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Interactive comment on "Impacts of climate change and climate extremes on major crops productivity in China at a global warming of 1.5 °C & 2.0 °C" *by* Yi Chen et al.

Anonymous Referee #1

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General:

Given the ambitions of charges of Paris Climate Agreement, the authors consider and quantify the climate impacts to maize, wheat, and rice in China, focusing on mean yield impacts, climate extremes, and variability. The authors take an ensemble approach using multiple climate models and the MCWLA family of crop models to conduct a large set of gridded simulations, allowing them to assess both the country level responses in each crop, but also consider the regional heterogeneity in response. The authors also consider these impacts with CO2 fertilization turned off and on – a critical source of uncertainty and needed dimension in all climate-crop projections, particularly un-

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Discussion paper

der high mitigation scenarios. In general, the authors find that though some negative yield impacts occur, particularly in maize, most declines are marginal and the potential national mean gains in crop yields, particularly wheat and rice, could considerably outweigh any deleterious effects of 1.5ËŽC-2ËŽC temperature rises. Gains in crop yields are a result of both enhanced solar radiation and more optimal thermal regimes for photosynthesis, and the impacts of CO2 fertilization further amplify regionalized yield gains. While the effects of extremes are important and locally impactful – the authors show extreme effects even with the productivity boosts of CO2 fertilization - these too have limited national impact. The authors conclude that so long as heavy mitigation takes place to limit large global temperature increases, China could take advantage of more optimal growth conditions that come with 1.5ËŽC-2ËŽC.

In general, this study is strong and fairly comprehensive in considering many aspects of climate change and crop growth, following methodologies that are now becoming standard for climate-crop assessments (ensemble approaches, with/without CO2 effects, assessing both mean changes and extremes, as well as variability). As such, I find this study to fit nicely into the growing body of climate-crop literature, and its focus on China is additive and widely useful. I particularly liked the clarity of the visualizations, as it was quite interesting to read not just about the country totals, but also consider the spatially distributed impacts, which follow clear gradients in surface attributes across China. I think this study also comes at a opportune time, in the context of several other 1.5ËŽC-2ËŽC assessments resulting from the Paris charge and so this will be important to publish sooner rather than later.

While I think this study is mostly comprehensive and complete, I do have suggestions for minor edits and clarifications that could help the work become accessible to wider array of readers, and eliminate some outstanding questions. As such, I recommend this study for publication after some minor edits are addressed.

Line Specific Comments:

Page 2, Lines 10-15: Perhaps good to have a more updated reference on the CO2 effects, as they have been more incorporated and studies in recent crop modeling exercises (e.g. see (Deryng et al., 2016))

Page 2, Lines 28-35: Line beginning with “So far there. . .” needs a rephrase, as it is long and awkward. In fact there are several examples of this dotted throughout the manuscript, so I recommend that this work receives a thorough editing to help with clarifying the sentences, as this will help to better convey the results.

Page 3, Lines 5-10: While the climate data has been well described, more information could be made available as to where the crop system information was sourced from. I’m guessing this came from national databases and statistics? It would help to know if someone wanted to reproduce components of this or use the same cultivation areas.

Page 3, Line 13: The historical time period needs to be corrected to 2006-2015 (not 2115)

Page 4, Line 5-10: The authors do cite prior studies here in their description of model validation and calibration, but I think there is room to add a couple of sentence regarding how regional or gridcell differences in management were handled (even if just summarized from prior studies). As one reads through the results, questions may arise of how management contributes to some of these patterns, particularly as one muses about impacts and adaptation. So having just a bit of explanation here on how management regimes change or how that was treated would be helpful (as this can be difficult to implement on a grid). If there is no space, it could be useful to put this in an appendix (with maybe some reference or table of the various parameter sets used).

Pages 4-5, Lines 30-3: I think the section on how heat stress and drought were defined and/or classified within a time period needs a bit more explanation. As I understand it based on what’s written, it seems that within a time period, periods that past a threshold for drought or heat stress were binned separately from periods that did not meat that threshold, and then the difference was taken. These differences were then compared

between time periods. Is this correct? I think how you classified these events needs more explanation, as it's not quite clear from the short amount of text shown here.

Page 5, Lines 10-30: I understand that the authors had a lot of power in their dataset, given the 70-member ensemble. I also appreciate that the under 1.5ËŽC-2ËŽC conditions, differences in crop response are bound to be somewhat small. However, I don't see a mention at all with respect to significance, particularly when some of these areas are bound to be highly variable. There is an opportunity to discuss this in the variability section later on, but I think that comes too late.

I do not think the significance needs to be over-emphasized as these changes are quite small, but it should still be addressed – and important point here being that under high mitigation scenarios, general yield variability owing to weather and CO2 effects and other factors might still be a more dominant forcing than climate change itself. These ideas could be addressed more in your discussion as well, as they would be consistent with other studies (for example in Section 4.3) that talk about driving uncertainties in climate-crop assessments.

Page 5, Line 30: I suggest that every where you use "slighter" in the manuscript, you replace it with "smaller" or something along those lines as the wording is a bit off.

Page 8, Line 2 and Figure 7: The two rows of picture in each sub-panel look exactly the same. I understand the authors said that CO2 made little difference on the impact of extremes, however it is impossible to tell any difference in the figures. I think when dealing with small differences, it would be better to show a difference plot between no CO2 and with CO2 so that the reader could better visualize how small or regionally different the change in impacts are.

Page 8, Lines 22-30 and Figure 9: Can the authors clarify here: is this exactly what's written – the standard deviation in the yield changes or anomalies? Or is this the change in SD/variation between the historical and 1.5ËŽC-2ËŽC? I think it's the former, but I think it could also be helpful to show the latter as well. The first way speaks a bit

to the uncertainty in the changes, while latter shows how the yield variability changes between scenario, and I was wondering about that as well.

Page 9, Line 25: Please break up this first sentence as it's a bit long to read in its current form

Reference Deryng, D., Elliott, J., Folberth, C., Müller, C., Pugh, T. A. M., Boote, K. J., Conway, D., Ruane, A. C., Gerten, D., Jones, J. W., Khabarov, N., Olin, S., Schaphoff, S., Schmid, E., Yang, H. and Rosenzweig, C.: Regional disparities in the beneficial effects of rising CO2 concentrations on crop water productivity, Nat. Clim. Chang., (April), doi:10.1038/nclimate2995, 2016.

Please also note the supplement to this comment:
https://www.earth-syst-dynam-discuss.net/esd-2017-99/esd-2017-99-RC1-supplement.pdf

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