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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Laboratory measurements of trace gas emissions from biomass burning of fuel types from the Southeastern and Southwestern United States" *by* I. R. Burling et al.

Anonymous Referee #2

Received and published: 25 August 2010

This paper presents results from laboratory experiments measuring gaseous emissions from the combustion of wildland biomass materials collected from five military bases in the southeastern and southwestern US. Emissions of 19 gas-phase species were measured using open-path Fourier transform infrared (OP-FTIR) spectroscopy in controlled burns of 18 different fuel types in the US Forest Service Fire Science Laboratory (FSL). OP-FTIR provides highly time-resolved measurements of these compounds with high specificity; comparisons with data from other collocated instruments are included in some of the paper's discussion. The results of this study are a large set

of fire-integrated, fuel-mass-based emission factors and ratios for a range of carbon-, nitrogen-, sulfur- and chlorine-containing compounds with varied atmospheric impacts. A strong association is seen between emission factors of many of these species and modified combustion efficiency (MCE), which is an indicator of the 'ideality' of a fire. Emissions factors are also associated with fuel composition and compared with values and fuel- and flame-dependencies observed in other laboratory and field measurements.

Biomass burning is the dominant source of many atmospheric trace species; these emissions are complex and play important and relatively poorly understood roles in oxidant cycles and the radiative balance in the atmosphere. Therefore, well-executed studies in this area are of wide interest. Overall, I found the research documented in this paper to be carefully done and the paper itself well written, readable and offering a fairly comprehensive comparison with other work in the area. I definitely recommend this paper for publication in ACP.

I have some general recommendations for the authors to improve the manuscript as they prepare it for resubmission. I found the paper to be lengthy relative to the material presented. In particular I feel that 13 figures and 3 large tables is somewhat excessive for a paper of this sort and that the manuscript could be trimmed without losing any important content while making the manuscript more succinct and readable. Specific suggestions for doing this are below. Another general comment is that linear regressions are used in the paper with minimal regard for the uncertainty associated with the fits – generating fit confidence intervals or uncertainties in fit parameters is part of many linear regression routines and these values should be used when comparing fits within this work or from previous work. This latter issue is of course is not a fault only with this paper, but I would like to see this work present details of fits and not over-interpreting regression results.

Here I offer some comments, clarifications and corrections that I would like the authors to address before resubmitting.

Specific Comments (p16427, l5 refers to line 5 on page 16427):

p16428, l23: A reference or references pointing the reader to evidence for, and the importance of, our poor understanding of HONO sources would be helpful. Is there evidence that direct emission from biomass burning may be an important source?

p16431, l12: What was the approximate size of the wood chips?

P16435, l18 – 20: Were low-consumption fires included in emission factor calculations? Were any systematic differences observed in burns with similar fuels that had different fuel consumptions (e.g. the vertical/horizontal ceanothus burns)? Will burn extent have large effects on fire-integrated emission factors for different fuels? Are there implications for using these emission factors for modeling actual wild fires?

P16436, l3-4: What is meant by 'higher mass loading and better heat transfer'? Is this because the fuel bed was more tightly packed? Is this a realistic burning geometry? This could bear more discussion.

P16436-37, l26-28 and l1-2: Making a comparison between your relationship and one with a R2 value of 0.15 is essentially meaningless. I'd suggest that at most you retain your comparison of average HCOOH emission factors for the two studies and note that the fuels and conditions (e.g. age of emissions) in the two studies are quite different.

P16437, L23-26: The fact that a good portion of the NMOC is unidentified should be emphasized a bit earlier; otherwise your 'identified' OVOC/NMOC ratios could be misinterpreted. I think this should go after the first sentence in this paragraph, though the later discussion of the WAS results can remain further down.

P16439, L17-23: This discussion is a bit sloppy. NOx is not 'a component of flaming combustion' – Higher NOx emissions are associated with higher temperature combustion through 'thermal' NOx production pathways. The fact that fuel nitrogen content will have a different impact on NOx production than MCE (with higher MCEs generally accompanying higher temperature combustion) should not be surprising (see

e.g. http://en.wikipedia.org/wiki/NOx) and a discussion of the different NOx production pathways would be fitting here. The interaction is not simple, as you show in the figure, because fuel nitrogen content seems to be systematically related to the MCE achieved during a burn.

P16440, l3-17 and Figure 5: This figure is not necessary and doesn't contribute much to the manuscript. A more precise discussion of your fits (see comments in the last paragraph in the opening portion of this comment document) and that generated by Goode et al. would be more useful than the plot. Your results do not appear to be significantly different than those of Goode et al.; this can be tested statistically either by generating confidence intervals on your fit or parameter uncertainties. I'm not sure if Goode et al. provided enough information to do this for their fit as well, but it's definitely possible for your data.

P16442, l25-26: For context, it would be helpful to give reasoning/references to identify why you suspect this might be an important pathway for HONO production.

P16442, L3: 'no obvious flow rate dependence' is a bit vague. Can you quantify this?

P16446, L25-26 and Fig. 11: Graph is unnecessary – just give correlation and parameter uncertainties.

P16449, L20-21: Switch order of N2 emission and ash sink as the former is likely the dominant end point for fuel nitrogen.

Tables 2 and 3: Include 'N' (number of experiments per fuel) as a row in these tables. Also, include a footnote that the sums of NMOC and OVOC here are only those identified by OP-FTIR

Figure 3: I'd like to see confidence intervals on your fits

Figure 5: Remove

Figure 7: Largely just aesthetic, but why only include y-axis ticks/units for one of the

spectra? I would show it for both or neither. . .

Figure 9: Switch order of laboratory studies so that yours is the bottom as it's the basis of comparison. What do the bars signify? Presumably 1 sigma, but it's somewhat confusing because you discuss a range in the text of 0.025 to 0.2 (e.g. P16443, L18-19) but the bars do not cover this range.

Figure 10: This figure is of limited use because there is little systematic variation in HCl EF. The current discussion of HCl coming from leafy combustion (and perhaps a listing of fuel types with higher HCl emissions is likely more useful than having a figure that distracts the reader as the actual values are all in the table.

Figure 11: Remove

Technical Corrections:

P16428, L28: 'The advantages of OP-FTIR include the quantification of. . .' should be 'An advantage of OP-FTIR is that it is able to quantify most. . .'

P16437, L14: 'identical to Yokelson et al. (2003)' should read 'identical to that presented in Yokelson et al. (2003)'

P16440, L15: 'fire-integrated MCE, compiled from several..' – remove comma.

P16440, L24-25: 'flaming combustion product'? – reword.

P16440, L26-27: '. . .measured by OP-FTIR, as well as. . .' – remove comma or rework sentence

P16441, L3: 'obvious regional effect on..' – this makes no sense, replace with 'a clear variation in the nitrogen balance with the region from which fuels were gathered' or something similar.

P16445, L16-17: 'These two studies. . .': Move 'to our knowledge' the start of the sentence.

P16445, L18: 'list' is more appropriate than 'recommend'

P16448, L1: 'from Camp Lejeune show' should read 'from Camp Lejeune fuels show'

P16448, L8-9: 'Four of the samples at Camp Lejeune in North Carolina represent the effects of fuel treatments. . .' should read 'Four of the samples collected from Camp Lejeune in North Carolina represent fuel treatments. . .'

P16449, L3: replace 'values' with 'emissions'

P166449, L9-15: this section should be tightened and made more clear

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Interactive comment on Atmos. Chem. Phys. Discuss., 10, 16425, 2010.