Atmos. Chem. Phys. Discuss., 12, C12245–C12249, 2013
www.atmos-chem-phys-discuss.net/12/C12245/2013/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "ACE-FTS observations of pyrogenic trace species in boreal biomass burning plumes during BORTAS" *by* K. A. Tereszchuk et al.

Anonymous Referee #1

Received and published: 3 February 2013

General Comments

This paper describes satellite measurements of pyrogenic trace gases in biomass burning plumes that were made by ACE-FTS during the 2011 BORTAS campaign. This campaign, which ran from 12 July to 3 August 2011, involved ground-based, aircraft, and satellite measurements of boreal biomass burning products, for the purpose of investigating their impact on atmospheric chemistry, and in particular, on the oxidizing capacity of the free troposphere. Vertical profiles of 15 trace gases measured by ACE-FTS are examined, with enhanced HCN used as the marker for biomass burning events. Emission sources are identified using MODIS fire data, HYSPLIT back trajectories, and IASI CO total column data. Tracer-CO correlations are used to derive age-dependent enhancement ratios for plumes up to seven days old. The HCN, CO,

and ozone data are used to determine the impact of biomass burning on ozone production; this work suggests that ozone in young plumes is destroyed while ozone outside the plume is enhanced. Examination of annual trends in NH tropospheric ozone (using 2008-2011 ACE-FTS data) compared with fire activity suggests that spring and summer enhancements in ozone correspond to boreal biomass burning. Overall, the paper concludes that production of ozone is negative in young plumes and positive in aged plumes. The ACE-FTS data are also used to show that biomass burning plumes are being injected into the stratosphere, while stratospheric air is being mixed downwards into the free troposphere, providing another source of enhanced ozone.

The paper is well written, and the results should be of interest to the biomass burning community, including those making measurements, compiling emissions inventories, and modeling the chemistry and transport. I recommend publication in ACP after the minor comments below are addressed.

Specific Comments

Page 31630, Abstract: Although the abstract is well written, it says very little about the results of the paper, focusing instead on a description of the BORTAS campaign. Some additional information should be provided, summarizing the conclusions of the work.

Page 31635, line 14: The choice of 100 times the MAD as the filter threshold for the retrieval error seems very large. Why choose 100? Would retrievals with errors of, e.g., 10xMAD or 50xMAD, still converge?

Page 31636, line 7: What determines the accuracy of +-1 day for the age of the plume as determined using HYSPLIT?

Page 31639-31644: Section 3 (Enhancement ratios) is long (six pages) and covers several topics. It would help the reader if this were divided into subsections, such as one dealing with the derivation of enhancement ratios and one with the discussion of ozone in biomass burning plumes.

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Page 31640, para 2: Define the errors on the enhancement ratios given in Table 1. What are they and how are they calculated?

Page 31640, para 3: Here (or elsewhere, e.g., end of para 1 on page 31635) add some discussion of how consistent the enhancements of other gases are for the occultations that have HCN > 0.3 ppb.

Page 31640, lines 25-29 and page 31641, lines 1-7: No results are given for the computation of emission factors that were derived assuming that the enhancement ratios for the long-lived species can be used as effective emission ratios, only that they agree with two other studies. For which species were emission factors derived in this work and what were the values?

Page 31644, line 13: What is the altitude or altitude range for the monthly median ozone VMRs shown in Figure 4?

Page 31644, para 2: Discussion of the annual cycle of ozone and the impact of other seasonal effects is limited. The sentence "As expected, O3 concentrations are at their lowest during the Winter months when biomass burning activity is minimal, but elevated concentration are clearly noted during the Spring and Summer months." implies that this annual cycle is entirely due to the presence or absence of biomass burning, which is not true. This discussion should be strengthened to include other factors that determine the annual cycle, and better address causation vs. correlation for ozone and biomass burning.

Page 31646, para 2: Add a reference to, and some discussion of, Figure 7 to the text.

Page 31654, Table 1 (and corresponding discussion in the text): How good are the matches to age? Does ACE-FTS sample the same plume more than once or are all these results independent? Are detections of enhancements of all 15 gases significant? What are the error budgets on the ACE-FTS VMRs used to derive these values? What are the uncertainties given in the table? Could also plot these data as enhance-

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ment ratio vs. day to clearly show the time evolution.

Technical Corrections

Page 31632, lines 26-29: This sentence appears to be missing a verb.

Page 31634, line 16: “data HAVE been”

Page 31634, line 25: change “concentration values” to VMRs. Also, throughout the manuscript, concentration should be changed to VMR when [ACE-FTS] VMR is the quantity being discussed.

Page 31637, line 1: “was used as A visualization tool”

Page 31637, line 8: “the type OF biomass material”

Page 31637, line 11: “from Boreal forests IS contributing”

Page 31638, line 8: “to determine the origin of the plumes and whether there is convergence from . . .”

Page 31641, line 9: “species take place”

Page 31642, lines 3 and 8: ozone has been used here but O3 elsewhere

Page 31643, line 2: This sentence is ungrammatical – perhaps “. . . sources or the likelihood of confinement within . . .”

Page 31643, line 12: “IS elevated”

Page 31645, line 2: “O3 production occurs”

Page 31645, line 10: “permitTING"

Page 31645, line 14: As noted above, “HCN VMR profiles”, not concentration

Page 31646, line 2: “plumeS"

Page 31647, line 8: Why redefine ACE-FTS?

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Page 31647, line 12: “enhancement ratios”

Page 31648, line 13: “subsequent mixing”

Page 31655, Figure 1 caption, line 2: “from ACE-FTS occultation”. Define the significance of the purple circle.

Page 31656, Figure 2 caption, line 3: “during ACE-FTS occultation”. Define the significance of the black dot – use the same symbol as in Figure 1?

Page 31657, Figure 3: Change concentration to VMR in top (ozone) and bottom (HCN) x-axis labels. Also change in figure caption.

Page 31658, Figure 4: Change concentration to VMR in y-axis label. Also change in figure caption. Line 2: “four-year”.

Page 31659, Figure 5: Change concentration to VMR in all x-axis labels. Line 3: “demonstrateS”. Line 4: “intrudING".

Page 31660, Figure 6: Change concentration to VMR in all x-axis labels. Also change in figure caption. Line 7: “which give AN indication”.

Page 31661, Figure 7: Change concentration to VMR in y-axis label. Also change in figure caption.

Interactive comment on Atmos. Chem. Phys. Discuss., 12, 31629, 2012.

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