Authors' responses on reviewers' comments

esd-2019-8: A multi-model analysis of teleconnected crop yield variability in a range of cropping systems

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We are delighted to hear that the editor and the reviewer were satisfied with our replies and revisions. We want to thank the reviewer and the editor for their comments and suggestions, as they have improved the quality of this study considerably. Please, find our responses to the reviewers' remarks below.

R1.1 The data used in the regression is a bit unclear to me. Since the model only simulates one growing season, this means that there is only one harvest per year. Are the climate indices used in the regression based on the harvest year or the sowing year, when they are different? Also, if there is only one growing season per year, why do the results change if the growing season is defined starting in May versus in January?

A1.1 Usually, an annual crop yield value is allocated to the year that the crop is harvested (Müller et al. 2017). Here, to align with the timings of these climate oscillations, that affect crop growth during the growing season not only at the moment of harvest, we have allocated the crop yield values based on sowing dates, where the "harvest year *t*" refers to the period from the beginning of May (year *t*) until the end of April (year *t+1*). For ENSO and NAO, the indices are calculated for December (year *t*), January (year *t+1*), and February (year *t+1*), while for the IOD, the index is calculated for September, October, and November (year *t*).

The results can change depending on how the crop yield values are temporally allocated. For example, areas where crops are planted after the beginning of May (year *t*), and harvested before December (year *t*), crop yields are now allocated to year *t*, but were previously allocated to year *t-1*. This would be the case for example for maize in some parts of the United States, where, according to the model input data, maize is planted after May, and harvested before December. As for example a La Niña event is often preceded by an El Niño event (Anderson et al. 2017), this could have an effect on the observed sensitivity direction as well.

We have revised the manuscript to clarify and discuss the points mentioned above (Page 6 Lines 10-11 and Line 20 and Page 18 Lines 5-14).

R1.2. Please provide some discussion of how the impacts of the same index on different crops can vary in the same region. For instance, in Line 20-22 on page 12, it is stated that wheat and maize have negative sensitivity to NAO but Soybean has the opposite. Is that because these are grown at different times of the year or because these crops respond differently to the NAO induced climatic conditions? Presumably negative soil moisture would be bad for all three crops.

A1.2 It is empirically known that the same climate oscillation index can impact distinct crops differently (Iizumi et al., 2014). However, revealing the exact reasons are challenging because of many potentially contributing factors. For soybean in the Middle East, based on the model input data, sowing dates vary from location to location (in some areas soybean sowing occurs in Spring before May, while in other areas soybean is planted later in the year) and also depending on the irrigation set-up used. This instability in sowing dates might have an impact on the observed signal, compared to maize and wheat which have spatially more stable growing seasons. We have now elaborated on these points in the manuscript (Page 11, Lines 15-19).

All in all, the question here relates to a fundamental issue regarding this study (raised in the original manuscript and discussed during the review process as well). The ultimate aim of research on this topic is to provide a mechanistic understanding of the effect of climate oscillations on crop yield, mediated by weather throughout the growing season. This is, however, too complex a task at this time, and this study is therefore limited to providing correlation-based evidence of association between climate oscillations and crop yield (with additional analyses of association of climate oscillations and weather added at the reviewers' request). Substantial assumptions are therefore made regarding treatment of temporal relationships (comment R1.1), and the ability to explain results is limited (comment R1.2). We trust that with the additional changes mentioned, the nature of this work is now sufficiently clear to the reader.

References

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