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Comment on amt-2021-345

Anonymous Referee #1

Referee comment on "Characterization of the MISG soot generator with an atmospheric simulation chamber" by Virginia Vernocchi et al., Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2021-345-RC1, 2021

We thank the Referee for his valuable comments. In the following, we reply point-by-point to his notes.

This manuscript describes the properties of soot generated by a mini inverted soot generator in terms of optical and physical properties, such as particle size, EC/TC mass fraction and absorption coefficient. The soot particles were generated by combustion of propane and ethylene.

The paper is written in clear language and is technically sound. However, there have already been several papers published that characterize the MISG soot properties under various operating conditions (both with ethylene and propane combustion), and which are cited in this manuscript. The results of this paper are largely consistent with these prior papers (which is good), but the novelty of the results presented in this paper is not clear.

In the revised version we will highlight, as suggested as well by other Referees, the novelty of our work. We added in the text:

Line 13: This work deepens and expands the existing characterization of this soot generator that is also coupled with an atmospheric simulation chamber. Differently from previous works, MISG performance has been also tested at different fuel flows and higher global equivalence ratios. MISG exhausts were investigated after their injection inside the atmospheric simulation chamber: this is another novelty of this work.

Line 24: The soot characterization opens to various kinds of experiments in ASCs. Particles with well-known properties can be used, for example, to investigate the possible interactions between soot and other atmospheric pollutants, the effects of meteorological variables on soot properties and the oxidative and toxicological potential of soot particles.

Line 63: Differently from previous works (Bischof et al., 2019; Kazemimanesh et al., 2019; Moallemi et al., 2019), the MISG has been connected directly to an atmospheric simulation chamber; performance has been tested also at different fuel flows and higher global equivalence ratios. The present characterization deepens and expands the existing knowledge on particles and gases produced by this soot generator. The comprehensive characterization of the MISG soot particles is an important piece of information to design the subsequent experiments. Well-characterized soot particles could be used to investigate the effects that atmospheric parameters can have on soot particles, and also to study the interactions between soot particles and other pollutants.

No attempt was made to further develop the MISG or the atmospheric simulation chamber.

The MISG is a commercial instrument specifically designed for producing soot particles with very few margins of modification. Anyway, we think that any (possible) modification should come after a deep and exhaustive comprehension of how the MISG performs in terms of soot production and properties. The modification/development of an atmospheric simulation chamber is beyond the scope of this paper, even if for sure interesting in this field of research.

Moreover, the link to atmospheric sciences is missing (for instance, an intercomparison of aerosol measurement instruments using MISG soot as test aerosol, validation of new measurement techniques or data analysis procedures etc.). In this sense, I believe that this manuscript does not fit so well into the scope of AMT.

As the Referee underlines, soot generators can be useful in several ways to study atmospheric processes and test related instrumentation. Therefore, we decided to investigate the MISG performance in detail. Moreover, the manuscript has been submitted to the AMT special issue "Simulation chambers as tools in atmospheric research". We consider the focus of our work coherent with the special issue scope: differently from previous studies, we characterized soot particles inside the atmospheric simulation chamber and not directly at the MISG outlet.

I would suggest to streamline the discussion on the soot characterisation (some of the results can be shifted to Supplemental Information) and add new results related to atmospheric sciences (e.g. interactions of soot with gaseous pollutants and bio-aerosols as suggested in Section 4 "Conclusions"). This would enhance the novelty of the paper. Another option would be to submit the manuscript to another journal, which is focused more on laboratory instrumentation.

Our paper focuses on the characterization of soot particles inside a simulation chamber. The interaction between soot particles and bio-aerosol, as well as the interaction with the gas phase are the next steps of our research, but they are beyond the scope of the present work.

Technical comments:

Line 46: The authors state that "The Inverted-Flame Burner (Stipe et al. 2005) is often considered as an ideal soot source (Moallemi et al., 2019 and references therein), due to its capacity to generate almost pure-EC particles and for the stability of the flame and of its exhaust (Stipe et al. 2005). To such category belongs the Mini-Inverted Soot Generator (MISG) used in this work". I find this sentence somewhat misleading. The MISG is known to suffer from poor day-to-day reproducubility for particle sizes below 150 nm (Moallemi et al.).

In the dedicate paragraph (§3.3) Moallemi et al. reported the repeatability (R) of the MISG in terms of 1) mode diameter, 2) number concentration, 3) mass concentration. In all the three cases they found that R depends mainly on the air flow given to the soot generator: in general, the lower is the air flow, the better is R. What is actually demonstrated by Moallemi et al., is that the MISG repeatability is very dependent on the feeding flows: it appears to be dependent on the global equivalence ratio and therefore on the flame shape. Indeed, it is shown that the variability increases (Fig. 5) when the combustion conditions are near to the Flickering flame operative range (Fig. 3).
By carefully choosing the pair of air and fuel flow values entering the MISG, the repeatability is more than satisfactory for all the three parameters. About the repeatability for particles below 140 nm, Moallemi et al. reported a poor day-to-day repeatability without defining a numerical range. It is worthy to note that the Authors underline how these values are affected not only by the burner, but also by the dilution system stability and the instruments measuring particles properties.

This might be the reason why in the current manuscript the authors only generated soot with mode diameters larger than 170 nm (Figure 4). Considering that most engines emit ultrafine soot particles (with GMDmob from about 20 nm for aircraft engines up to about 90 nm for diesel vehicles), it is not clear to me how the MISG can generate realistic soot size distributions.

We agree with the referee about the capability of this kind of burners to produce ultrafine soot particles: the size distribution also inside the chamber is picked to bigger particles while real engines produce smaller ones. However, our statement is not about engines, but limited to ideal soot sources. If necessary, we will specify in the text that this generator is not suitable for ultrafine particles.

Particles with mobility diameter <100 nm could potentially be size selected, e.g. with a DMA, but this was not investigated in this study. Moreover, it is not clear whether the number concentration of the size-selected particles (after being diluted in the chamber) would be sufficiently high for most type of experiments.

The possibility to use a DMA to inject inside the chamber ultrafine particles only is reasonable and can be investigated. We think that concentrations useful for most kind of experiments can be reached easily just increasing the injection time favouring the accumulation inside the chamber.