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Comment on acp-2022-348

Anonymous Referee #1

Referee comment on "Transport patterns of global aviation NO_x and their short-term O_3 radiative forcing – a machine learning approach" by Jin Maruhashi et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2022-348-RC1, 2022

General Comments

The paper titled “Transport Patterns of Global Aviation NOx and their Short-term O3 Radiative Forcing – A Machine Learning Approach” by Maruhashi et al. explores the pathways traced out by aviation NOx emissions and the effect this has on radiative forcing, including spatial variations. Overall, the paper is well written with a logical structure and makes a solid contribution to the field. The introduction of a new method borrowed from neuroscience can benefit the field of climate research and is of interest to many ACP readers, particularly given how well it works when applied to NOx pathways here.

Readers will appreciate that the introduction gives an overview of the field currently, including where similar methods have been used in the past, making the novelty of this work clear. The methods are generally well described. Addressing some of my comments below will make the methods even clearer to the reader.

The analysis of the results is very in depth and there are multiple new contributions made in the paper. The authors show the pathways of NOx in both horizontal and vertical directions as well as the evolution of O3 production, which are useful contributions to the community. In the last results section, the authors present the radiative forcing, including both local and remote effects of NOx emissions with a particularly interesting finding that the largest radiative forcing associated with regional NOx emissions are not always co-located near the source (e.g. Eur is the strongest receptor of RF given NAm source emissions in Jul-Sept. in Table 2). These results are of interest to the community, although they would benefit with some expansion and more with reference to the atmospheric circulation of the time to explain whether the results would hold year to year. Overall, the findings are backed up with relevant references throughout. Some minor revisions will make this paper ready for publication.

Specific Comments

Section 2.1: it was not clear to me if all 28 trajectories are released in independent simulations or within the same simulation. If it is the same simulation

L232: "instead of the longitude which exhibits less variation between the trajectories with each region."

This sentence confused me initially as it is not yet clear that the clustering is done within each region. Some rewording could make this clearer.

L259: "It consists of finding the intersection between two linear regressions that model each half of the curve generated from plotting the evolution of a trajectory-based metric as a …"

This does not explain the method well. The method becomes clearer when we are introduced to Fig. 5 so some reshuffling may be needed.

L285: "The rate of descent"

Could you explain further the relevance of this quantity, why do we care about it? How do we expect it to relate to O2 production? Is this a commonly used quantity in other studies of aviation NOx? Is it always defined in this way? Is there a benchmark value that we can expect this quantity to be from previous studies?

L315: “Table 1 Statistical correlations using the Pearson, Kendall, …”

Should be "statistical correlations between H and mean O3 contribution using the .... "

Fig. 7 and other similar plots:

I would suggest a darker color scheme, even just shifting this slightly to lower O3 mixing ratio as the pale yellow does not appear too clearly. I would also recommend to reduce opacity of each point (e.g. in python, alpha = 0.5) if this has not already been applied.

Fig. 9 and other similar plots:

For this an other similar figs. there is a lot of information in the green dots, perhaps making different trajectories different shades of green and/or slightly transparent would help. Alternatively, the time series of the trajectories could be shown graphically, e.g. so that starting points on the trajectory are lighter and ending points are darker, which should verify L395 “As the trajectories spread and wrap around the globe, they mostly arrive within a similar longitudinal range”.

Also, for Fig. 9, please check whether the red points are visible against the green for people with red-green color blindness.

Section 3.2:

There could be more explanation of the results of Fig. 12 and 13 based on the atmospheric circulation in Fig. C1. Do we expect these to hold year to year? Are there particular conditions e.g. ENSO that occurred in 2014 that may bias these results?

L533: "This suggests that flying over the North Atlantic in January (local winter) will lead to a radiative forcing that is almost half compared to the one induced in July (local summer). In other words, the radiative forcing is larger when flying in their respective summer (or dry season for the Tropics) seasons for all regions."

A rather bold statement, worth reminding the reader that this due to NOx only, not including GHG contributions? Also move "seasons" to before "(or dry season for the Tropics)".

Section 3.3.2:

The findings here are the most interesting of the paper. Can you explain why Europe may be most impacted by N. America source emissions in summer. Given the detail in the earlier sections of the paper I would like to see more explanation of this, as the tracer profiles are already available and we can see where the emissions end up e.g. Fig. 9., 12 and 13. Please also swap the order of the table months so that Jan-Mar comes above July-Sept. to coincide with the order of figures as well.