Atmos. Chem. Phys. Discuss.,
https://doi.org/10.5194/acp-2020-558-RC1, 2020

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Airborne measurements of fire Emission Factors for African biomass burning sampled during the MOYA Campaign" *by* Patrick A. Barker et al.

Anonymous Referee #1

Received and published: 1 August 2020

General Comments:

This is a clearly written paper, easy to follow and understand, and presents an accessible and rigorous analysis of an important dataset. The authors nicely motivate their work and the measurement campaigns and lay out a clear story which is backed up logically. The figures are generally good and easy to understand. The primary weakness in the paper is the use of the ordinary least squares (OLS) regression, there are some figure selection issues, and some minor technical questions. With minor revisions this paper will be a welcome addition to the literature.

Specific Comments:

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Discussion paper

This paper uses OLS regression, which is inappropriate for calculating trace gas ratios. While OLS is scale invariant, ratios taken from the slope of this regression cannot be inverted. Since all OLS regressions presented in this paper use observed data, a weighted regression (such as the York regression; please see York et al. 2004, Cantrell 2008, and Wu and Yu 2018, references below) using instrument precision as the variable weights will provide a robust trace gas ratio that is both scale invariant and slope invertible. Please do not use unweighted orthogonal distance regression (ODR) in place of OLS for trace gas ratios, as ODR is sensitive to the scales of the axes.

The emission factors calculated in this paper use a single value for the mass fraction of the dry fuel. With the context that the primary fuel is changing from C3 to C4 plants between MOYA-I and MOYA-II, is this single mass fraction appropriate for both regions?

I have some question about whether figure 6 is currently adding significantly to the discussion. In its current formulation this figure is only applicable to the MOYA-II flights, and the B panel is repeating information that it shown with better context in Figure 1. If a similar ground cover map for Senegal was available keeping figure 6 as a ground cover discussion would be useful, but in its current form figure 6 could be moved to the supplementary material without impacting the discussion.

For figures 7 and 8, the plots where clearly motivated in the text; I would like to see this analysis applied to the other trace gas species. While the primary motivation of these missions was to quantify methane emissions, extending this analysis to CO, CO2, and the additional MOYA-II species either in these plots or as supplemental material would be a welcome addition to the paper.

The Far Field Sampling section feels moderately unorganized compared to the rest of section 4. Currently the paper discusses the two flights separately, with 6 total figures; changing the structure to discussing both flights together by type of analysis (back trajectories, vertical distributions, and trace gas ratios) would allow the authors to combine the plots into three figures and compare and contrast the two flights more

effectively.

Technical Corrections and Small Issues:

There are some minor structural issues the methods sections. Section 2 and 3 would work better as a combined methods section, and I recommend splitting both the CIMS instrument and the WAS measurements into their own individual subsections.

Was the data used in this paper time synced? This is important for capturing trace gas ratios from regression methodology and should be included in the methods.

Since the identification of the plumes was done with statistics above the background, how was the "width" of the plume assigned? Is the plume only valid when your tracer species is at or above the threshold, or is the plume assigned with some buffer time on either side?

Figure 2 is out of order – it's cited after Figures 3 and 4.

In Figure 4 was the linear relationship applied to all measurements in the C004 and C005 flights, or did it leave off the high inverse CH4 data? If some data was left off, what was the threshold for that decision?

The following statement in lines 480-485: "The trends in mean MCE and EFs observed during C132, C133, and C134 suggest that EFs are mostly determined by the completeness of combustion over other factors." would be more effectively shown as a figure, either in the supplementary material or as a replacement for figure 6.

The time series plots should include notations or icons showing when the WAS samples were collected. Please include time series plots for the Far Field Sampling flights; including them in the supplementary material would be fine.

For the Far Field Sampling figures, two things need to be clarified in either the text or the figure captions. First, are the high split back trajectories run on distinct plumes, or where they initiated on a regular time step? And second, what is the vertical binning

on the box and whisker plots in Figures 10 and 13?

Weighted Regression References: York, D., Evensen, N. M., MartÄśÌĄnez, M. L., & De Basabe Delgado, J. (2004). Unified equations for the slope, intercept, and standard errors of the best straight line. American Journal of Physics, 72(3), 367–375. https://doi.org/10.1119/1.1632486

Cantrell, C. A. (2008). Technical Note: Review of methods for linear least-squares fitting of data and application to atmospheric chemistry problems. Atmospheric Chemistry and Physics, 8(17), 5477–5487. https://doi.org/10.5194/acp-8-5477-2008

Wu, C., & Yu, J. Z. (2018). Evaluation of linear regression techniques for atmospheric applications: the importance of appropriate weighting. Atmospheric Measurement Techniques, 11(2), 1233–1250. https://doi.org/10.5194/amt-11-1233-2018

Weighted Regression followup note: Since it appears that the plots in the paper were created in Igor Pro, a weighted regression that is equivalent to the York Regression (assuming uncorrelated errors between the variables) can be calculated using the built in curvefit function. In this formulation, the uncertainty waves are the pointwise precision (or uncertainties) for the x and y waves in the same units as x and y (ie, ppb, ppm). /I=0 (the default) sets the regression to expect reciprocal uncertainties, which can cause issues, so make sure to check before running. I am happy to iterate about weighted regressions in the comments if you have any questions.

Curvefit/odr=2 line y_data_wave /x=x_data_wave/I=1 /Xw=x_unc_wave /W=y_unc_wave

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