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Atmospheric Chemistry and Physics Discussions

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.

Anonymous Referee #1

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This manuscript presents analysis long-range transported fire smoke emission transport to the arctic based mainly on air craft measurements. The paper focuses on two case studies. The text is quite well written and most parts of it can be considered scientifically sound. The paper also fulfills the originality requirement. In my opinion, the paper is worth to get published in ACP after the authors have addressed the following, mostly minor issues.

Scientific issues:

The last paragraph of section 2.2 and interpretation of figures 5 and 7: It remains a bit unclear how the "age" of air masses has been determined. Especially, how the zero

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point of air has been obtained for different air transport situation. I suppose one needs somehow to define the dominant source area of measured air masses? How this is handled when multiple sources affect the measured air? More explanation is needed here.

Page 4551, lines 3-5: It is extremely dangerous to extrapolate the particle size backward to the emission point as done here. Different processes can affect particle growth rates, and in very different ways, during different stages of atmospheric transportation.

Page 4554, lines 23-24. The authors should state more clearly what they mean by the Aitken mode being affected more than the accumulation mode by condensation. Since they refer to eq. 4, I suppose they mean the particle diameter growth rate, which indeed is expected to be somewhat larger for the Aitken mode. Many people might be more interested in secondary aerosol mass formation by condensation, and this is usually dominated by mass flux into the accumulation mode (or coarse mode if substantial amounts of sea salt or dust are present).

The last statement of section 3.4: I do not buy this explanation, as modeling the coagulation process is expected to have relatively low uncertainties. I would rather seek for a process other than coagulation or condensation explaining the observed shift in the accumulation mode. How about cloud processing which is know to add material into this mode effectively in the atmosphere?

The authors should make some interpretations of the relatively large volatile fraction of about 80 per cent. How this value compares with observation made by others and what it reveals about the aging of measured particles?

The discussion in section 4.2 is a bit difficult to follow and should therefore be improved. Basically, the mean size of particle modes any measurement point results from the combination of two things: 1) the means size of particles at the emissions, 2) the processing of particle during atmospheric transportation. The first of these depends on the source type and in case of fire emission also with the burning conditions. The

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second one depends on the initial particle number concentration and size distribution (coagulation), the amount of aerosol precursors (condensation, cloud processing, nucleation) and the time available for these processes (transport distance). The analysis should somehow be arranged along these points. Now it is very difficult to see whether and how section 4.2 supports the hypothesis 1 (page 4557, lines 2-3) as claimed in lines 9-11 on page 4557. Why cannot the authors test the hypothesis 2 with their coagulation model similar to what was done in section 3.4? One could easily give different numbers of Aitken mode particles at the initial condition and simulate the time evolution of the system by coagulation.

Technical issues:

The instruments measuring the aerosol size distribution (or size fractions) rely on at least 3 different particle diameters. This should be brought up and explained in section 2.1.1 and perhaps elsewhere in the text.

Page 4552, line 10: Figs. 7, 7 and 7? Should be either Fig. 7 or Figs. 7a, 7b and 7c.

There is something strange in the way the paper by Adam de Villers et al (2010) is either referred to or located in the reference list. Should it read "de Villers et al."?

Interactive comment on Atmos. Chem. Phys. Discuss., 12, 4541, 2012.