Atmospheric Measurement Techniques Discussions

Atmos. Meas. Tech. Discuss., referee comment RC2
https://doi.org/10.5194/amt-2021-209-RC2, 2021
© Author(s) 2021. This work is distributed under
the Creative Commons Attribution 4.0 License.

Comment on amt-2021-209

Anonymous Referee #1

Referee comment on "Measurement of black carbon emissions from multiple engine and source types using laser-induced incandescence: sensitivity to laser fluence" by Ruoyang Yuan et al., Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2021-209-RC2, 2021

This publication adresses an important uncertainty in aircraft nvPM measurement campains: The Laser-Induced-Incadescence method is known to show a carbon-particle-type dependent (artificial) response, which other instruments like the Micro Soot Sensor do not. Hence, it is very difficult to calibrate LII instruments properly, and also the repeatability of different experiments suffered from this shortcoming. Here, the authors show that by determining an optimal laser fluence range, LII performance can reach very good agreements with other reference measurement principles, irrespective of which engine or fuel type is measured. For future operational nvPM mass measurements, this work will prove to be very valuable for the establishment of SOPs, especially what concerns e.g. regular calibrations.

General Comments

In general, the manuscript is of good quality: The language style is very consistent, the sections are mostly clearly formulated and well-organized. The illustrations are useful to undermine the different statements.

The authors describe their approach to find the "optimal fluence" of the LII for different rigs. Non-straightforward results are explained, pointing at possible factors influencing non-standard shapes of mass concentration curves vs. fluence.

Despite some shortcomings described below, I recommend publishing this manuscript after some modifications, as it is the first work considering a wide range of combustion engines as suitable LII calibration sources, thereby helping the measurement community to decrease nvPM mass measurements uncertainties.

Following points should be improved:

- The MSS is known to be influenced from ambient effects, like changes in humidity. I suspect a similar behavior of the LII, and I am convinced the manuscript would benefit from an additional discussion of ambient effects on LII measurements. E.g., what were ambient conditions during the measurements?
- The authors performed the measurements on the different rigs over different periods of time: Other than in Fig. 3, the reader gets very little information how the authors made sure to assume "stable combustion conditions" for all rigs. Was there any CO2 measurement attached to the rig? Is there any EGT measurement available, which could be used as a potential tracer for combustion stability? As well, little is known about the warm-up sequence of the engines, neither do the author describe if any exhaust gas treatment (especially for rigs E & F) was present.
- What is the essence of the project? What are, after all the measurements performed by the authors, the recommendations? Can a low-cost engine like in rig F be used as a calibration device for an LII, if aircraft emission measurements following ICAO Annex 16 Vol. 2 be performed operationally? If yes, how large are the remaining uncertainties in terms ov nvPM mass, and how does this uncertainty compare to e.g. MSS measurements?

Specific Comments

L165: Add information what total volume was sampled onto the quarz filter
2. Methods: How did you define "stabilized conditions" for representative measurements? How long did you wait after any load change on the engines? Were the engines warmed up? Was any of the reciprocal engines fitted with any exhaust treatment mechanism?
Fig. 2/4 & others: It is only explained in line 358/359 why you are using arbitrary units instead of mJ/mm^2. I suggest adding this information earlier in your manuscript.
Fig. 10/11: I recommend adding a Loess curve as in Fig. 9 for consistency
Fig. 13: I am missing an explanation why the range for Rig E & F can't be more specifically indicated ("uncertainty" or "variability"?)

Technical Corrections

L44: Add "The" World Health Organization...
L49: CAEP & SARPs as abbreviation unnecessary, never used later
L80: Recommend to put all cited papers at the end of the sentence
L123: Add info: At which wavelengths? Comes too late (L138)
L141: Add comma after "or EC"
L151: "It is therefore important to operate..."
L425: relative -> relatively
L441-L445: Reformulate sentence: It is very lengthy and there seems to be some problems in the syntax.
L514: reformulate sentence after ", although was still..."