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Editorial Office

Atmospheric Chemistry and Physics

January 10th, 2024

Dear Dr. Querol and reviewers,

Second revised submission of "Global impacts of aviation on air quality evaluated at high resolution" to *Atmospheric Chemistry and Physics*

Thank you for your time and effort in considering our manuscript a second time. We greatly appreciate the comments made by the reviewers, and have again made an effort to address their concerns. A response to each reviewer comment is given below; the original comments are shown in **bold** with our responses shown in *italics*.

Referee #1

The revised manuscript has been greatly improved, it provided a more in-depth discussion of why and how aviation affected air pollution and a evaluation of the mortality impact. My previous comments were also properly addressed. Therefore, I would recommend it to be accepted for publish.

We thank the reviewer for their comments and their encouragement.

Referee #2

I appreciate the authors responding to the detailed reviews and comments of myself and the other reviewers. I think they have done a decent job in this regard.

We thank the reviewer for their assessment.

However, the two main points I still think remain.

1. **I dislike the use of mortality and having the main uncertainty derived from public heath studies. The authors indicate ACP is publishing this sort of work, so that may justify it in the editor's eyes, but I don't think it's really appropriate. Maybe it's just my skepticism of getting big numbers of deaths from very tiny changes. So discount that if you want. I'm not a public health expert (but also this is not Atmospheric Chemistry or Physics).**

We appreciate that this is a philosophical question. However, based on review of other similar publications in ACP, in addition to an increased focus in our manuscript on both the question of how aviation affects air quality (Section 3.3) and how the specific approach to atmospheric modeling affects the simulated outcomes (Sections 3.2 and 3.4), we believe that our work is appropriate to this journal.

2. **The resolution issue is a bit weak, and by doing more low resolution runs, they have not helped their cause here. I don't think the paper adds much except to say resolution doesn't matter at the scales they are looking at, all else being equal. Since there is no downscaling I am not surprised.**

We respectfully disagree with this assessment. Firstly, we do find a substantial resolution effect when comparing coarse (400 km) and higher-resolution (100 or 50 km) simulations. As stated in the abstract, simulations at coarse resolution (~400 km) underestimate the air quality impacts of aviation by ~17% compared to simulations at resolutions of 100 or 50 km (i.e. the use of high-resolution modeling increases the estimated impact by 20%). This means that almost all prior studies of aviation's impacts – including those performed in the intercomparitive study

by Cameron et al. (2017) *which relied exclusively on models at resolutions of ~200 and 400 km – included a then-unknown underestimate.*

Furthermore, the finding that a resolution change from 100 to 50 km results in little change is in contravention to an existing study. As detailed in Section 3.5 of the manuscript, Vennam et al. (2017) *found an order of magnitude decrease in air quality impacts associated with aviation when using a higher-resolution (~40 km) nested model than when using a lower-resolution (~100 km) hemispheric model. This result was recently used as the basis for a study by Lee et al.* (2023) *to justify neglecting aviation's effects on air quality in favor of focusing only on aviation CO_2. Our work specifically refutes this by showing that, when a single, consistent, global model simulates aviation's effects at similar resolutions (~100 and ~50 km), we instead find that there is no such decrease in impact. To help make this point more clearly in the manuscript we now make it explicitly on lines 59-61 and 511-513 of the manuscript.*

Referee #5

This study utilizes the GEOS-Chem model to perform simulation experiments to evaluate the impact of aviation emissions on air quality and associated health effects. The authors also explore the influences of both local sources and transported pollutants. Overall, the manuscript is well-written, and the manuscript quality has notably improved based on suggestions from reviewers. I believe that the content related to air quality and its health effects aligns with the scope of ACP. Consequently, I recommend the publication of this study. However, before publication, the authors may consider the following points outlined below:

We thank the reviewer for their assessment and review.

Comments

1. **It would be better to provide a Table to describe the configurations of different simulations.**

We agree and now do so in Table S1, which is now referred to on line 218.

2. **The authors put a lot of effort into the simulations. However, it seems that the results of different simulations are not sufficiently demonstrated. For example, the influence of different model resolutions is only exhibited in Figure 4. It would be more helpful if the authors could produce figures (similar to Figures 5-7) with other resolutions to demonstrate the possible impact of different model resolutions on horizontal and vertical distributions. Similarly, it would be more interesting if the authors could provide figures (similar to Figure 5) to show the contributions of various sources (such as US-domain emissions) and transport more clearly.**

We do now include a graphical comparison of the effect of model resolution in Figure S2. Although we chose to exclude this from the main text due to the length of the manuscript, we do discuss this figure on lines 288-296. We would be happy to bring this figure into the main text, however, if it is considered to significantly improve the manuscript.

Unfortunately the simulations which provided ozone production and loss rates were only performed at one resolution, meaning that we cannot extend Figure 5 to the coarser and finer resolutions. However, we agree that it is interesting to see how the different resolutions affect not only the horizontal but also the vertical distribution of aviation-attributable ozone. We therefore now include a new evaluation (Figure S3, reproduced below) and analysis of the differences in zonal mean ozone throughout the Northern Hemisphere for the simulations at 50, 100, and 400 km (lines 400-403).

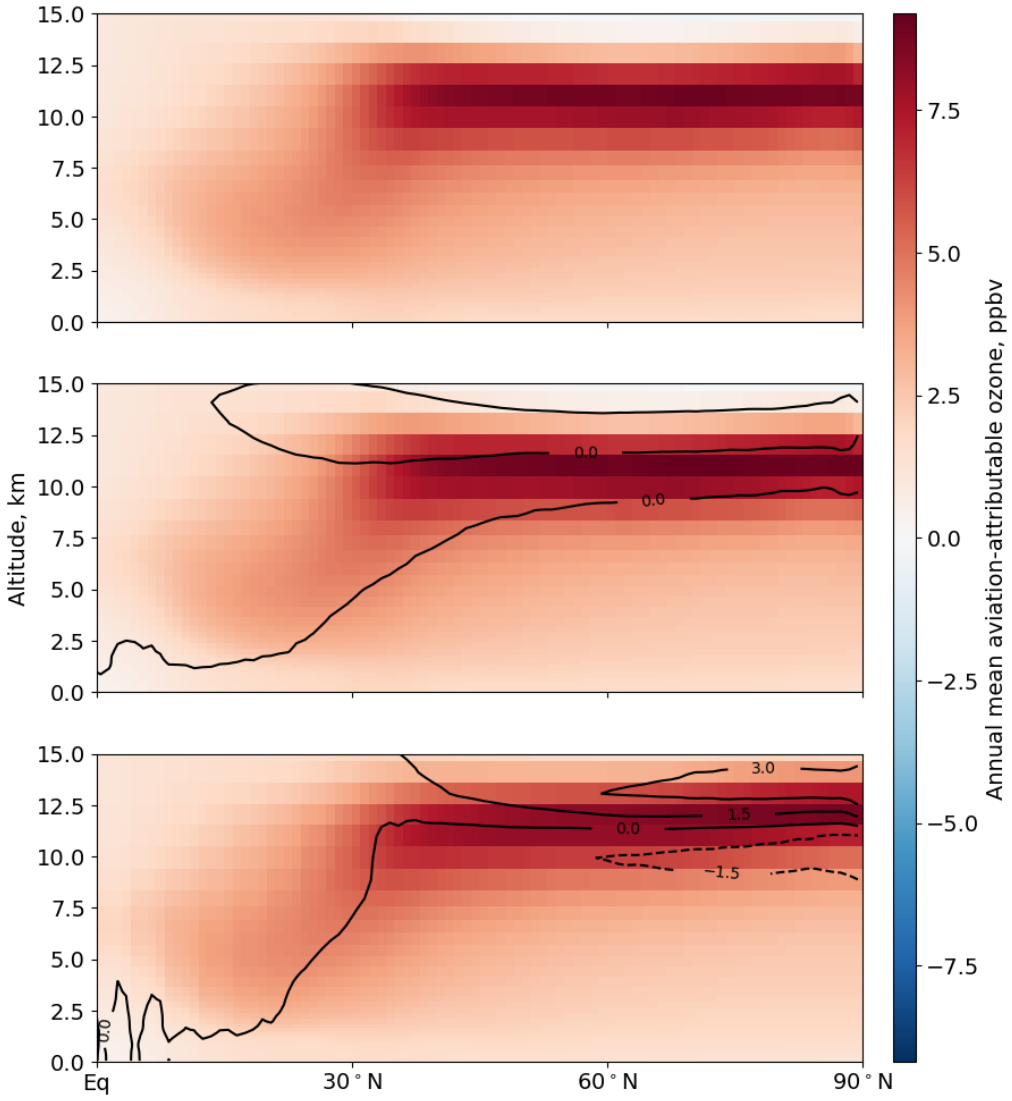

Figure R 1. Annual mean aviation-attributable change in zonal mean ozone at C180 (top), C90 (middle), and C24 (bottom) for the Northern Hemisphere. Contours show the difference between the estimate at that resolution and at C180, with positive values indicating that the simulation at the lower resolution is overestimating the change in ozone relative to the simulation at C180. Each contour corresponds to a 1.5 ppbv difference. This is reproduced as Figure S3 in the Supplemental Information.

3. **Figure 4: the contribution of US-domain aviation emissions to surface PM2.5 concentrations in China is larger than that in the US itself. It is hard to understand and needs to be explained.**

This is due to the higher concentration of particulate matter precursor gases over China than over the US, meaning that the same quantity of aviation-attributable oxidant would result in more additional particulate matter. We now explain and quantify this effect on lines 318-321.

Thank you for considering our submission for *Atmospheric Chemistry and Physics*. We hope you agree that the comments and concerns raised have been addressed and look forward to your response.

Regards,

Sebastian Eastham

References

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