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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Wildfire smoke in the Siberian Arctic in summer: source characterization and plume evolution from airborne measurements" *by* J.-D. Paris et al.

Anonymous Referee #1

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Summary:
This paper presents measurements of CO, CO_2, O_3, EBC and ultra fine particles gathered over Siberia in July 2008, as a part of the POLARCAT campaign. These measurements are analyzed in combination with backward and forward simulations from FLEXPART. The Authors present a detailed analysis of one period impacted by fire emissions, in which emission factors for CO and BC are estimated. Using FLEXPART simulations, the Authors determine that the e-folding lifetime of ultrafine particles and EBC is 5.5 and 5.1 days, respectively.

General comments:

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Discussion Paper

In my opinion, this paper has significant results that should be published. The science is good and the topic is of interest to the readers of the Atm. Chem. Phys.. The manuscript is of good quality, well written and organized. However, the Authors should include and comment results from more recent work and consider a number of changes proposed below.

Specific comments:

1. page 1, abstract. Where do the Authors determine the combustion efficiency? I could not find this calculation in the "Results and Discussion".

2. page 1, abstract. The Authors do not include results from the EBC e-folding lifetime. Is there a particular reason?

3. "ppb", "ppm" are mixing ratios or levels, but not concentrations. Please, revise text accordingly.

4. page 5, section 2.3. May you please comment the spatial and temporal resolution of the meteorological fields used in the FLEXPART runs?

5. page 6, section 3. "..flights over Northern Siberia and tundra typically revealed vertical profiles with weak ... of efficient CO_2 uptake by trees for photosynthesis. ". Please, include a reference.

6. page 6, section 3. "O_3 variability in the lower troposphere could be largely driven by deposition processes.". I would comment here that O_3 variability in the lower FT is due to less influence of stratospheric O_3 rather than O_3 deposition. Ozone is deposited mainly over surfaces within the boundary layer, not in the lower FT.

7. page 7, section "Reasons for the model shortcomings". What about the spatial and temporal resolution of FLEXPART?

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8. page 8, section 3.2. The Authors describe the determination of the CO, EBC and particles background. However, they do not comment how the CO_2 background is determined, although they report ΔCO_2 in Table 1. Later in the text (page 8), the determination of the CO_2 background is described for two methods, which one is used to calculate the ΔCO_2 values in Table 1?

9. page 11, section 3.3. According to previous studies (e.g., Kasischke et al, 2005, Wooster et al. 2004), Siberian fires are less intense than North American boreal fires as a result of more surface fire activity (i.e., more smoldering-type fires). Thus, I would expect the estimated EF_{CO} value to be in the order of the one determined by Cofer et al., 1998 for Siberian smoldering Taiga fires. Since plume V and VI are less than 1 day old, I think the estimated EF_{CO} value is associated to a flaming-type fire, which emits relatively less CO than a smoldering fire. I would discuss this in the text.

10. page 11, section 3.3. I strongly recommend the Authors to discuss/compare their EF_{CO} and total estimated CO emission values to more recent values reported in the literature by Kasischke et al., 2005, Jain et al., 2006 and Kajii et al., 2002 (see complete citations below).

11. page 11, section 3.3. "total fuel consumption (ground, surface and aerial)". I think it would be clearer if the Authors describe the total fuel consumption as "below and above ground" instead of "ground, surface and aerial".

12. page 11, section 3.3. "As a result, a total of between 1.25 and 3.10 t CO (ha burned)$^{-1}$ were emitted by the forest fires during this period". I recommend the Authors to smooth this conclusion as they use several assumptions and an estimated value for EF_{CO}. I think the sentence would read better as "were potentially emitted" or "may have been emitted". The Authors should consider this change in the abstract and conclusions.

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13. page 12, section 3.3. How well does the EF_{BC} compare to that reported by Lavoue et al 2000?

14. page 13, section 3.4. It is not clear what "N" refers to, please, define.

Figures:
Figure 1b. Axis values for altitude are not displayed in figure.
Figure 4. What is "FF"?
Figure 5. What are the black dots?
Figure 9. What are the red and black dots? This figure is hardly mentioned in the text, and I wonder if it is totally necessary.

Editorial comments:
Plume 1 instead of Plume I, in e.g., page 7 and caption Table 1.
Add "." before "The latter" in page 11

References:
Jain, A. K., Z. Tao, X. Yang, and C. Gillespie (2006), Estimates of global biomass burning emissions for reactive greenhouse gases (CO, NMHCs, and NOx) and CO2, J. Geophys. Res., 111, D06304, doi:10.1029/2005JD006237.

Kajii, Y., et al., Boreal forest fires in Siberia in 1998: Estimation of area burned and emissions of pollutants by advanced very high resolution radiometer satellite data, J. Geophys. Res., 107(D24), 4745, doi:10.1029/2001JD001078, 2002.

Kasischke, E. S., E. J. Hyer, P. C. Novelli, L. P. Bruhwiler, N. H. F. French, A. I. Sukhinin, J. H. Hewson, and B. J. Stocks (2005), Influences of boreal fire emissions on Northern Hemisphere atmospheric carbon and carbon monoxide, Global Biogeochem. Cycles, 19, GB1012, doi:10.1029/2004GB002300.

Lavoue, D., C. Liousse, H. Cachier, B. J. Stocks, and J. G. Goldammer (2000), Mod-

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eling of carbonaceous particles emitted by boreal and temperate wildfires at northern latitudes, J. Geophys. Res., 1035(D22).

Wooster M. J. and Y. H. Zhang (2004) Boreal forest fires burn less intensely in Russia than in North America GRL, 31, L20505, doi:10.1029/2004GL020805.

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 18201, 2009.