

Interactive
Comment

Interactive comment on “Intercontinental trans-boundary contributions to ozone-induced crop yield losses in the Northern Hemisphere” by M. J. Hollaway et al.

Anonymous Referee #1

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In this study, the authors examine the effects of local NO_x emissions on local and downwind ozone production and the resultant effect on crop yield. Results were calculated using current estimates of NO_x production and hypothetical situations in which NO_x emissions in selected regions is eliminated. This was done using a model that estimates movement of chemicals through the atmosphere, which used meteorological data and chemical emissions data as inputs. The effect on crops was estimated using previously determined yield dose-response functions to various ozone concentration indexes and global crop distribution maps. Models of ozone concentrations generally match ground-based observations well, but with occasional problems in certain regions at certain times. The authors found that local emission of NO_x has large effects

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on ozone concentrations in countries downwind of emissions, and hence regional NO_x emissions affect crop yields not only regionally but in other countries as well. Estimates of how strongly emissions in a region affect ozone concentrations and yield in other regions are dependent on atmospheric dynamics and the ozone concentration index used. The study seems well conducted with some minor complaints below, and the questions and findings are important for several reasons, one is that the findings provide a good impetus for countries to cooperate to lower NO_x emissions, since the results suggest that the benefits to crop yield would be strongly mutually beneficial.

The study overall seems well conducted and shows that there are strong transboundary effects. However, I am somewhat skeptical of the magnitude of the effects because the choice of a single growing season for all crops and locations would give poor estimates of yield loss. Aside from that, I think there would be a lot of value in calculating how the percentage reductions in losses translate into increases of production. Clearly, the results show that there are transboundary effects, but to understand the importance of those effects, they need to be expressed in different terms. For example, a regional reduction of emissions in Europe eliminates all wheat yield losses from emissions locally and eliminates about 40 % of losses in North America. There is no indication of how large those losses are though. If wheat production in North America is decreased by 1 % because of European emissions, then eliminating losses from European emissions would have almost no influence. I would like to see something like Figure 8 but showing increase in production. I do not think that would be necessary for publication, but such information would be a valuable tool for convincing international policy makers that there is real economic value in cooperating to reduce emissions, and it would likely result in a publication with considerably more impact.

The biggest problem I see is the use of the same growing season for all crops in all areas (May to July in the Northern Hemisphere with a 6 month offset in the Southern Hemisphere). The justification for this is that it “enables more comparability between the effects of the emissions reductions and the subsequent impact on ozone-induced

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yield losses for each of the crops.” To me it seems that this was done only because it was simpler than defining a different season depending on location and crop. It makes comparing effects of emissions reductions on ozone concentration easier, as claimed in the quote, but it certainly seems to make it impossible to compare the effects of emissions reductions on yield losses between crops, despite the claim in the quote. Crops have different growing seasons depending on species and location, and ozone concentrations are highly variable spatially and temporally. The indexes calculated here will only partially reflect what the crops were actually exposed to, which means using those indexes in a dose-response function will likely give a rather poor estimate of the effect on yield. If the only goal is to show that there are transboundary effects, then this may not be that important, but I think this study could be greatly improved by going a little further and showing how eliminating regional emission would increase transboundary production, and I don’t see how good estimates could be made using the same growing season everywhere for everything. Not being very familiar with the resources required to run these models, I do not know how feasible that would be, but I do know that the SAGE group has data sets for this, although they do have substantial limitations.

On page 8658, the authors make the argument that AOT40 is a less robust index for modeling than Mx indices because model biases when using AOT40 are more variable. I am not sure this is a complete argument though. The utility of the index would depend on both how well it can be modeled and how well it predicts yield loss, which is not discussed.

In the last full paragraph of 8657, I think it needs to be specified that this is over the growing season because there are many months throughout the year where the model is outside of one standard deviation.

Overall, the manuscript is quite easy to read, but there are numerous grammar mistakes and several places where the wording could be improved. I have listed some suggestions, but it would be nice if the manuscript were thoroughly proofread.

The sentence starting on Pg 8652 L 5 is difficult to follow.

Pg 8647 L 7, I think the description of NO_x should be done with words because the notation used incorrectly implies a chemical or mathematical relationship.

Throughout the paper, “ozone” is used in place of “ozone concentration”. It makes no sense to say, “led to increased ambient ozone over many regions.”

Pg 8646, L 11, “Northern Hemispheres” should have an apostrophe, likewise for Pg 8652 L 10, “Hemispheres” and Pg 8652 L 23, “regions.”

The words “transboundary” and “AOT40” are inconsistently hyphenated.

There are a few places with comma splices, e.g., Pg 8647 L 19 and Pg 8656 L 23.

The spelling of “modeled” is inconsistent.

In the list of emissions scenarios on Pg 8652, it is not clear why they all start with “as control scenario.”

The word “data” is plural.

Pg 8653 L 11, S.I. convention is a single space or a dot between units when they are multiplied. As a very nitpicky point, panel d in Figures 5, 6, 7, and all panels in Figure 10 have strange values in the legends. I doubt that they need to go out to 3 decimal places, and a nice round spacing between intervals would be nice.

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