

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.

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

- 1. Combustion efficiency is now defined explicitly in section 3.3

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

- 2. This was already included in the proof-read version of the ACPD paper 3. “ppb”, “ppm” are mixing ratios or levels, but not concentrations. Please, revise text accord-

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ingly. - 3. Where appropriate, “concentration” was changed for “mixing ratio”

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

- 4. We have added two sentences explaining the resolution of the data used: “Both data sets were used at $0.5^\circ \times 0.5^\circ$ resolution and 3 hour time resolution. The ECMWF data used has 91 vertical levels, whereas for the GFS data only 26 pressure levels were available.”

5. page 6, section 3. “..flights over Northern Siberia and tundra typically revealed vertical profiles with weak : : : of efficient CO₂ uptake by trees for photosynthesis. ”. Please, include a reference.

- 5. we added a reference on this question, including Nakazawa et al. (1997)

6. page 6, section 3. “O₃ variability in the lower troposphere could be largely driven by deposition processes”. I would comment here that O₃ variability in the lower FT is due to less influence of stratospheric O₃ rather than O₃ deposition. Ozone is deposited mainly over surfaces within the boundary layer, not in the lower FT.

- 6. A role of stratospheric O₃ is possible and now we have acknowledged this in the revised ms. We also additionally discussed earlier results (Paris et al., 2009b) where we have shown that in other summer campaigns above Siberia we found little correlation between lower tropospheric O₃ and stratospheric input.

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

- 7. As a Lagrangian model, FLEXPART is not directly limited by the resolution of its input or output data, as particle trajectories are not calculated on any specific grid. Nevertheless, the reviewer is correct that the resolution of the input data plays a role. We have used a relatively high spatial resolution (0.5°) but the data are available only every 3 hours, and this may currently be the major limitation for the accuracy of transport

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calculations as, for instance, diurnal cycles of boundary layer heights are not captured particularly well. This last notice has been added in the revised ms.

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 CO₂ background is determined, although they report _CO₂ in Table 1. Later in the text (page 8), the determination of the CO₂ background is described for two methods, which one is used to calculate the _CO₂ values in Table 1?

- 8. This has been clarified in the revised ms

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 EFCO 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 EFCO value is associated to a flaming-type fire, which emits relatively less CO than a smoldering fire. I would discuss this in the text.

- 9. We have added this discussion on possible fire type in the revised ms. 10. page 11, section 3.3. I strongly recommend the Authors to discuss/compare their EFCO 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).

- 10 We expanded the comparison of our EFCO with the suggested literature in the revised ms

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”.

- 11. We modified the sentence according to suggestion

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 EFCO. 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.

- 12. We have softened the conclusion as suggested.

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

- 13. We included the comparison with results in Lavoue et al. 2000

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

- 14. We added this precision in the text

Figures: Figure 1b. Axis values for altitude are not displayed in figure.

- Fig. 1b This has been corrected in the revised ms

Figure 4. What is “FF”?

- Fig. 4. FF means fossil fuel. This is now explained in the revised ms

Figure 5. What are the black dots?

- Fig. 5. Black dots represent active fires detected by MODIS. This is now explained in the revised ms

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.

- Fig. 9 Black dots and red dots represent active fires detected by MODIS. We removed this figure on the suggestion of the reviewers

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Editorial comments: Plume 1 instead of Plume I, in e.g., page 7 and caption Table 1.

- Plume denomination was changed according to suggestion

Add “.” before “The latter” in page 11

- Dot was added where needed.

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