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Interactive comment on “Anthropogenic and forest fire pollution aerosol transported to the Arctic: observations from the POLARCAT-France spring campaign” by B. Quennehen et al.

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Anonymous Referee #3 Received and published: 3 April 2012

GENERAL REMARKS

The manuscript presents data from airborne observations of pollution plumes transported from Asia and Europe to the Arctic. The observations were part of the POLARCAT-France spring campaign using the French ATR-42 research aircraft. The reported observations of aerosol size distributions, trace gases, aerosol light absorption coefficient combined with FLEXPART plume analyses and aerosol modelling make a significant contribution to the research on climate change impacts on the Arctic

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region. The manuscript fits well into the scope of ACP and deserves publication.

ACPD

12, C2895–C2900, 2012

Major weaknesses of the manuscript are an incomplete description of the applied data analyses steps and - more important – a large portion of speculation in the data interpretation; see specific comments for details. Concluding, the manuscript is acceptable for publication in ACP after major revisions.

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General answer: We thank anonymous referee #3 for her/his interesting and valuable comments. The manuscript has been modified following her/his and referee #1 and #2 recommendations. For each point, a specific answer is given.

SPECIFIC COMMENTS

1. The authors state that the evolution of the particle size distributions could not be explained by coagulation only. However, earlier studies on the ageing of biomass burning aerosol from an event in 1998 (Fiebig et al., 2002) and 2004 (Petzold et al., 2007) showed in combination with results from source studies as cited in (Dentener et al., 2006) that the evolution of biomass burning aerosol in the accumulation mode can be explained by coagulation. Another good reference for the study of aged boreal fire aerosols is (Müller et al., 2007). The above-mentioned references should be included into the introduction.

Authors' answer: We assumed referee #3 referred to the sentence P4542 L7-8 starting from "Modelling of the aerosol particle ageing..." The European air mass mentioned originates from anthropogenic sources. This is why this statement is not in contradiction with the results from other studies listed above. However, these studies are of great interest and references have been added in the introduction.

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2. It is recommended that the authors plot their size distributions in Figs. 5a and 10 in the same way as in Dentener et al. (2006) and Petzold et al. (2007) to check whether their observations fit into the presented scheme. Although Fig 5a refers to the Aitken mode, there should be a link between modal diameter and distribution width. In addition, at least a brief description of the coagulation model is needed. Does it, e.g., include particle nucleation which would enhance Aitken mode growth by coagulation, etc.?

Authors' answer: We followed the recommendation of the reviewer and plotted the size distributions accordingly. Size distributions from Fig. 10 have been compared to the scheme from Petzold et al. (2007).

The model only considers aerosol coagulation. No particle nucleation or dilution were involved. A sentence has been added in the manuscript to explain the simplistic model.

3. The attribution of the missing size shift to condensation is valid only if all data refer to a Lagrangian case. This however is not shown in the manuscript. If the measurements were not performed in a Lagrangian way then the authors have to evaluate very carefully if it is justified to connect size distributions from different plume ages by a single model run. Methven et al. (2006) have shown a very powerful approach for testing Lagrangian cases in airborne studies.

Authors' answer: The Methven et al. (2006) approach was already used to test the Lagrangian case. A specific section (2.3) has been added in the manuscript to describe it.

4. The authors do not explain how they determined the excess CO and the aerosol absorption coefficient from PSAP data. A careful discussion of the determination of the background CO for subtraction from the signal in order to determine excess CO

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is required. Furthermore, the authors should describe how they performed the light scattering correction of the PSAP data.

Authors' answer: Since the air mass is always sampled between 4000 and 5000 Å in altitude, we considered that a constant background value of 120 Å ppbv (Pommier et al., 2010) could be applied to background CO for springtime conditions. This constant background CO then was subtracted from measured CO concentrations.

As indicated in the manuscript we didn't correct the PSAP data for light scattering (no direct measurement of light scattering). Since the spot size has not been measured explicitly for the specific PSAP, we have used the spot size value of 19.23 mm², suggested in Müller et al (2009). We consider this value an average value for PSAP instruments. The flow rate has been measured (critical orifice) and calibrated. Since the correction of the absorption coefficient for the scattering is in the order of a few percent, the conclusion on Fig8b remains unchanged.

5. The abstract needs to be rewritten and substantially shortened to highlight the key outcomes of the presented work.

Authors' answer: The abstract has been shortened and rewritten.

6. A discussion section is missing which compares the reported observations to results from earlier studies. It could be an option to shorten the conclusions and replace this section partially by a more extensive discussion of the observations and the resulting consequences in relation to earlier studies.

Authors' answer: A discussion section has been added before the conclusion and is presented as suggested by referee #3.

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MINOR COMMENTS

1. Please use either log-normal, or lognormal.
2. Page 4548, line 24: delete “trace gas” at the end of the line.
3. Page 4552, line 10: Check the numbering of Figs. 7 which you are referring to.
4. Page 4552, line 13: I suggest “First” instead of “Firstly”.
5. Page 4554, line 23/24: I suggest “the Aitken mode” and “the accumulation mode”.
6. Page 4560, line 17: please check the wording of this sentence.
7. Page 4561, line 6: correct “transported”.

Authors' answer: All the above comments have been taking into account.

REFERENCES

Dentener, F., et al.: Emissions of primary aerosol and precursor gases in the years 2000 and 1750 prescribed data-sets for AeroCom, *Atmos. Chem. Phys.*, 6, 4321-4344, 2006. Fiebig, M., et al.: Optical closure for an aerosol column: Method, accuracy, and inferable properties applied to a biomass-burning aerosol and its radiative forcing, *J. Geophys. Res.*, 107, 8130, doi:10.1029/2000JD000192, 2002.

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