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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Atmospheric sub-3 nm particles at high altitudes" *by* S. Mirme et al.

Anonymous Referee #2

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Review of the contribution "Atmospheric sub-3 nm particles at high altitudes" by S. Mirme, A. Mirme, A. Minikin, U. Hõrrak, V.-M. Kerminen, and M. Kulmala.

This paper represents an important contribution to the knowledge about new particle formation and air ions in the troposphere. It shows a great amount of novelty in its experimental approach and instrument development. The data presented in this paper covers the troposphere over a limited fraction of the globe and represents only a limited time slot, as airborne measurements usually do. Still, the contribution to our knowledge of distributions of nanoparticles and ions in the troposphere is significant. I recommend publication after the authors carefully considering the following comments.

General comments: The first goal of this work is, according to the introduction bottom of page 19438, to demonstrate the capability of Airborne NAIS to measure neutral sub-3 nm clusters in the free troposphere. This goal is not evaluated in the conclusions. I

would suggest that it is and that the importance of the novelty of these experiments is put forward.

I have a problem with the statement "indicating a minor overall effect by clouds". Assuming that you are referring to an effect on particle formation and small ions I do not think that a comparison between in-cloud and out-of-cloud will be informative in the case the effect takes place in the outflow of clouds. A comparison of outflow vs other out-of-cloud data or outflow vs in-cloud may show a different picture.

The figures are well chosen and prepared and all very relevant. The figure captions are, however, in some cases very short. I would recommend that you carefully consider if more information is needed. Please see also some detailed comments below.

Detail comments: I have two comments concerning the vocabulary and choice of expressions. The first one is the use of the word aerosol. In many cases in this paper the expression "aerosol formation" is used referring to formation of particles in an existing aerosol and changing its properties. An aerosol is defined as airborne particles AND the carrying gas. It is my opinion that we should be careful not to let the meaning of the word aerosol drift to represent only the aerosol particles. I would therefore suggest that the authors use e.g. the expression "particle formation" and carefully check the use of the word aerosol in the manuscript.

In many cases, the expression "size range" is used in combination with numbers in nm. It is, however, not stated if the size refers to radius or diameter. From equation 4, expressing mobility as a function of radius, one would assume the size refers to radius but diameter is also mentioned in some cases. I would recommend that you change "size" to "radius/diameter" at least the first time that size ranges are presented in a paragraph and in all figures.

Abstract line 10: What does the word "actively" refer to?

Introduction, line 16: "particle" should be "particles".

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page 19436 last 3 lines: Do these observations refer to ground based observations or are there also airborne measurements?

page 19437 line 13: "Secondy" should read "Secondly".

page 19439 line 19 and page 19442 line 11: In one of these places the flows are given as l/s and the other one as cm3/s. I would recommend that you are consistent.

page 18439 line 22: I do not understand the meaning of the expression " which removes analysed particles from the air sample".

page 19443 line 15: "3 m" should probably read "3 μm".

page 19446 lines 18-23: It is stated that the 2.5-3 nm particles varied little with altitude and that the 4-10 nm particles showed distinct vertical profiles. This indicates a very pronounced different in the vertical distribution of these two sizes, but when looking at figure 8 they look rather similar. This is especially the case for the total particle number. Please comment on this.

page 19447 line 2 and figure 8 c,d and 10: Is it possible to give numbers on the fraction of charged particles at charge equilibrium or to indicate the level in figure 8 and 10? To illustrate the statement on the top of page 19447. Also, would you not expect undercharge for growing particles as they may remember their charging state when they were smaller?

page 19447 line 14-16: What is the reason for the loss of negatively charged clusters? Do the inlet losses increase at height? Or does it have something to do with the size range of the instrument at different pressures?

In the first part of the conclusion section, a new discussion is brought up. Would it be possible to have this discussion earlier?

page 19448, line 25: does continuous refer to continuous with height or continuous in time?

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Table 3: Why are there no data for positive charging and 4-42 nm?

Figure 3: What does the color code refer to?

Figure 10: Since different colors are used you can also give the color code.

Figure 13: Would you not assume a bimodal histogram for nanometer sized particles: either there is a particle formation event (high concentrations) or there is no particle formation (low concentrations) and medium concentrations would be less frequent?

Thank you for very interesting reading!

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 19435, 2009.