R2: General comments

The paper named "**Expanding spatial and temporal coverage of climate change functions: Assessment and comparison with aCCFs**" aims at providing an updated version of the climate change functions (CCFs) previously published by Grewe et al. (2014) and Frömming et al. (2021). In parallel, Algorithmic climate change functions (aCCFs) are developed (van Manan and Gewe, 2019; Dietmüller et al., 2023; Yin et al., 2023). The underlying concept of the CCF/aCCF is not described in the paper but the reader is sent to previous paper.

The new developments related to the CCFs update are the extension of the geographical coverage by introduction of the United States and European airspaces, the introduction of a new weather situation, the revision of the horizontal resolution of contrail modelling, the enhancement of the temporal coverage, the improvement of the RF estimation for ozone (O3) and the introduction of the Average Temperature Response overs a time horizon of 100 years (ATR100) climate metric.

The authors claim that the objective of the paper is to advance the current understanding and modelling of aviation's non-CO2 climate effects but it seems more that the paper is reporting on the intercomparison of a new set of CCFs with previously published CCFs/aCCFs.

- *Thank you for this comment. We reformulated the title and parts of the abstract and text accordingly to avoid misinterpretations and clarify that we focus on the intercomparison with existing (a)CCFs.*

Overall, the paper is gathering a significant piece of work regarding the update of the CCFs including the analysis of the new results obtained with those new CCFs in comparison of the results using the previous version of the CCFs/aCCFs.

I must say that the paper is not always easy to read as some sections could be reorganized and details/simplified. Also, the conclusions of the work should be clearly highlighted and reported in the abstract. I would therefore suggest some major corrections before the paper can be published into JECATS.

- *We reorganized some sections and simplified some details. We reformulated the abstract, to clearly report the conclusions of the study and in particular the limitations of the aCCFs.*
- *Thank you for this comment, we agree, that some reorganization would improve the structure and readability of the paper. In this light, we moved figures and the comparison with REACT4C CCFs (winter situation) to a separate section and condensed the text, as these CCFs are for a different season which may confuse and distract the reader. The intention of showing these CCFs was to demonstrate similar magnitudes and variability despite the different season, however the focus should be on the spring case study and the comparison with aCCF and the according analysis.*

Specific comments

Abstract

L11: I am not sure, the paper really advance aviation non-CO2 climate impact modelling as it is mainly using preexisting codes. Please rephrase.

- *Sentence was rephrased.*

L15 to 21: This past is confusing. I understand that there is a comparison of the nex CCFs with the old aCCFs, then the authors say that the new CCFs will be use to update the aCCF but is this last point is really done in this work? Please simplified and rephrase.

- *Thank you for mentioning this. We reformulated this part of the abstract to make this clearer.*

See also my comment in the conclusion section in relation with the abstract.

Introduction

L47-48: As said before, is it really the objective of the work here. Please rephrase.

- *True. We reformulated this paragraph to adjust the objective of the study.*

Section 2

Subsection 2.1: Please considers reducing massively this section or merge it with the next one as it is optional according to me for this paper.

- *Done.*

L85: I suggest to replace “in principe” by “in theory”.

- *Done.*

L107: Why those 2 days are selected? Can add some context especially with respect to the previous version of the CCFs and the associated seasons.

- *Done.*

L141: How this is affection the CCFs outputs? Any hints?

- *Contrail cirrus RF was estimated nine times larger than that from line-shaped contrails (Burkhardt and Kärcher, 2011, DOI: 10.1038/NCLIMATE1068), hence if only line-shaped contrails were included, CCFs were smaller by that factor.*

L142: Why not using Bier and Burkhardt (2022) for the contrails initialization and evolution?

- *The results from Bier and Burkhardt (2022) were not available yet, when the present study started. In addition, B&B used a different model version (ECHAM5-HAM), which does not include atmospheric chemistry nor does it offer the possibility of Lagrangian transport of air parcels.*

L144-148: Is this part should not belong to the discussion section?

- *Done.*

L172-174: Not sure to understand this part related to the pulse. I guess is the explanation on how AirClim is calibrated. Please clarify.

- *True, this sentence was not clearly formulated. We rephrased this part accordingly.*

L177 to the end of the section 2: It make an historic of the CCFs/aCCF/paCCFs. Not sure it is appropriate here as it is confusing. I would also reduce 2.3 subsection unless it is justified to keep it and merge 2.3 with 2.4 with a focus on the actual update of the CCS using Table 1.

- *We shortened and merged where possible, confine the model description to new CCFs and added a short separate section on previous (a)CCFs at the end of section 2.*

Section 2.4.2: confusing. It seems that some old simulations are used. Is it still relevant to use it for the CCFs? Also, could you recall why the 2.8°x2.8° is used for the contrails modelling.

- *There seems to be a misunderstanding. We were not using old simulations. We revised the text to avoid misunderstanding. We restrict the model description to the new calculations to avoid misunderstanding. The time-regions for contrail modelling are irregularly distributed, through the subsequent interpolation within confined contrail coverage regions, CCFs with a resolution of 2.8°x2.8° emerge.*

Subsection 2.4.3: Any possibility to use ERF? Please discuss this possibility eventually in the discussion section.

- *Our results are based on simulations that calculate RF instead of ERF. A simplified conversion to ERF as in Lee et al. (2021) would be possible, however, as all (a)CCF results are converted to F-ATR100, which does already incorporate efficacy (r_i), i.e. both fast and slow feedback mechanisms, while ERF only includes fast feedback mechanisms, we see no added value.*
- *We changed the text in section 2.3 somewhat to make this clearer.*

Subsection 2.4.4: The shortcomings related to the contrails modelling and their implications in the used of CCFs should be clearly highlighted.

- *Added text regarding the underestimation of contrail optical depth and implications to contrail CCF underestimation. The factor of underestimation is also highlighted in the conclusions and the abstract.*

Subsection 2.4.5: This section seems to have been dropped there with no clear connection which the previous section. Either the location of tis subsection is not appropriate or it should be merge a previous subsection. Also, I would consider to use also the GWP100 (ERF-based) as it is considered as a reference metric (e.g. see IPPC reports).

- *Thank you for this comment. We merged subsection 2.4.5 with section 2.3 (General methodology to derive climate change functions) and added information why we chose ATR as climate metric instead of (E)GWP in the present study. Nevertheless, conversion from ATR to EGWP would be possible following Dahlmann et al. (2026) and absolute figures would change by a factor of approximately 150, however the relation between the different species would only change marginally.*

Section 3: It is not clear why those 2 days have been chosen. Please clarify.

- *Done. See comment to L107.*

Section 4

Subsection 4.2:

L372: New references linked for example to ACACIA project work are available and should be added. Please check in the relevant literature.

- *Thank you for pointing this out, we included these valuable references.*

Section 5

Overall, section 5 have a lot of results using multiple graphical representation. The description/interpretation is not easy to follow and I would recommend to reorganize/use shorter sentences which will make to paper nicer to read.

- *Thank you for this comment. We agree, that the description of results and according interpretation was not easy to follow. In addition to moving figures and comparison with REACT4C CCFs to a separate section, we tried to shorten sentences and condense some of the detailed and lengthy description.*

L428: only the winter season can be use for contrails?

- *Other seasons than winter are indeed off-design for contrail aCCFs.*

L437-440: This sentence is for example difficult to understand. Please rephrase.

- *Thank you for pointing this out. The sentence was indeed long and complicated. We rephrased it.*

Subsection 5.1 and 5.2:

l480-484 and l506-507: Following the statement of those line, what is the conclusion of this section about the use of the current ACCs?

- *Regarding particle shape, the habit mixture used in aCCFs is reasonable in its actual form, however, if CCFs also used non-spherical particles, the daytime CCFs would be smaller or more often negative and would probably agree better with aCCFs for daytime contrails.*
- *Regarding O3 and total NOx aCCF gradients below 300 hPa our clear recommendation is, not to use the aCCFs at altitudes below 300 or 350 hPa and above 200 hPa. However, main cruise altitudes are usually between 200 and 300 hPa.*

Subsection 5.4 and 5.5:

L538 and l553: The overestimation (for O3) /underestimation (for H_20) is quite strong. Would you then recommend to use of ACCs for re-routing?

- *Thank you for this question. The key indicator for eco-efficient routing is not the exact value of (a)CCFs but the orientation of horizontal and vertical gradients which provide meaningful incentives for route optimization. We added this criterion to the abstract, discussion and conclusion section.*

Section 6

My overall understanding for this section is that CCFs/aCCFs capture the general magnitude/variability of the different forcers that were modelled in this work but there are strong underestimation/overestimation are modelled for some of the forcers. If so, could you make a general recommendation on the use of CCFs/aCCFs.

- *See point above on gradients. Nevertheless, we elaborate more on this in discussion and conclusion including general recommendations on the use of aCCFs..*

Conclusion:

L645: “novel season”: Is it correct to say that for contrails which were modelled over 2 days only?

- *True, we reformulated this throughout the manuscript to “spring case study (days)”.*

L654: Is the used of aCCFs can be recommend if strong over/underestimation is seen for some of the forcers?

- *See above, we reformulated this part. In addition we address, that for route optimization the orientation of gradients is crucial, while the absolute size of climate response is secondary.*

L655-l659: This section should be clearly rephrase and reported in the abstract.

- *We reformulated this part in the conclusion and report in the abstract.*