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Interactive comment on "New particle formation in air mass transported between two measurement sites in Northern Finland" *by* M. Komppula et al.

M. Komppula et al.

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We would like to thank the referees from their comments to improve our paper. Our answers and clarifying comments are listed below.

Response to C. Clement's comments:

General comments

The comments 1-3 of the referee are linked to each other, so we first answer comment 3 and then comments 1 and 2 together.

Comment 3:

The quantities in Tables 1 and 2 and Figure 3 are calculated in the following way: Ex-

cluding the start and end times of the events and their duration, each quantity is first averaged over each aerosol formation event. These event-average, or event-specific, quantities are then grouped according to the season (Table 1) or air mass type (Table 2). The means given in Tables 1 and 2 are simply the averages of the event-specific quantities over all the events in the group in question. The same concerns other statistical parameters in Table 2. In Figure 3, a suitable subset (explained in the text) of event-specific quantities has been chosen.

We agree that our averaging procedure was not explained very well in the manuscript. In order to avoid further confusion, the Table and Figure captions have been made more informative and more explanation is added in the section 2.3.

Comments 1 and 2:

We definitely agree with the reviewer that atmospheric aerosol formation, being a very non-linear process, is very like to be sensitive to fluctuations in vapor source and sink rates as well as on fluctuations in the ambient temperature and relative humidity. However, as pointed out above (see the answer to comment 3), the large standard deviations reported in Table 2 refer to differences between the different events, not to fluctuations within individual events. We apologize for this confusion due to our improper definition of quantities in Tables 1 and 2.

Certainly, it might be fruitful to investigate the influence of fluctuations within individual aerosol formation events. However, we feel that such an analysis is more appropriate for the much longer and more extensive data set measured in the SMEAR II station in Hyytiälä.

As pointed out by the referee, our data set might provide a way to look at the persistence of fluctuations over the 250 km travel distance between the two stations, which is not possible using data from a single station alone. Based on the results obtained in section 3.1.3, we can say the behavior of the aerosol formation events in the two stations is affected by both diurnal changes (photochemistry, meteorological variables)

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and by air mass properties. Because of this, it is extremely hard to compare the time series of different quantities (aerosol formation and growth rates etc.) of individual events between the two stations. We think that investigating the persistence of fluctuations between the two stations would require a very detailed analysis of its own, which is beyond the scope of this paper.

Specific points

1. An explanation was added to the text, section 2.1: A fjeld is an arctic round-topped hill.

2. A more detailed explanation of the event classification was added to the text, section 2.3.

3. The new data analyzed and mostly used in this paper is from years 2002-2003. In the air mass analysis presented in Table 2 and Figure 3 the whole available data set (2000-2003) was used to get more reliable statistics.

4. The sulphuric acid production rate was calculated from chemical reaction of SO_2 and OH using measured SO_2 and estimated OH concentration. In case 1 we used organics production rate that is proportional to OH concentration which peaks at midday. Figure 7 shows, however, the resulting gas phase concentrations, which are affected by condensational sink of the particle population. By 10 o'clock the nucleation mode has grown to sizes large enough to cause a significant increase in condensation sink compared to situation before the event. This increase in condensation sink increases the loss rate of condensable vapours (both sulphuric acid and organics) resulting to concentration profiles that start to decline already at 10 o'clock.

In case 2 we used a constant production rate for organics, which naturally results in a more flat concentration profile than in case 1. However, the concentration of organics is not constant because of varying condensation sink during the simulation: CS first decreases due to dilution related to boundary layer increase and later increases together

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with the growth of the nucleation mode. The intensity of the nucleation burst is smaller in case 2, and thus the increase in condensation sink due to growing nucleation mode is not as pronounced as in case 1. Therefore the condensable vapour concentrations behave more smoothly and they peak a bit later than in case 1 having their maxima at about 11 o'clock.

5. OK, corrected.

6. Larger than 10^{-3} means > 0.001. In the simulation for case 2, presented in Figures 8 and 10, a scaling factor 0.0015 = 1.5×10^{-3} was used.

7. We suppose that "clear nucleation peaks, the particles in which are all coagulating with the growing peak after a short time" mentioned by the referee mean enhanced number concentrations below 3 nm that appear as a separate "mode" in the simulations. Due to efficient coagulation with bigger particles, only a small fraction of this large number of < 3 nm particles survives to bigger sizes making the growing nucleation mode. Along the growth of the nucleation mode, the condensation and coagulation sinks of the particle population increase leading to increasing coagulation loss for small, below 3 nm particles. At some stage, the coagulation sink for small particles becomes big enough to suppress the feeding of new particles to the growing mode, which leads to ceasing of the nucleation burst. However, the growth of the nucleation mode continues also after the feeding of new particles is stopped.

This separate "mode" of freshly nucleated particles below 3 nm, that appears in the simulations, is thus fully acceptable and can be explained by the competition of growth and coagulation processes acting on small, freshly nucleated particles. These competition processes seem to happen below 3 nm, which is the lower limit of the DMPS setup, and therefore based on measurement data we can neither prove nor disprove the occurrence of this type of separate "mode" in the simulations. However, above 3 nm the correspondence between measurements and simulations is fairly good.

A new paragraph was added in section 3.2.1 to clarify this separate "mode" below 3

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nm.

Response to Referee 1's comments:

Night-time particle formation is not discussed in this paper. Only particle growth is mentioned to be observed as long as until midnight. Now we searched through the whole data set and actually only few events during dark hours were found (mainly in January). Only two-to-three of these could be classified as a clear event (classes 1 or 2). No such day was found when dark-hour events would occur at both sites simultaneously. At this moment we have no new explanations on the night-time events and therefore they are not mentioned in the paper.

Interactive comment on Atmos. Chem. Phys. Discuss., 5, 11929, 2005.