial resolution of 1.9 by 2.5 degrees. The authors found that the anomaly forcing CLM could not produce crop yields identical to the standard CLM with subdaily forcing, but captured the relative changes between scenarios and over time, as well as regional crop yield variations.

Overall, this manuscript is neat. It fits the "model evaluation" category of GMD and should be very interesting to the broader community. It is well written and organized. I only have the following minor concerns for the authors to consider.

it is not very clear to me how the authors calculated the "forcing variance R2" as shown in Fig. 1. The definition in the caption is unclear. Does "every ten year-averaged monthly variance" represent variance of very ten-year-averaged monthly forcing or I should interpret it by the wolds themselves? It would be good to also note the sample number for it, which would help the understanding.

We added descriptions in the method section at line 202-203:

We calculated the variation for twelve months in each decade, so we have 7 decades and 12 months variance and the sample size is 84 when setting up the regression.

I suggest the authors give more details on how to calculate the averaged yield across different crop species and regions for a specific country/region as shown in Fig. 4 and other maps. Is it simple area-weighted average?

The integrated crop yield are area weighted crop yield. The crop area map we used was MAPSMAP (https://www.mapspam.info/) 2005 crop area. The regional average in Figure 4 are simply the regional average of integrated crop yield.

L165: could you elaborate why the computational cost is high when using transient CO2 and nitrogen fertilization? Is the higher computation cost from the "transient CO2 and nitrogen fertilization" simulation itself (compared with constant CO2 and fertilization cases) or just more experiments?

Using transient CO2 and nitrogen fertilization did not add extra computational cost. Here me mean computational cost due to more experiments.

L252-L253: what's the consideration for not masking the insignificant differences here?

We did not mask so the readers can have a better visualization on the detailed bias, even they are insignificance. Because I feel it would help some readers who cares about the overall bias.

In the discussion part, the authors discussed the potential causes for some exceptions, which is good. However, I suggest the authors give some example figures for those exceptional data, either in the main manuscript or in the supplementary materials. It would help strength the statements in this part.

We included three figures in the supplementary materials and referred these figures in our discussion. We hope that could strength the discussion. In particular, we add Figure S1 to show the grain fill days difference between anomaly forcing CLM and standard CLM; Figure S2 to show the percentage differences of leaf area index, gross primary production, soil water, latent heat flux, and sensible heat flux between anomaly forcing CLM and standard CLM; Figure S3 to show the percentage differences of boreal summer latent heat flux differences between anomaly forcing CLM and standard CLM.

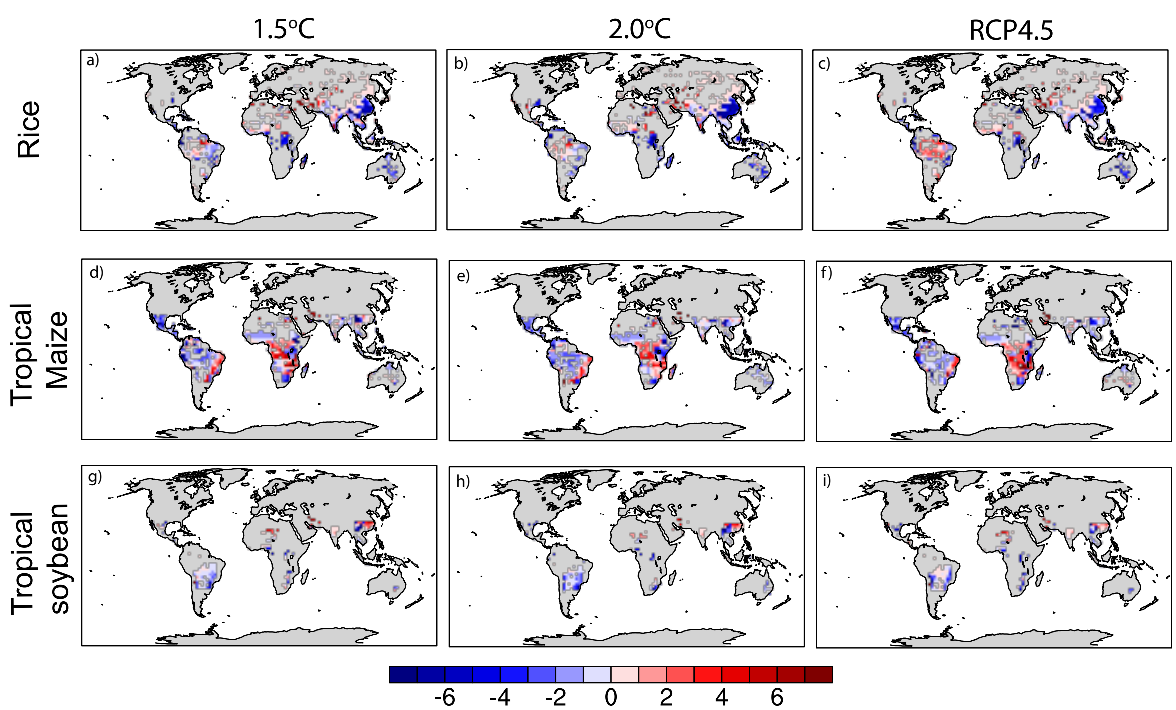

Figure S1. 70-year averaged differences of grain fill days between the anomaly forcing CLM and the standard CLM for rice (a-c), tropical maize (d-f), and tropical soybean (g-i) for the 1.5ºC, 2.0 ºC, and RCP4.5 scenarios. All differences shown here are statistically significant differences tested by the Kolmogorov-Smirnov test with a sample size of 84. The gray areas are regions that did not show significant differences.

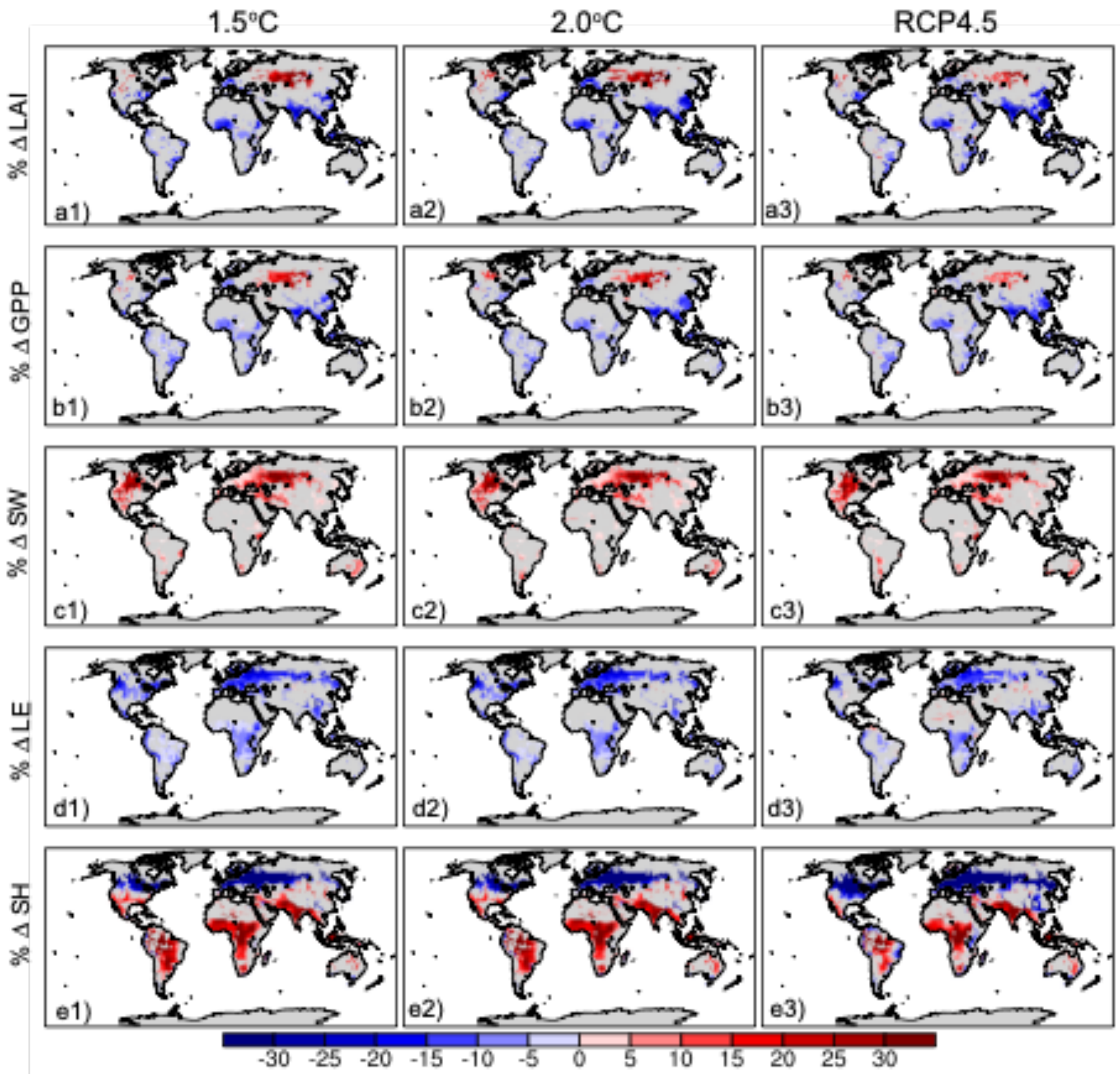

Figure S2. The percentage differences between the anomaly forcing CLM and the standard CLM for Leaf Area Index (LAI; a1-a3), Gross Primary Production (GPP; b1-b3), Soil Water (SW; c1-c3), Latent Heat Flux (LE; d1-d3), and Sensible Heat Flux (SH; e1-e3) for the 1.5ºC, 2.0 ºC, and RCP4.5 scenarios. All differences shown here are statistically significant differences tested by the Kolmogorov-Smirnov test with a sample size of 84. The gray areas are regions that did not show significant differences.

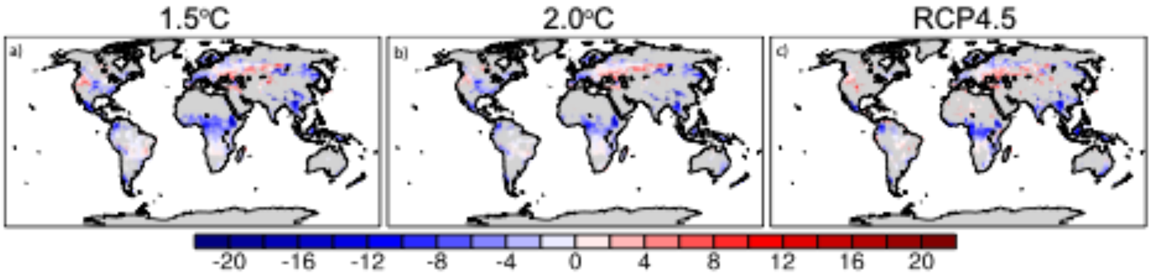

Figure S3. The percentage differences of boreal summer latent heat flux between the anomaly forcing CLM and the standard CLM for the 1.5°C, 2.0 °C, and RCP4.5 scenarios. All differences shown here are statistically significant differences tested by the Kolmogorov-Smirnov test with a sample size of 84. The gray areas are regions that did not show significant differences.

Figure 4 is not referred in the manuscript at all.

We referred figure 4 at line 269

L340-L341: "is due are due"->"are due"

We revised the typo at line 343.

It would be good to give some implications for CLM5.0 too in the final discussion part. For example, whether there is any changes of the anomaly forcing mode in CESM2.0 and whether the results for CLM4.5 still holds for CLM5.0. That would be also helpful.

We added some discussions of the implications for CLM5.0 at line 378-384:

The anomaly forcing method in CLM5.0 remains unchanged so the bias due to anomaly forcing may still exists in CLM5.0. For example, CLM5.0 uses the same threshold to differ rain and snow, so the bias due to higher snow cover in the Northern Hemisphere may still exists in CLM5.0. However, the crop model in CLM5.0 includes new features as reported in Lombardozzi et al., (2020). For example CLM5.0 uses time-varying spatial distributions of major crop types and has updated fertilization and irrigation schemes. These updates of crop model in CLM5.0 may improve crop yields of anomaly forcing CLM5 compared to crop yield in reality.