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Earth System Dynamics
Discussions

Interactive comment on "Projected changes in crop yield mean and variability over West Africa in a world 1.5 K warmer than the pre-industrial" *by* Ben Parkes et al.

Anonymous Referee #2

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The paper intends to quantify the changes in maize, sorghum and millet yields in West Africa under 1.5°C of global warming. This is done based on a mixture of process based and empirical crop models. The selection of the different models for projections of individual crops and testing for two adaptation strategies seems to be primarily driven by availability and could be better motivated or the differences in results could be analyzed better to get some understanding of the problems associated with the projections (e.g. missing information about today's management) rather than just the numbers.

1. Information about crop models: The basic characteristics of the crop models should

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be given in the main text (Which models do account for CO2 fertilization? etc.). The predictors and equations of the statistical models have to be provided.

2. Entire distribution of changes in crop yields: Instead of showing the heat maps of mean changes it would be much better to report the results of the individual models to illustrate the spread in the projections and allow for a risk assessment that does not only depend on ensemble mean changes but also on the range of plausible projections. For example, each individual simulation could contribute one dot to a scatter plot of present-day mean yields (x-coordinate) against relative changes in yields from present-day climate to a "1.5°C world" (y-coordinate). All simulations generated by one crop model could be shown in one color. Such plots could be provided for the entire region or individual countries. I consider it particularly problematic to simply average across models accounting for CO2 fertilization effects (GLAM and ORCHIDEE-crop (I assume although it is not stated in the SI)) and others that do not (Sarra-H and the statistical models (I assume)). This could be avoided on this way.

3. Representation of present day management in process-based models: The paper needs a more detailed discussion to what degree the process-based crop models represent present day management (fertilizer input, specification of growing seasons, representation of multi-cropping). Is there additional information about growing season or fertilizer input to evaluate the models assumptions?

4. Inter-crop model spread of projected changes: It is usually hard to really explain model differences. It may be impossible. However, any idea would be extremely valuable and should be discussed to advance the field and create a better understanding of the processes and potential deficits in their representation.

5. Comparison of return periods of crop failure: How are the return frequencies of crop failures derived? I assume that they are determined from crop-model specific samples of N = 16 climate simulations x 20 years = 320 data points. In this case it could be an artefact that the distribution of yields at 1.5°C of global warming is wider (and po-

tentially less normal) than the associated present-day sample: The 1.5°C distributions simply comprises the inter-climate model spread of the simulations which is reduced in the present-day sample due to the underlying bias-correction. To avoid this artefact the change in variability would have to be estimated within each individual climate model. Averaging across the different climate models would have to be done afterwards. However, that approach would reduce the sample size to only 20 (or 30) years, probably not enough to robustly estimate crop failures in the proposed way. So it may only be possible to compare the standard deviations (or percentiles) of both 20 (30)-year samples (present-day vs 1.5°C) as an alternative measure of the variability.

6. Assessment of adaptation methods: Figure 7 is hard interpret. I think it would be better to 1) show the effects of the on present-day distributions in one panel and 2) show the effects on the 1.5°C distributions in a second panel. In each panel the 16 values of simulated yields (from the 16 climate model simulations) for one model setting could be shown in a box plot such that the first panel would include four of them (one from the default simulation and three from the alternative ones). The second panel could show the associated box plots of relative changes in yields.

Given the uncertain representation of the current present-day management in the crop models and the artificial turn-off of the heat stress routine in GLAM I am wondering whether the analysis could be really considered as an adaptation scenario. It may be better to frame it as a test whether the simulated yield changes are more driven by temperature stress or water scarcity. In this sense one could think about a more general indicator that measures these stresses in the process-based simulations. It would be a way to include the other models, too. It would be good to include the other models in this assessment.

More specific comments: P2L9-P3L2: Add the level of global warming or at least the emission scenario and the timing when discussion the crop yield changes found in other studies. Do they account for the CO2 fertilization effect or not? Are projections based on the assumption of no adaptation? All the reported changes are conditional

on these assumptions and are meaningless otherwise.

P2L9: Crops could also be imported. Add the information to what degree the considered countries currently fulfill their demand.

P2L12 : Add the information which of the considered crops is C3 or C4 as the differences in CO2 fertilization effects are discussed before.

P3L5: I am wondering whether the aim of the paper really is to “identify and quantify some of the sources of uncertainty in the West African agriculatural system as the global climate passes 1.5°C”. Is it not a probabilistic projections of the impacts of 1.5°C of global warming on crop yields?

P3L15: Is there a trend in the reported crop yields, e.g. due to technological progress? Such a trend is probably not expected from the crop model simulations that do not account for these effects. Could that explain part of the difference between the present-day simulations and observations? The technology or management induced trend in the observations would also lead to a wider distribution of the observed present-day yields and the simulated ones. How do you account for these effects?

P5L11-13: are the differences due to different warming levels considered in these studies?

P5L14: How is the IAV calculated? See potentially associated problems mentioned in the general comment above. Differences in the variability of observed and simulated crop yields could also be induced by the technological progress affecting the observational data but not represented in the observations or differences in the variability of the climate forcing compared to the observed weather fluctuations. To what degree does the bias-correction the adjust the variability of the simulated climate to the variability of the observed climate?

P6: There should be some more detailed information about the representation of high temperature effects within GLAM.

Section 1 of the SI What does it mean that “GLAM used the maize yield data as an input” (SI)? Is the model calibrated to reproduce reported yields in the historical period when forced by observational climate data?

Minor issues: P2L4: “or” instead of “of” P2L9: “need to increase” instead of “need increase” P2L19: change “predicted” to “projected” as the results are conditional on the emission scenario. P3L9: “Two adaptation methods. . .” instead of “The use of two adaptation options. . .” P3L18: Would be good to directly name it RCP8.5 P4L26: “With increases” instead to “with to increases” P6L9: “simulation for the historical period” instead of “Simulations in for the historical period” P6L16: Change “predicted” to “projected” P6L32: Delete “agree” Caption of Figure 1: I do not understand the sentence “Sarra-H indicates the model simulating the 90 day variant of maize.”

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