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Atmospheric Chemistry and Physics Discussions

Interactive comment on "The effects of global change upon United States air quality" *by* R. Gonzalez-Abraham et al.

Anonymous Referee #2

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The Effects of Global Change upon United States Air Quality

R. Gonzalez-Abraham et al

The authors present findings related to the application of the WRF and CMAQ models to downscale future climate predictions estimated with a global model simulation. They find that improvements in ozone and PM air quality due to decreases in anthropogenic emissions are somewhat offset due to climate change and increases in global emissions. The manuscript is generally well written and the approach is thoroughly described. However, certain aspects of the study need further explanation. The scope of this manuscript in its current form does not present particularly novel work in this area, especially for ACP.

The current year model performance is concerning. If these results are consistent with other downscaling efforts then maybe that is a notable addition to the literature and could be focused on in more detail as a potential confounding factor in interpreting these projected future year scenarios.

RCP scenarios are not always good indicators of future changes in air quality since they are focused on greenhouse gases rather than O3 and PM precursors. The conclusion that ozone reductions due to lower anthropogenic emissions being totally offset by increases in global ozone and climate change impacts seems inconsistent with other studies. Even more importantly, observed ozone concentrations continue to trend downward in many places in the United States suggesting US emissions reduction impacts are outpacing climate and international emissions increases. We are 10 years past the baseline for this model simulation so that reality should be recognized in some way.

How closely did the projections using MARKAL match those of the IPCC A1B scenario for areas where both are applied? Are the ozone changes aggregated and post-processed similarly to other similar studies? More clarity is needed regarding methane. The authors state they do not consider methane but may have indirectly as impacts of increasing methane emissions globally may be part of the global 2050 simulation.

Introduction section:

First paragraph; the authors have 2 references for negative health effects associated with O3 and PM. Typically journal articles focus on either O3 or PM so it not clear that both of these references are relevant for both O3 and PM.

End of second paragraph; it would be appropriate to also reference Cooper et al 2010 and Cooper et al 2012 here.

Page 31847 lines 1-5; It would be helpful for the reader if the authors add what time scale these increased ozone concentrations are seen. Annual average? Average of

the highest days? Just the highest days or are low ozone days part of the average?

Page 31847 lines 6-20; This section should mention the time period over which the climate changed and whether the climate impact was isolated or US emission changes were also considered.

The A1B scenario has aggressive methane emissions growth through 2040. Is that impact included in the semi-hemispheric model? That is not clear but important in interpretation of the global impacts offsetting decreases in US anthropogenic emissions.

Methods section:

Sections 2.3 and 2.4: A summary Table similar to Figure 3 showing the non-U.S. emissions would be extremely helpful with interpretation of the results. This is especially critical given the main conclusion that global emissions increases are offsetting reductions in US anthropogenic emissions.It is unclear what is driving the large increases in VOC, primary PM2.5, and ammonia. Primarily emitted PM2.5 is fairly cost effective for point sources and VOC would seemingly be decreasing due to vehicle fleet turnover and mobile source sector regulations. It is not clear why emissions from confined animal operations and/or fertilizer application would just continue to increase in the future. There is only so much land to farm and so much fertilizer than can be put in the soil. One of the reasons the authors see global emission increases compensating for decreases in US anthropogenic emissions is related to the choices made here for these species so the reasoning behind these VOC/PM/ammonia increases are important.

Evaluation of model performance (2.6): A tighter scale for Figure 4 would make this Figure more useful for interepreation.

More explanation and discussion is needed regarding the overestimated temperatures in the central and eastern U.S. These are rather large overpredictions and would seem to result in overestimated biogenic VOC.

These ozone overestimates are extremely large. Mean MDAO3 in the Midwest in cur-

rent conditions is 50 ppb but the modeling suggests 70 ppb! I appreciate that the authors have not tried to generate Tables and Figures to minimize our focus on the current conditions model performance but it is important to consider these issues when thinking about the results.

Given the large overestimation bias it would be good for the authors to show that rather than refer to a different manuscript. Also, it would be helpful to know why it is important to represent the correlation between ozone and temperature. If they are both grossly overpredicted is model performance really ok just because these variables correlate well?

These underpredictions for PM2.5 are very large and puzzling since ozone is grossly overestimated. Generally when a modeling system can predict a lot of ozone there would be a lot of sulfate, but the spatial plot of average current condition PM2.5 does not show the typical eastern US regional sulfate signature typical for model runs representing the early 2000s. The PM2.5 performance looks like there is something fundamentally wrong with either the CMAQ simulations or the way they were post processed. Despite what the authors suggest in 375-377 this type of underestimate is not typical of other regional CMAQ simulations for this time period and performance here is far worse than Foley et al and Appel et al (and probably the others but I don't have time to go back and check them all).

There is really no value to discussing the fractional composition of PM2.5. How is that important for providing confidence in the model? If the model gets the composition right how does that make the large underestimates of all the major species ok? The fractional evaluation should be removed from the manuscript. Please just provide a comparison of speciated mass for the major species.

It is very debatable the model is performing well for PM2.5. A five year summer average of 5.6 ug/m3 for total PM2.5 mass during the early 2000s is extremely small. Typically models do quite well capturing regional sulfate and since these simulations are under-

predicting so much it raises some questions about the model inputs, in particular the emissions.

Results section:

The A1B scenario is a not a great projection of what will happen to global methane and NOX in the future so that caveat would be useful here and in other places where this is mentioned.

Does the Hogrefe 2004 paper detail how much of this increase in related to methane emissions?

Please provide more explanation about how biogenic VOCs are sequestering ozone precursors and which ozone precursors are being sequestered. NOX? Toluene? How do the authors separate the impacts of this sequestration and recycling of isoprene nitrates? It sounds like this information is available and since this might be a more novel aspect of this research I suggest the authors provide spatial plots or some way to present the relative contributions of these processes here.

Probably worth noting these increases are driven by global emissions changes.

Conclusions section:

Are Asian and Mexican emissions impacts tracked separately from other countries? It would be nice to see the breakdown by country if that is available.

The biases in the model current conditions period should be mentioned here again.

Suggest changing the word “will” to “may” since this assessment is not singularly conclusive.

Figures:

Figure 1. The US only map is impossible to read with the current color scale.

Figure 4. Please show number of stations similar to Figure 5.

Figure 6. Please show absolute speciated PM2.5 predictions and observations. The fractional plot does not terribly useful. Since the authors are referencing EPA guidance I suggest showing prediction-observation pairs with shorter averaging times like either the 24-hr or monthly averages to be more consistent with that guidance and to provide more useful information.

Figure 11. Its not clear that any of these panels isolate the biogenic impacts. Is that on here already?

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