

Atmos. Meas. Tech. Discuss., referee comment RC2  
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## Comment on amt-2020-472

Anonymous Referee #2

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Referee comment on "Species correlation measurements in turbulent flare plumes: considerations for field measurements" by Scott P. Seymour and Matthew R. Johnson, Atmos. Meas. Tech. Discuss., <https://doi.org/10.5194/amt-2020-472-RC2>, 2021

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Review for "Species Correlation Measurements in Turbulent Flare Plumes: Considerations for Field Measurements".

### General Comments

This paper describes the application of a novel device to investigate the short-term variability of the BC/H<sub>2</sub>O ratio in a lab-scale flare using two different fuel compositions representative of the Bakken and Ecuador regions. The authors performed a Monte Carlo simulation to estimate variation and skewness in the BC/H<sub>2</sub>O ratio. They found that high ratios can be related to high BC production and further discuss the impact it could have on uncertainty and field measurements that assume a constant ratio.

The topic of this study is in the scope of the Atmospheric Measurement Techniques Chemistry journal and addresses an important subject relevant to field measurements of flaring emissions. Nevertheless, the implications of the study would benefit with more clarification and the Conclusions need to be improved since they read very similar to the Abstract.

### Specific comments

1) In Section 4.1 the authors mention the impact that crosswind might have on the short-term variability of the ratio. As part of the experimental method they also use data from CFD simulations of flares under crosswind conditions. However, the authors use a vertical flame to conduct the measurements of the BC/H<sub>2</sub>O ratio and in the manuscript it is not mentioned if they conducted experiments under crosswind conditions and why. My question is if the results obtained with a vertical flame can be representative also for

crosswind conditions. What are the implications for the experimental device / setup to explore that ?. Are the histograms of both the sample mean and ratio distribution subject to change, and if so, to what extent ?.

2) Regarding the implications of the study, the authors suggest that based on the results of the BC/H<sub>2</sub>O ratio, aircraft-based estimates may be under-sampled and the estimated black carbon emission rate would be biased low. However, the techniques might not be comparable between each other. Factors like a large variability in the operating conditions which can impact the estimates substantially even from day to day [Conrad and Johnson, 2017], or the difference in the volume sampled between these approaches are not discussed in detail in the manuscript. In addition, the measurements in the paper were obtained with freshly emitted BC which might not be the case for those obtained with an aircraft, especially those sampled kilometers downwind. A brief discussion considering differences between non-intrusive and extractive sampling techniques will add more clarity to the paper.

### **Technical corrections**

Ln 7. Briefly state why these measurements are important.

Ln 21. Replace '*should be easily avoidable*'. Consider rephrasing.

Ln 27. Consider rephrasing '*up 3% from 2018*' to something like (just an example) '*up to 3% higher than in 2018*'.

Ln 28. Maybe mention that methane is also considered a Short Lived Climate Pollutant (SLCP). It is indirectly mentioned for Black Carbon on Ln 38.

Ln 66. Change '*been study*' to '*been a study*'.

Ln 77. This sentence is not clear. Are these gas mixtures representative for both off-shore and on-shore facilities worldwide, or just for specific regions? A brief sentence would be good to clarify and help introduce the oil regions on Ln 86.

Ln 78. remove '*in schematic*'.

Ln 84-85. Consider moving this sentence to the previous paragraph and merge with Ln 81.

Figure 1. Please increase the font size. It can be hard to read.

Ln 96. Consider changing '*well away*' to '*far enough*' or similar wording.

Ln 190. It is mentioned that the profile fitting technique was implemented to laminar flames. Is it specific for laminar flames? What are the basis to use it for turbulent flames like those in the paper?

Ln 274. Why is the error in H<sub>2</sub>O volume fraction much higher than the error in BC volume fraction?

Ln 286. "*an apparent dependence on flare gas composition.*" It is an interesting result but it was only mentioned and not discussed with more detail. Did you consider the effect of the composition on soot chemistry? According to Table 1, Ecuador composition has more branched-chain isomers. It could produce different intermediate radicals, which affect the formation of molecular soot precursors [Lei et al., 2020].

Ln 705. Figure 2. Change '*shown*' to '*show*'.

Figure 3. include the meaning of  $q_{amb}/T_{amb}$ , etc also in the Figures' description.

Figure 5. Spell out '*NM*' in the Figure's description.

Ln 291. Remove the hyphen, it might be read as a negative value.

Ln 340. remove '*etc.*'

Please consider adding a paragraph, either in Section 4 or in the Conclusions, briefly mentioning the features and limitations of the novel measurement method device.

## References

Lei Xu, Fuwu Yan, Yu Wang, A comparative study of the sooting tendencies of various C5–C8 alkanes, alkenes and cycloalkanes in counterflow diffusion flames, *Applications in Energy and Combustion Science*, Volumes 1–4, 2020.