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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Comparison of the chemical evolution and characteristics of 495 biomass burning plumes intercepted by the NASA DC-8 aircraft during the ARCTAS/CARB-2008 field campaign" *by* A. Hecobian et al.

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Interactive comment on "Comparison of the chemical evolution and characteristics of 495 biomass burning plumes intercepted by the NASA DC-8 aircraft during the ARCTAS/CARB-2008 field campaign" by A. Hecobian et al. Anonymous Referee #1 Received and published: 31 July 2011

R1.1)This statement is presented in response to both reviewers' comments:

Since the inclusion of the two different analyses in the same paper seems to have

caused confusion, and as the reviewers have made the majority of the requests for changes on the detailed boreal emission and evolution analysis, the authors have decided to present the boreal analysis in a separate paper where a more detailed analysis will be applied to the data and the comments of the reviewers will be considered in that paper. As the authors feel that the additional analysis will add to the scope of the paper, such that the assimilation of all the data in one paper will be cumbersome for the reader, only the comparison of the 495 biomass burning plumes has been included in this paper, with the incorporation of the comments from the reviewers.

**This paper investigates the composition of biomass burning plumes measured during the NASA ARCTAS-2008 experiment. Almost 500 plumes were identified and their compositions analysed. This must have been an enormous amount of work. Despite the enormous amount of work that must have gone into this I found the paper, in the end, rather unsatisfying. The "vision" of what the paper is for should be strengthened. At the moment it feels like it has been forced into being because it was felt that a paper should be written rather than because the authors feel they have something specific to say. I think the major themes of the paper are to investigate 1) changes in concentration with time within plumes and 2) changes in concentration between plumes. The conclusions appear to be be that there is little systematic change in the concentration with time within a plume and that there are significant difference in concentrations between plumes. I feel that authors should try and work their analysis to these conclusions and then state them more strongly.

R1.2)As noted above, the premise of this paper has been changed to discuss the changes in the concentrations in plumes encountered during ARCTAS-2008 field project. The conclusions have thus been changed to reflect this point. All inferences to the changes of concentrations with time in boreal plumes have been deleted and a new paragraph has been added to the conclusion to show stronger and more detailed conclusions of observations when comparing the different biomass burning plumes encountered during ARCTAS-2008. Regarding the "vision of what this paper is for": The

paper now focuses on documenting the normalized excess mixing ratios (relative to CO) for a wide range of fires following methods commonly used in the published literature to characterize fire emissions. The unique advantage of this data set and our analysis is that due to the duration of the study, the large region covered during the various study phases (i.e., ARCTAS-A, ARCTAS-B and ARCTAS-CARB), and using an aircraft with long-range capabilities (DC-8) with a constant payload, a large range of fires can be characterized by a single suite of advanced instrumentation. This has never been done before. Thus, we feel the statistical results presented are important to the scientific community that studies wildfire emissions and their impacts, and so is worthy of publication.

**I feel that the box modelling should be removed from the paper. I don't think that this offers anything new and I find the explanation of what was actually done for the modelling incomplete, and confusing. Not enough detail is provided here to evaluate whether the methodology is suitable. Are the authors considering this to be a semi-lagrangian experiment with the same plume being intercepted at multiple time down-wind? The transport model analysis is then used to convert the actual time the observations were made into a time since emissions? Where observations are available the model is constrained to those and when they are not available the model is allowed to calculate its own concentrations? This is really not explained at all well explained. The large jumps in the concentration of HO2 and the tendencies of O3 and PAN must be due to large changes in the concentrations of compounds or is it changing temperatures? It is not obvious to me what the model is doing? I don't think the conclusions here are particularly novel thus my suggestion is that this is removed and the emphasis placed on the data analysis.

R1.3)As the box model was a part of the explanation of a possible cause of lack of net SOA formation in the boreal plumes, it has been deleted from this paper.

**Overall I feel that the paper be subject to major corrections and re-reviewed once this has been achieved.

R1.4)Since the bulk of the reviewer comments were directed towards the boreal plume analysis and those results are no longer included in this paper, we feel that the request for major changes has been met.

**Abstract The last sentence is very weak. When the plumes were compared what was the result?

R1.5)The last paragraph of the abstract has been deleted and a new section added to reflect the information presented in the paper.

**Introduction At the end of the introduction I think the authors should put a section to explain the rest of the paper. I've become quite confused as to the "vision" for the paper but as I see it the analysis is split in two, with the first section looking at the processing within the plumes and the second section looking at the difference between plumes. This is not clear in the abstract or in the body of the paper.

R1.6)Since the reviewer's comments seemed to allude to the fact that the presentation of the two analyses in one paper were confusing, the authors have presented only the plume comparison data in this paper.

**Section 2.2.1 (Page 18598) Could typical examples or the complete set of trajectories be given here for each of the classification types?

R1.7)Done. The typical back trajectory figures from HYSPLIT for the major categories are presented in Fig. 2. However, the authors would like to point out that the only process for the categorization of the plumes was not back trajectories; wind direction and speed data and the presence of fires in specific locations from FIRMS data, including visual verification when possible, were also used.

**Section 2.2.2 (Page 18599) Two methods are discussed for determining the ratio in the plume of [X] to [CO]. The authors should provide an example here of the two methods. Do the conclusions change if just use one of the methods is used? Which method was used for which species or does it change on a plume by plume basis? It

would be worth using one method and seeing how this changes the conclusions.

R1.8)Done. The averaging of the plumes and the subtraction of background values has been used. Section 2.2 has been changed to reflect this analysis. The use of one method did not change the results of the plume analysis.

**Section 3.2 The use of ANOVA in evaluating whether there are significant difference is good. Could a similar approach be used in previous sections? Are the concentration changes seen within a single plume statistically significant? One of the issues here is that most ANOVA approaches assume a normal distribution of the population. It is probably unlikely that this is the case here. Are the same conclusions reached is the ANOVA is performed on log concentrations as well as concentration. It would be good to give the some indication of the statistical difference (F value or p value) for each comparison. Are there some species for which the statistical differences are larger than for other? The statistical description for different compounds (concentrations, standard deviations etc) in the different plumes should be given as in a table so that they readily interpreted by other groups looking at other plumes.

R1.9)Since the boreal analysis has been excluded from this paper, the authors will address the inclusion of ANOVA for this data in a future paper. As for the use of ANOVA for the multiple plume comparison, although ANOVA is best attempted on normally distributed data, some studies have shown that the violation of this assumption does not produce a false positive result in most cases. Indeed, the authors applied ANOVA to the log of the NEMRs for all species. As expected the p values were lower than before, but once again CH3CN and WSOC NEMRs were still higher than 0.05. The authors also used the Krushal-Wallis test, which is sometimes used as a substitute to ANOVA analysis when data is not normally distributed, but did not add it to the paper since the results were the same. Fig. 3 presents the statistical data for the NEMRs of the plumes. Table 3 has also been added to provide the mean NEMRs, standard deviations and the p values for each species from the ANOVA analysis.

**Conclusions Again I found this section weak. The final paragraph covers a lot of work but really doesn't tell us very much.

R1.10)The conclusion has been changed to reflect the information from the analysis of the plumes presented in this paper.

**Minor Comments Why are the OH team not included in the authorship? This seems a little odd.

R1.11)Dr. William Brune (the principal investigator of the OH instrument on board the NASA DC-8 aircraft) had been offered a co-authorship in the paper, however he kindly declined stating that "...contribution was too small to merit..." a co-authorship and asked the addition of a note in the acknowledgement section, which was done.

**The word level should be replaced by concentration or mixing ratio.

R1.12)Done.

**Page 18698 How was the 40% value reached for the uncertainties? This is not well explained and seems rather arbitarty.

R1.13)As this calculation was a part of the boreal plume analysis, it has been deleted and it will be discussed in great detail in a future paper.

**Page 18601. Processes in the plume other than dry or wet deposition can lead to changed. Chemical processing, uptake onto aerosol might make a difference here as well.

R1.14)"...or uptake of gaseous species into aqueous phase." has been added.

Interactive comment on Atmos. Chem. Phys. Discuss., 11, 18589, 2011.

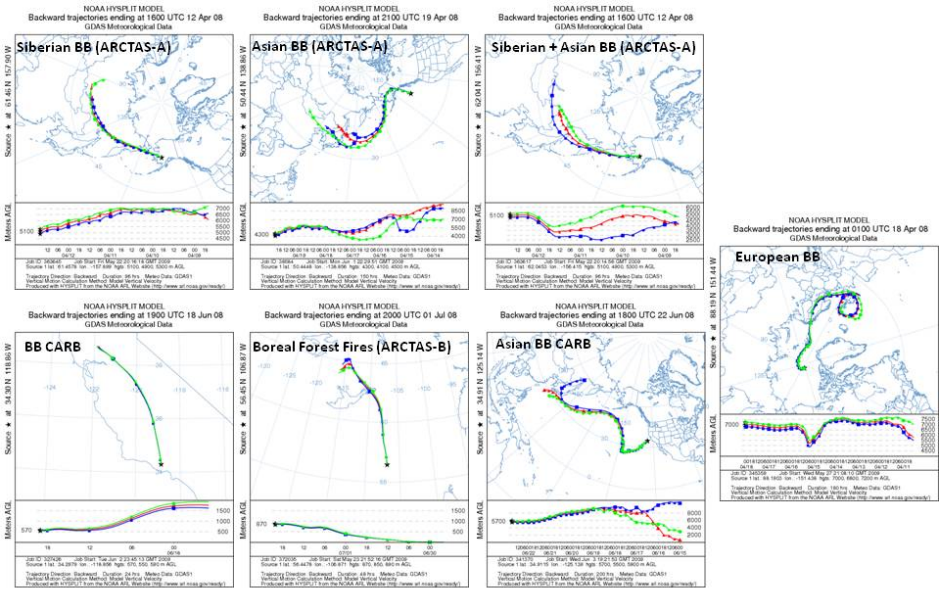

Fig. 1. Figure 2: Typical HYSPLIT back trajectory analysis results for some of the major plume categories.