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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Trace gas emissions from combustion of peat, crop residue, biofuels, grasses, and other fuels: configuration and FTIR component of the fourth Fire Lab at Missoula Experiment (FLAME-4)" *by* C. E. Stockwell et al.

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Response to Referee #1

We thank the Referee (M. Wooster) for his comments and suggestions. All of the comments and suggestions have been taken into account and were helpful in improving the manuscript. We address the specific comments below.

R1: Why is N2O not mentioned, was its detection attempted but it found to be present undetectable quantities? If so, can a minimum EF be put on its production from the various fuels burned herein? Some information of the spectral fitting window, additional species included in the fit for each major target gas, and any other parameters would be useful for others wanting to replicate all or part of your methodology. Perhaps in the Supplementary Materials ? If you used a set of parameters taken from elsewhere then at least a reference to that work.

In referee #1's comments, he suggests adding information on our spectral fitting windows. We have added a supplementary table (Table S2) which includes our spectral fitting windows and species measured. Additionally, we've inserted text into L23, P10076, which also addresses the referee's inquiry about N2O detection:

"The selected spectral windows and hence interfering species depend strongly on resolution, relative humidity, pathlength, and concentration of the smoke. The spectral regions and parameters are re-optimized for every experiment with current ranges reported in the supplementary information (Table S2), though we caution against using our settings in other work. Although nitrous oxide (N_2O) is fitted as part of the CO and CO_2 analysis, it is not reported because any enhancements are too small to be resolved confidently at 0.67 cm^{-1} resolution. Even with higher resolution OP-FTIR significant N_2O enhancements were not observed in smoke confirming it is at most a minor product (Griffith et al., 1991)."

This additional reference is also added to the paper:

Griffith, D. W. T., Mankin, W. G., Coffey, M. T., Ward, D. E., and Riebau, A.: FTIR remote sensing of biomass burning emissions of CO_2, CO, CH_4, CH_2O, NO, NO_2, NH_3, and N_2O, in: Global Biomass Burning: Atmospheric, Climatic, and Biospheric Implications, edited by: Levine, J. S., MIT Press, Cambridge, 230–239, 1991.

R1: Section 2.6 is very interesting, so much so that some parts could be presented in more detail. The prior section on derivation of EF and MCE goes into

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a lot of detail about these topics, which are presented in many other papers, so Section 2.6 (which is reporting not so commonly available material) should I think be covered in more detail than it is ideally. For example expanding on the "a simple field/lab correction factor can be used when warranted" - what is this correction factor?

In order to expand upon and clarify the statement concerning the use of a simple correction factor, we have changed the sentence in L26, P10080 to: "Finally in the simplest approach the average ratio of field EF to lab EF can be applied as a correction factor to adjust lab EF (Yokelson et al., 2008). This approach was also warranted for adjustments to fuel-specific lab EF reported in Yokelson et al. (2013) because the results had the lowest error of prediction"

R1: Whilst I agree that MCE is measured in many field fires, it is not always measured at the same location (e.g. sometimes on the ground and sometimes in the air; which may represent different types of smoke to some extent). Perhaps this needs a brief mention as well.

To briefly expand on the description of "field" fires, we've added text to L12, P10080 "For fires that may be dominated by poorly lofted emissions, such as peat fires or residual smoldering combustion (Bertschi et al., 2003b), a ground-based MCE could be most representative." While we also change changed "airborne" to "field" in L13, P10080.

This additional reference is added to the paper:

Bertschi, I. T., Yokelson, R. J., Ward, D. E., Babbitt, R. E., Susott, R. A., Goode, J. G., and Hao, W. M.: Trace gas and particle emissions from fires in large diameter and belowground biomass fuels, J. Geophys. Res., 108(D13), 8472, doi:10.1029/2002JD002100, 2003b.

R1: Section 3.1. When you say "average MCE" perhaps better to say "mean

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MCE" if the mean was the statistic used.

In order to clarify that mean was the statistic used we went to the earliest mention of “average” in section 2.6 (L8, P10080) and changed “average” to “average (i.e. the mean)”

R1: Also, this approach will only presumably work if the relationship between MCE and EF of the compound is linear, which it is in these cases. Are non-linear relationships ever found with the lab data....or a relationship so poor that it is not possible to use it to derive the EF at the typical MCE measured in the field?

A good linear correlation doesn’t necessarily indicate how effective the plot-based approach is at predicting field EF. While Fig. 5 shows good correlations for some species, other species do have poor correlations such as nitrogen-containing species since fuel N varies quite a bit. However, the plot based approach still yields decent estimates at the field average. This is more of an empirical approach and its ability to provide reasonable estimates is best determined by comparison to field values.

To clarify this point, on L28, P10080 we add: “When lab EF are adjusted it is not expected for instance that the EF versus MCE relationship will be identical in the lab and field or always be highly correlated, but simply that the adjustment procedure will nudge the EF in the right direction.”

R1: Also, on the linear fits of Figure 5 it would be useful to put the uncertainties on the slope and propagate them into the uncertainty of the derived EFs?

There are many potential sources of uncertainty in the overall projections, each retrieval (H2O and S:N), representativeness, etc., of which some are hard to characterize. Thus, we think an estimate of uncertainty based on difference with real world fires is a better indicator of real world uncertainty than the uncertainty in the lab slope. Examples of these comparison-based uncertainties are shown at bottom of the Tables 2 and 5 and mentioned briefly in Sect. 2.6 where we changed L28, P10080 to: “We can take

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the level of agreement between the lab-based predictions and the airborne-measured averages (for species measured in both environments) as the most realistic estimate of uncertainty in using lab equations for species not measured in the field."

R1: With the tropical peat, no in situ MCE measurements are available. I presume you therefore present the results from the lab without recourse to the "plot based analysis" of EF vs MCE [e.g. Fig 5] as done with the other samples? Making it very clear when they are first reported as to which fuels the "plot based analysis" was conducted for, and which fuels the lab-based EFs are reported as is would be helpful. This is mentioned in the Conclusions section though

To clarify that the tropical peat reported in earlier studies was not field data we've added "laboratory burned" when describing the Sumatran samples (L17, P10085) and added the text "To our knowledge, all detailed chemical characterization of peat fire smoke has been done in the lab." (L21, P10085)

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