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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Online measurements of the emissions of intermediate-volatility and semi-volatile organic compounds from aircraft" *by* E. S. Cross et al.

Anonymous Referee #1

Received and published: 12 April 2013

This paper examines the emissions of low-volatility organic compounds from two gas turbine engines operating on the NASA DC8 airframe. The data were collected using a new instrument that includes a cryogenic inlet trap for capturing the organic compounds followed by thermal desorption into a mass spectrometer. Thermally desorbing the collected organic compounds provides some information on the relative volatility of the compounds in the sample, however it seems that in its current state the instrument is not able to quantify the absolute volatility because of differences in instrument configuration between calibration runs in the laboratory and exhaust collection in the field.

Using the collected data and PMF, the authors identify three factors to describe the

emissions: an aliphatic factor, an aromatic factor, and an oxygenated factor. At low engine loads the aliphatic and aromatic factors are dominated by more volatile species, consistent with emissions of unburned fuel from the engine. At higher loads the aliphatic factor is dominated by lower volatility species that perhaps originate from pyrolysis products.

Overall the manuscript is well written and easy to follow. The conclusions follow logically from the measurements. The instrument presented here marks an important step forward in recent research efforts to measure and quantify low volatility organic species in emissions and in the atmosphere. I recommend publication after addressing the minor comments below.

What about lubricant contributing to the aliphatic signal at higher temperatures? All of the lower volatility aliphatic signal is attributed to pyrolysis products, but certainly there is some lube oil in the POA. Lube oil consumption rates as a function of engine power should be available for either the DC8 or for another aircraft using a CFM-56 engine. The lube oil signal would be overwhelmed by fuel and 4 and 7%, but could be more important to there overall emissions at higher powers.

The explanation of the behavior of the oxygenated PMF factor is curious. Figure 7 focuses on one engine load and one ion ($C_2H_4O_2$), and makes it seem like the oxygenated fraction is strictly desorbing at high temperatures. However the PMF indicates that most of the oxygenated factor at 4% load, and maybe half at 7% load, has similar volatility to the fuel. Comparing the 7% data in Figure 7 to the full PMF analysis can therefore be confusing, since the former suggests that the oxygenated material is all lower volatility while the latter says essentially the opposite.

Page 8068, Line 25-29: Previous studies have used sorbents and quartz filters to collect I/SVOCs, not just filters. Also, an hour might be overstating the sampling time needed for filters sampling exhaust at low dilution, though the point remains the same - filters have low time resolution, need to be changed between engine loads, etc., and the instrument presented here is an improvement over filter sampling.

Page 8070, Section 2.1: it is probably worth noting that these power settings correspond to the ICAO test points. Were the tests done in a standard ICAO LTO cycle, or was each load held until you saw the plume? It seems that some of these questions are answered later in the manuscript in the description for Figure 4. It would be easiest to understand if all of the testing details were placed in one section, rather than split across separate parts of the manuscript.

Page 8070, Section 2.1: Fuel flow should be reported in SI units to be consistent with other units used in the manuscript.

Page 8071, Line 4-5: It's not clear where the 12-ft long sample line went. One end is obviously at the inlet of the instrument. Where was the other end? The sampling manifold for the Aerodyne mobile lab? Or did this line go directly outside? Where was the instrument physically located?

I don't know how to interpret the valve in the inset to Figure 1. It's not clear which flow is going to or someone from where in either the trapping or desorbing setup. Perhaps there is a better way to label the valve in the figure.

Figure 2a: how did you define C* for the n-alkanes? i.e., what was the source data for the compound vapor pressures?

Figure 4 is very hard to read: the lines, especially for the temperature trace, are too thin, and the labels are hard to read. Zooming in did not make the labels particularly more readable, suggesting that maybe the resolution of the figure is too low. Perhaps indicate wind direction on Figure 4 since it is discussed in the text.

It took me about 10 minutes to determine that the left-hand panels in Figure 8 each represent the time trace for one of the PMF factors. The right-hand panels have the same issue, though I was able to determine what I was looking at based on the mass spectra. It would help immensely to specifically label the panels with "aliphatic", "aromatic", "oxygenated".

Did you observe a difference in I/SVOC EF for FT-only 7% versus mixed JP8/FT? It seems the FT-only emissions would be lower, at least based on previous studies.

There is a section 4.1 but not 4.2, which makes the 4.1 label unnecessary

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Interactive comment on Atmos. Chem. Phys. Discuss., 13, 8065, 2013.