Anonymous Referee #2

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The paper address non-CO2 climate impact of aviation, quantifies and presents climatology of these effects for the North Atlantic and discuss possibilities for mitigation of these impacts through alternative routing. This is a very complex scientific question relevant for ACP, also very topical as the non-CO2 climate impacts, if unresolved, makes it difficult for the aviation sector to achieve the Paris agreement targets. The paper present results of model simulations where the local aircraft emissions are followed in a global ECHAM5/MESSy Atmospheric Chemistry model system on Lagrangian trajectories. There are several novel modules developed within the model system associated with these calculations which have been published and are cited as accompanying papers, the most important Grewe et al. (2014) and Rosanka et al. (2020). While Grewe et al. (2014) presents results for 1 case (weather situation), this paper presents results for a number of situations under winter and summer season which allows for more general conclusions based on thousands of simulated trajectories and their complex analysis. These papers represent an impressive piece of work which gives a new insight in climatology of non-CO2 climate effects of aviation and I would like to congratulate the authors to this achievement.

We thank the anonymous referee for seeing the value of our work and estimating our work as relevant for ACP. We gratefully appreciate his/her time reading our manuscript thoroughly and pointing towards paragraphs which were not clear enough or needed improvement. We amended the manuscript accordingly. Please find our responses (red) to the review points and recommendations (black) below.

Before recommending the paper for publication, I would however like to draw their attention to the following issues:

The methods and assumptions in the paper are extremely complex and described in many cases rather briefly with references to other papers. This makes it rather difficult to follow and assess the methodology. I would recommend including more comprehensive and systematic description of the methodology which would give clear idea about how the crucial processes are treated in the model simulations performed for this paper.

Thank you for pointing this out. We agree, that the description for such a complex set up was too brief to follow and assess the methodology. We added extensive parts and more details to the methodology description, also proposing a substructure of Section 2 in order to increase the comprehensibility of this essential part of the manuscript.

Even when going to the references I could not follow how the chemistry of the ‘multitudes of background trajectories’ which the local emission trajectory is mixed with is calculated, recommend explanation of this part in particular.

We agree, that this aspect was not covered in the methodology description. We added this and we hope it is now clearer (l. 156ff).

After reading the papers describing the tagging mechanism for quantification of impact of studied emissions, I would like to ask if the non-linear plume effects on ozone formation from NOx emissions, or rather on NOx removal, are considered in some way and, as this has been subject of scientific discussion under quite a long time, what impact these effects have or could have in case they were not considered).

This aspect was not considered in the present study. Plume effects on ozone formation have been studied by several groups, however the results vary considerably, ranging from -33% to +5% compared with the grid-scale approach (e.g. Cameron et al., GRL 2013). This effect might be largest in the North Atlantic Flight corridor (Cariolle et al., 2009, JGR). However, as the results of the variety of studies on these effects are not yet conclusive, we did not consider non-linear plume effects on ozone formation. Nevertheless, Grewe et al 2014b performed a sensitivity study on the cost-benefit analysis and related air traffic responses with respect to potential errors in the climate-change functions. For example, they changed the weighting between the climate impact from NOx and contrail-cirrus. In this case, the air traffic system still behaves similarly during the optimization. These sensitivity studies indicate a stable response in the shape of the cost benefit analyses and the way air traffic is routed for climate impact. We consider this point to be covered through the uncertainty/sensitivity studies performed by Grewe 2014b by means of these data. We added more detailed information on these sensitivity studies in the discussion (l. 533ff).

Specific comments: Fig. 2 – Potential contrail coverage for the representative weather situations – what is the figure showing – mean over certain time period of each weather situation? Supplement – Caption or some explanation to the figures is missing

This information was indeed missing in the figure caption. The original Figure was showing mean potential contrail coverage for the three emission time steps 6, 12 and 18 UTC, however, we decided that it is more helpful to show 12 UTC only to better estimate the relation of potential contrail coverage at the time step of emission release to the CCFs shown in Figure 7.