

Interactive comment on “Airborne observations of trace gases over boreal Canada during BORTAS: campaign climatology, airmass analysis and enhancement ratios” by S. J. O’Shea et al.

Anonymous Referee #1

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The paper describes a set of aircraft measurements performed in Eastern Canada aiming at the investigation of biomass burning plumes from boreal forest fires. Biomass burning plumes are identified using a set of trace gases. The presentation of a comprehensive data set makes the paper a valuable scientific contribution, however, the way the data are presented should be improved prior to final publication. Often the data analysis is lacking structure, e.g. when moving between different aspects and concepts of varying complexity rather than taking the reader along from the discussion of measurements to a scientific interpretation using elaborate models and concepts such as for example MCE and NEMR.

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In particular, section 3 is in parts poorly organised, switching back and forth between different aspects of data discussion and interpretation. The paper would greatly benefit from reordering the structure of data presentation, e.g. in section 3.1., 3.3.1., 3.3.2. These sections contain partly technical aspects of data such as different time resolution of data sets and plume identification strategies that mix up with data interpretation.

While the introduction gives appropriate credit to previous research on biomass burning, the discussion lacks references to other studies of biomass burning plumes, both at high latitudes and in other regions.

Specific comments

Figures

In the current version, labels and annotations in most figures are barely readable. For final production please enlarge font size.

Figure 1 has a unpleasant aspect ratio of height and width, it looks rather distorted. Consider colorcoding with a tracer mixing ratio. It might enhance understanding to refer to this figure later in the text more often when discussing individual flights.

Since it is stated several times in the text that data from the transfer flights was not included in the analyses, these flight tracks can be omitted. Showing only the campaign region will make it easier to distinguish individual flights.

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Abstract

ACP allows paragraphs in abstracts, and I suggest to make use of this to structure the abstract.

P 14071, L 21 change "By examining individual case studies" to e.g. "Examining individual cases".

See also detailed comments on text, in particular on section *Large Scale Distribution*.

Introduction

P 14072, L 18–21 This statement mixes the inherent episodic character of biomass burning events with the difficulties of complete monitoring. "Coupled" is not a good choice of word here as it implies an interaction.

P 14072, L 24/25 "Fires ... composition". This wording does not make any sense to me. What is meant by "Fires ... attributed ... to changes". Fire to be the cause of observed changes? Or atmospheric changes to cause fires? Please clarify.

P 14073, L 12 emission - emissions ?

Aircraft Sampling

P 14074, L 22/23 "based out of" appears an odd choice of word; "based in" or "operated out of"

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P 14075, L 22/23 What were the actual mixing ratios of the used standards? Please identify the respective scales (WMO-X2007 and NOAA 2004 ?).

Analysis

P 14076, L 1/2 What do the given percentages refer to? Total Emissions?

P 14076, L 12–16 How did you deal with the PTRMS data that as stated above has a time resolution of 9–20 s when merging the data, especially for the 3-merges ?

P 14076, L 23 ff A complicated argument for an obvious fact.

Large scale distribution

This subsection is not well organised and therefore difficult to follow for a reader not familiar with the data analysis procedure. The heading implies an overall discussion of the data but the section mixes bulk statistics with plume identification. I suggest to split it into two parts, separating the bulk statistics and comparison with published data from other projects from the issue of plume analysis.

In general, I think, there is not much information in mean values of all the data (also applies to numbers given in abstract). It was described above how the PBL differs from the free troposphere, but mean values for only the PBL are not given. Averaging all altitude levels does not consider the observed changes in the PBL, and it does not take into account the frequency at which individual altitude levels were probed, nor the altitude distribution of plume encounters. Thus, the comparison with previous campaigns are rather meaningless.

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The data presentations lacks a discussion of the spatial plume distribution. Where and at which altitudes were plumes probed? Was ojn any occasion one plume probed several times at different altitudes or at different ages to document plume aging? In Figure 2 outliers on the high end show up in all altitude bins. Is there a layer where plumes occur more often than in others?

It was stated above that two different merges of the data were produced, but it is not always clear which one was used in a particular step of the analysis.

P 14078, L 10–18 Comparison of station and ground data are difficult in general. Comparing free tropospheric altitude data to a mountain background station may be useful to do, the same applies for selected low altitude flight data and ground stations. Comparing the ground station data to the mean value of all altitude does not give meaningful information unless explained in more detail.

How do PBL values measured from aboard the aircraft compare to Sable Island mean vales?

P 14078, L 21 ff Did ARCTAS and ABLE-3B cover a similar altitude range? At which altitude were plumes encountered in this study and the previous ones?

P 14079, L 9–14 Move this paragraph to the above discussion of figure 2.

P 14079, L 15–28 This paragraph does not belong here, it would only make sense if the data was presented without the plume encounters. Consider moving all aspects of plume identification to a separate subsection or to the methodology section 2.2

P 14080, L 7 Correlation of what with CO? CO₂ and CH₄?

P 14080, L 12-14 "The flights ... influenced by BB" - This is a very important, though also very general statement and should be moved up.

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P 14080, L 15 Which merge (10 s or 3 s) was used for this?

P 14080, L 19/20 Why is this correlation not shown in Figure 3? Consider replacing panels a and b by the respective ones showing the data after removing plumes.

P 14080, L 20 orthogonal regression or least square?

P 14081, L 4–6 Not clear what this sentence means, please reword.

P 14081, L 8–13 How representative were the samples of the plumes? Were plumes represented to a similar extent as in the high resolution data set? Especially narrow plumes might me missed when taking flask samples. Please specify what you mean by "specific but irregular". How were the times/places for sample collection determined. Was sampling automated or manually?

P 14081, L 24 What does near-field mean here in terms of distance to sources and age of the plumes ?

MACC comparison

P 14083, L 10 The altitude binning in Figure 4 is different from Figure 2. Please comment on the choice of altitude bins.

ER an EF

P 14083, L 26 Skip first sentence, using emission ratios and factor is common practice for this type of data analysis.

P 14084, L 15 I don't think NEMR is a widely used concept, therefore explain.

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Near-field

P 14085, L 12 How old and how distant from the region of origin is "fresh"?

P 14085, L 20 ff The issue of data availability on different time scaled needs to be discussed above in the context of data merging. The method presented here seems to be a compromise to deal with the lower resolution PTRMS data. Was it only used for the data for that one flight? How much better are the results with the first method?

P 14086, L 10 "with a standard deviation"

P 14086, L 12/13 A lack of measurements can hardly have a meaning. Change to "Due to a lack of measurements the distribution . is not well known"

P 14086, L 20 What do you mean by "grouping" ? Using just the point marked red in the figure?

P 14086 L 17) comment on the "blue" outlier at about 400of CO ?

P 14086 L 24) Discuss the "good agreement" in more detail, especially the difference between fresh and aged plume. EF for CO and CH₄ for fresh plumes are markedly different from literature values. Does this allow conclusion on the fire characteristics the burning phase fires were in, ...

P 14086 L 26) Which threshold do you refer to here?

P 14087 Is there a relation between the determined ER/EF and plume age and the MCE given in the table.

P 14087 The MCE concept is applied to all plumes and should therefore not be part of the discussion of the plume on 26 July, but be moved to a more general section of the text.

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Far-field

Give a brief summary on NEMR before using the concept so intensively. The NEMR discussion is mixed up with the trajectory analysis.

P 14088 L 17 ff / Figure 6 It's difficult to see details in the trajectory plots. Are the trajectories shown for the complete flight or only for those sections that have been identified to be within a plume?

Figure 7 a A discussion of the CO₂ time series seems to be lacking. Why do the low CO₂ mixing ratios not occur during the low altitude flight sections? The second low CO₂ phase corresponds to high CH₄ but lower CO and HCN inside the plume. Did the aircraft fly in an out of the plume? Maybe use shading in the Figure to illustrate which parts of the flight were identified as being inside plumes and which not.

Figure 8 Labels a,b,c,d are difficult to see in the figure, move outside maps. In Figure 6 labelling was clock-wise, here it's counter clock-wise.

P 14089 L 6–8 Unclear grammar, please reword.

P 14089 L 6–8 NAME is driven by HYSPLIT trajectories, so isn't it by default that it traces back the airmasses to the same region of origin as HYSPLIT does?

P 14089 L 10 "However , ..." – general comment: in many longer sentences a lack of commas makes it tedious to extract information.

P 14089 L 12–14 In Figure 8b the maximum sensitivity seem to be south east of the active fires detected by MODIS. However, according to the color scale (which is difficult to see give the size of the figure) there still seems to be significant sensitivity in that region. Is it possible to illustrate the better agreement for case 8d by quoting values of the sensitivity footprint for the region of interest in comparison to 8b? I can't follow the

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later statement that this indicates that NAME points to "more distant" sources. Looking at the sensitivity map it rather seems to point to sources more close to the region where the aircraft was operated.

Figure 9 Labels a,b,c missing.

Figure 9 According to the text the figure provides a comparison between IASI and BORTAS data. According to the caption all three panels show IASI data. Please clarify. I suggest to include aircraft tracks in these figure.

P 14090 L 10–23 These two paragraphs contain introductory information for this section and should be moved up. Without illustration the descriptions of in and out of plumes are difficult to follow.

P 14090 L 24 Such basic data treatment issues should be discussed prior to going on to more sophisticated interpretation tools such as trajectory analysis.

P 14090 L 26 There has been no information yet about plume altitude during the campaign. How did you do the partitioning here?

P 14090 L 28 Check table reference. What is meant by "runs and profiles"? Again, the discussion switches back to an issues that was in part discussed above. Please streamline and discuss the table, including the difference between the fresh plume and the aged plumes in one place.

P 14091 L 4–7 higher MCE/higher flaming contribution in aged plumes – is this by chance or is there a cause for his?

P 14091 L 13 What do you mean by "straight-and-level run"

P 14092 L 17/18 ? Those airmasses that spent the most time over the HBL (50 hours, large blue circles) have lower CH₄ mixing ratios.

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P 14092 L 28 Check Figure reference.

Interactive comment on Atmos. Chem. Phys. Discuss., 13, 14069, 2013.