Atmospheric
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Discussions

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Interactive comment on "Reductions in aircraft particulate emissions due to the use of Fischer–Tropsch fuels" *by* A. J. Beyersdorf et al.

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We thank the reviewer for the helpful and detailed comments. Comments are summarized and responses are in italics below. We apologize for any missed opportunities to improve the manuscript and welcome any feedback.

1) Table 1 lists two different instruments for number measurements – which of both threshold values (4 or 6 nm) was used for the plotted number densities? Were the identified trends qualitatively equal for both systems / how did they compare?

The measurement for the EEPS was used and the following text included: "Two measurements of aerosol number concentration were made (Table 1); one by a condensation particle counter (CPC) with a size cut of 4 nm and the other by integrating the size

distribution from 5.6 to 560 nm measured by an engine exhaust particle spectrometer (EEPS). At the 1 m probe, both instruments gave similar concentrations. However at the 30 m probe, the higher particulate number concentrations caused saturation of the CPC signal. Particulate levels were never large enough to saturate the EEPS signal. Therefore, the EEPS data were used for determining EI_N."

2) In the second paragraph the authors mention the search for alternative fuels having similar physical properties; they might add that similarities of chemical/combustion properties are equally desired (heat of combustion, ignition delay, flame speed ...).

Included

3) Were the sampling lines heated? What about line losses? Was tip dilution applied or has the sample been diluted x m downstream in the line? I suggest adding one or two references on the sensitivities related to "technical sampling".

The sample lines were unheated and dilution was applied at the tip of the probes (text added). Line losses are now discussed in the "Experimental Design" section.

4) Independent from the manuscript contents: is extrapolation of the ambience temperature dependence possible to in-flight conditions?

It is likely not possible to extrapolate to in-flight conditions because: (a) temperatures are much colder than the current temperature range, (b) the effects of pressure have not been studied, and (c) the temperature dependence at these cruise conditions is small and has high uncertainty. A brief discussion has been added to the conclusion.

5) On page 15114 the authors mention that "The EI_V values follow the same trend as EI_{BC}, however the trend in EI_N differs due to varying particle size with power (Fig. 4)." I suggest adding a short description of the trend difference.

Included

6) Page 15116: "Further downwind, these particles are likely to coagulate causing a

drop in EI_N while EI_V remains constant." – where is this statement evident from the plots?

This statement was speculation and has been removed.

7) Page 15117: "Conversely, the soot-mode particle number concentration increases as power increases." – where do I see this? I suggest referring to suitable figure.

This has been changed to refer to soot-mode volume and a reference to figure 10 added.

8) Page 15119: "Comparing each of the fuels, the efficiency follows a similar trend with low efficiencies at low and high power (0–1.5%) and maximum conversion at midpower (1.5– 4%)." Is this trend significant relative to signal error bars/reproducibilities?

Uncertainties for each data point are likely 25% (due to higher uncertainty in finding the $EI_{volatile-M}$, thus the trend is not statistically significant. Text has been added stating this.

9) In the conclusions the authors elaborate on the influence of ambience temperatures on aerosol formation by condensation. Couldn't the determined effect be a question of temperature history? Maybe the plume simply needs a moderately longer time (i.e. distance) to show the same condensation mode intensity at slightly warmer ambience temperature?

Good point, text has been added stating that this is an uncertainty.

10) Fig. 4: is there an argument why the JP-8 idle emissions increase at large diameters?

These large diameter aerosols (>150nm volume-weighted) are regional ambient aerosols (not engine emissions) that were sampled. During the calculation of EIs these ambient size distributions were subtracted from the engine runs resulting in no aerosols larger than 150nm for these idle runs. The corrected size distributions have now been

plotted for Figure 4 and 6. I have also checked to make sure that all other plots used the corrected data.

11) Fig 5, density subplot: why is scatter so much larger for 65% load?

The scatter is the result of lower loadings than at 85 and 100% (by over a factor of 2)

12) Fig. 8: mostly, the vertical ordering of colors for a power setting is following temperature, but not always. What is the main reason for the scatter? What are the errors/reliability bars of the single dots?

The original figure was made using limited data from the right engine. This has been replaced with data from the left engine which was always burning JP8. This allows for more data points which show the trend more clearly. Figures 8-10 have been updated. Uncertainties are on the order of 10%.

13) Fig 13: Is identified trend for conversion efficiencies significant over scatter behavior of single dots?

Uncertainties for each data point are likely 25% (due to higher uncertainty in finding the $EI_{volatile-M}$, thus the trend is not statistically significant. Text has been added stating this.

14) I suggest replacing C consistently by K.

We have chosen to keep ambient temperature in Celsius as this is used for the majority of ambient temperature measurements.

15) Abstract lists PM mass reductions when using alternative fuels, absolute; I suggest adding relative values.

We are confused as the abstract listed only relative values (very few absolute). To possibly answer the reviewer, we have included absolute reductions for EI_{BC} at 7% and 100%. We apologize if we have misinterpreted the comment.

16) On page 15114 the authors write ". . . result of formation of soot from primary spherules"; these primaries ARE already soot. I recommend an expression like ". . .result of formation of soot aggregates from . . ."

Changed

17) Page 15114: "Density calculations are only made . . ." – authors should clarify which volume this density is referring to.

The volume used is total EI_V at 1 m behind the engine. Text has been included in the sentence for clarification.

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