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Comment on acp-2021-582

Anonymous Referee #2

Referee comment on "Reduced ice number concentrations in contrails from low-aromatic biofuel blends" by Tiziana Bräuer et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2021-582-RC2, 2021

As sustainable aviation fuels have been adopted by the airline industry at an increasing rate, this paper addresses a highly relevant and timely topic of their non-CO2 climate impacts. The authors present unique experimental data obtained during elaborate chase studies at cruising altitudes representative of commercial flights. The work presented extends the subset of results shown by Voigt et al. 2021 from the same campaign to higher altitudes and gives more details on the experiments.

Overall, the paper reads well and provides enough background information for non-experts to understand the results and implications. The title and abstract reflect well the contents of the paper. The methodology and results are well supported with appropriate references.

General comments

1. In the introduction, the authors summarize nicely what we do know about the climate impacts of aviation today. However, it is unclear what is the knowledge gap this paper tries to fill (besides providing more data than the recently published study by Voigt et a.). Perhaps it is obvious to experts in the field, but a general reader might benefit from information on why these kinds of measurements are needed and what data is missing (e.g., for climate impacts modeling?).

2. The authors mention several times that the fuel composition effects on soot emissions (and AEI of ice) depend on the types of aromatics. To account for the effects of different types of aromatics, fuel hydrogen content (or H/C) has been found to be the best (practical) predictor. Data from numerous studies (including data from engine manufacturers) were used to develop a standardized correlation of fuel composition effects with engine thrust setting and fuel hydrogen content, which is now part of the non-

volatile PM emissions certification (see the latest version of the ICAO Annex 16 Vol. II, Appendix 7, section 6.2; It can be downloaded here: https://www.bazl.admin.ch/dam/bazl/de/dokumente/Fachleute/Regulationen_und_Grundlagen/icao-annex/icao_annex_16_environmentalprotectionvolumeii-aircraftengineemis.pdf.download.pdf/icao_annex_16_environmentalprotectionvolumeii-aircraftengineemis.pdf)

Of course, this correction is applicable for ground emissions tests, but it seems that a fuel H (or H/C), based on results in Figure 2, could be used for predicting reductions of contrail impacts.

3. Can it be assumed that the results presented apply to a wide range of aircraft engines with different soot emission characteristics? The engine type measured here has relatively high non-volatile PM emissions compared to other engine types (ICAO emissions databank v 28C). Some of the latest engine types of the same size (should) emit up to 5 orders of magnitude fewer soot particles per kg fuel at medium to high thrust. Assuming similarly low emissions at cruise, would the reduction of soot emissions with SAF still play a role in contrail impacts, or would the sulfur content be more relevant?

Specific comments

- Figures

Figure 2
1.1 The legend should include information about the error bars shown. Do they represent standard deviations of the single plume encounters?
1.2 The dashed lines connecting the means may be somewhat misleading given the low number of data points, suggesting there are linear trends between the means. Consider removing these lines.

Figure 3
1.3 No information about the error bars is provided. Only a subset of points includes error bars. Do the points without error bars represent single observations?
1.4 In panel c, the error bars are "sticking out" of the panel. Consider changing the range of the x-axis or pushing the error bar back.
1.5 The purpose of the shaded areas is not clear to me. Is it just to distinguish between panels a and b? If that is the case, perhaps using open symbols might work visually better.
1.6 The horizontal reference line at 0 m is barely visible in the pdf and invisible in a printout. Perhaps you could increase the line thickness.

Figure 4

1.6 There is no description in the legend of what we see in panels a and b. Perhaps a sentence similar to the description in the text (line 132-133) could be included.

Figure 5
1.7 One more comment on the missing description of the error bars (sorry). In the text (line 160), you mention that variability bars (error bars?) "reflect the uncertainties in the physical depths of the contrails". How were these calculated?

- Tables

Table 1
2.1. In the comment for the fuel Ref 4, you could replace the word "probed" with "used" if that is what you meant.

- Text
  3.1 Line 35. The study by Beyersdorf et al. was done on an old aircraft type (the DC-8 used in your study) and actually proved that it could not operate for a long time with 100% SAF (leaks in the fuel system due to the absence of aromatic compounds). Consider rephrasing or deleting.

3.2 Line 36 even higher reductions could be reached with higher blending ratios and old engine technology (see Tran et al. 2020 https://pubs.acs.org/doi/10.1021/acs.energyfuels.0c00260)

3.3 Line 103 You write the AEIs are independent of thrust level. The soot EIs depend on engine performance (which depends on aircraft speed, weight, altitude, delta T from ISA, etc.). Therefore, aren't the AEIs of ice also dependent on engine performance (thrust level)?

3.4 Line 152 "In a next step...in the following section." This sounds repetitive. Consider rephrasing.

3.5 Line 203. The very last statement about hydrogen fuels seems irrelevant and not supported by the results. Consider deleting.

Thank you for the interesting work!