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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Mode resolved density of atmospheric aerosol particles" *by* J. Kannosto et al.

J. Kannosto et al.

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Comments for the referee #1 We would like to thank the referee for his/her useful comments. First we reply to referee's general comments and then we answer detailed to specific comments.

Referee gave general comments concerning the quality of the manuscript and scientific content of the paper.

Our comment: The data set introduced in this paper is gathered in campaign which duration was 2 weeks. The referee is correct: longer data set would have been more valuable. Unfortunately we did not have longer data set at hand. Anyhow, we would like to point out, that in this paper we present the density results for atmospheric particles in the size range of nucleation, Aitken and accumulation modes for the first time. We

also present the time dependent behaviour of the density for the first time. This allows us to investigate for example the density progress of the nucleation mode particles during the growth process associated to particle formation events. This kind of data and analysis is not published before. It is true, that the longer data set would allow us to investigate the processes more detailed and would lead to the deeper interpretation. This will be the subject of the further studies.

We have improved the manuscript according to the referee comments. The introduction is modified and the conclusions are rewritten. We also added relevant citations concerning the particle formation. In addition, the language has been checked.

Referee asks many relevant questions concerning the density fitting method itself. Here we answer to those questions.

1. The lognormal mode fitting was done according to Hussein et al. (2005). The number of fitted modes was restricted to be 1-3. The automated fitting algorithm was used, thus the resulted number of modes was not user dependent.

2. The method is not strongly dependent on particle concentration, if the devices are not close to their detection limit. In this case neither the ELPI nor DMPS was close to their detection limit. In laboratory we have tested the method at different concentrations and no concentration dependence were revealed.

3. The "carefully calibrated impactor" means, that the impactor cut-off curves are determined accurately. This is challenging especially in the case of the lowest part of the s-shaped curves. In fig. 1, it is shown, that when there was a small inaccuracy in the cut-off curve of the 1st impactor stage, the density results of smallest particles was not correct. The inaccuracy was revealed when the impactor was re-calibrated. The calibration was done by using monodispersed DOS particles. We followed the calibration method presented by Keskinen et al. (1999). Also the charger efficiency was determined. We have tried to clarify this in the text.

ACPD

8, S5548–S5551, 2008

The referee also asked for calibration in different concentrations. In the calibration the monodispersed particles are generated by using DMA. Thus the concentrations in calibration are always low and really high concentrations are not possible to achieve. As mentioned above, we have tested the density fitting method in laboratory for different concentrations and no concentration dependence was found.

4. When all the restrictions mentioned in the chapter 2.1 were taken into account, 42 % of analyzed size distributions resulted unreliable density value and the results were rejected and 58 % were taken to the further result analyse. This is now added into the text.

The referee has also questions concerning the execution of the campaign. Here we answer to those questions:

1.The turbulence is not the issue, when the sub-micron particles are measured. Anyhow, the flow in the sampling lines was not turbulent (Re$<$3000, for turbulent flow Re$>$4000). The residence time in ELPI (10 lpm) sampling lines was ˜5 s and the calculated diffusion losses in the sampling lines for 15 nm particles were ˜1%. These losses were not corrected in ELPI data. In DMPS data, the losses are corrected according to the "standard" data processing of the SMEAR station (see Aalto et al., 2001).

2. The referee asks why we used two sites with different instruments. This question is of course understandable. And the reason for the two different sites is very practical: there were no room for additional ELPI in the cabin where the DMPS was located. We wanted to use the Hyytiälä DMPS due to the wide measurement range (3 - 500 nm). The referee is correct when he/she states that the double instrumentation is perfect for comparison. We have made the instrument comparison and it is published by Kannosto et al. (2006). According to the comparison, the difference in density results gained by using different instrument pares was less than 17%.

The referee wants more explanations concerning the reasons behind the reported density variations and asks more speculation and deeper interpretation. We have tried

ACPD

8, S5548–S5551, 2008

to improve the manuscript results section and conclusions according to referee comments. Here we answer the questions point by point.

1. The referee wants more explanations concerning the reasons behind the density variations in nucleation, Aitken and accumulation mode. We have related the increase of Aitken mode density to the period during which the particle formation events took place. This indicates that the composition of the Aitken mode particles also changes as a consequence of condensation of volatile species. We have now added more speculation into the text.

2. The referee also asks why there is no big difference in densities of nucleation and Aitken mode particles. We have the following explanation in the text: "The density of growing nucleation mode particles was lower during the May 11th than during the May 12 - 14th. This follows the overall density progress of Aitken mode particles. This refers to the same origin of the nucleation and Aitken mode particles."

3. The referee points out that we have interesting results concerning the density change of the nucleation mode particles during the growth process. Indeed, we observed this also for other days. This is stated in the last paragraph of the result section. The conclusions concerning this development are added now to the "Conclusions" section of the paper.

4. We have rewritten the conclusion. We also took into account all technical corrections listed by the referee.

Interactive comment on Atmos. Chem. Phys. Discuss., 8, 7263, 2008.

ACPD

8, S5548–S5551, 2008

Interactive Comment