Geoscientific Model Development Discussions

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Comment on gmd-2022-203

Anonymous Referee #2

Referee comment on "A Python library for computing individual and merged non-CO_2 algorithmic climate change functions: CLIMaCCF V1.0" by Simone Dietmüller et al., Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2022-203-RC2, 2023

The manuscript by Dietmüller et al. presents an open-source python library to calculate so-called algorithmic climate change functions for non-CO2 climate effects from aviation. The tool requires information on meteorological conditions as well as certain aircraft parameters like NOx emission index and fuel consumption as input data and calculates the climate impact due to water vapor and NOx emissions as well as contrail formation individually or as combined non-CO2 climate effect. The authors demonstrate the application of CLIMaCCF for a case study in summer 2018 over Europe.

While the tool certainly provides an interesting contribution to the field of climate-optimized flight planning, I find the description given in the manuscript rather difficult to follow. This might be related to the fact that the authors provide a mixture of technical description of the python tool and scientific explanation of the underlying assumptions. Furthermore, the authors refer to several studies that are still in preparation. This is very unfortunate as the reader is left with insufficient information and open questions, e.g., about the calculation of the climate metric conversion factors (sect. 2.4) or the updated set of algorithmic climate change functions, aCCF-V1.1. It might be helpful to restructure the manuscript by starting with the description of the tool, the required input data, the workflow etc., and only then describe the underlying scientific assumptions or simplifications. In particular the description of how the merged aCCFs are calculated (current Sect. 2) needs improvement and clarification. For the authors it is certainly clear what is behind all the parameters, conversion or efficacy factors, and where they come from, but for the inexperienced reader it can be very confusing. Some further detailed comments are given below. Overall, I recommend this paper for publication in GMD after some revisions.

Specific comments:

- L15: which non-CO2 emissions?
- L51/52: I find this sentence a bit confusing. On the one hand the authors talk about climate optimal trajectories, on the other hand they consider only non-CO2 climate impacts. How about additional CO2 emissions that might arise from a re-routing to reduce non-CO2 impacts?
- L90/91: What do you mean by “NOx induced methane”? To me, NOx induced methane sounds like CH4 produced from NOx, but as far as I know NOx emissions from aircraft lead to a reduction of CH4 via NOx induced OH formation, right? So maybe “NOx induced CH4 loss”?
- L94/95: As stated here, the contrail aCCFs are obtained from contrail radiative forcing

calculations based on ERA-Interim reanalysis data, but in the example given in the manuscript ERA5 data are used as meteorological input. Do you expect any errors/biases arising from the different meteorological data sets?

- L100: Please provide some more details/examples on the assumptions and simplifications. And how do these affect the results of your tool?
- L106/107: This sentence is not clear to me. How do the different units of the individual aCCFs affect the weighting for different aircraft/engine classifications? Please clarify.
- L147-149: How is this statement related to the values provided in Table 2?
- Table 1: This table provides altitude-resolved average specific NOx emission indices for three different aircraft categories. The values are provided with three decimal places, which implies a high accuracy. However, I would assume that these numbers are associated with some (large?) uncertainties. For example, the wide-body aircraft type seems to include a wide range of different aircrafts. I would be interested to see some uncertainty ranges of these emission indices. Same holds for table 2.
- L182/183: Is the statement on the different emission scenarios a more general comment related to climate metrics or is this directly related to the aircraft emissions? In general, it is not quite clear to me which emission scenarios are meant in Sect. 2.4. Aircraft emissions along a flight track or climate scenarios like the RCPs in general?
- L191: Why is the climate metric P-ATR20 not suited for some questions? And why are F-ATR20/50/100 better suited? Please explain.
- Table3: Why are the conversion factor for H2O aCCF and O3 aCCF identical? Same for CH4 aCCF and PMO aCCF?
- L239/240: "… compatible and tested with the standard of European Centre for Medium-Range Weather Forecasts (ECMWF) data…" What exactly does this mean? Format, naming conventions, meta data? And what is meant by "standard ECMWF data"? Reanalysis? Forecasts? And what would be necessary to use the library with different meteorological data?
- L274: What is meant by "provided default data set"? Does the python library come with a climatology of meteorological data? And if so, where does the default data set come from?
- L289: Why is the PCFA-SAC more accurate and how does is consider aircraft and engine properties? In L282/283 it is written that SAC uses rel. humidity over ice and temperature.
- L368: What is meant by "MET information"? Is MET an abbreviation? If so, please explain.
- 4: Is there any specific reason for using 15 June 2018 as an example?
- A1: Is there any difference in the H2O aCCFs for the different aircraft categories? To me, the plots look identical.
- L408: ".. gets somehow more important…" This formulation is not very scientific and should be rephrased.
- Climate hotspots: I am wondering how meaningful the usage of percentiles as threshold values is? If I understand this approach correctly, it will always identify climate hotspots, no matter how strong the absolute climate impact is, but a re-routing could lead to additional CO2 emissions, so I am wondering how applicable this feature is in practice?
- 5.3: I think this section would benefit from a more quantitative discussion of uncertainties. For example, what is the uncertainty range of the non-CO2 climate effects? Although it is a bit unsatisfying that the authors strongly refer to a paper that is still in preparation. What is the status of Matthes et al, 2022?
- 5.4: Would you expect different results for meteorological input data other than ERA5? How sensitive are the calculated aCCFs to the meteorological data?
- L536/537: What would be necessary to use other meteorological data than ECMWF products in CLIMaCCF? Is it only a coding issue or would the calculation of the aCCF require additional adaptations?