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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Field measurements of hygroscopic properties and state of mixing of nucleation mode particles" *by* M. Väkevä et al.

M. Väkevä et al.

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Response to the Anonymous Referee # 1

We intend to add some discussion into the summary to better highlight the similarities and differences in the different data sets.

1) Old text: "In all the above mentioned sites the diurnal variations were significant and a relatively wide range of growth factors were observed daily. High growth factors were mostly observed during only few day time hours during which also the concentrations were at their highest."

Will be replaced with: At both of these sites (Hyytiälä and Helsinki, 1998) a relatively wide range of growth factors was observed daily, and especially in Hyytiälä the high growth factors were mostly observed during only few day time hours during which also the concentrations were at their highest. This is also the case for the nucleation day

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in Luukki (February 19th 1997). On this day the highest number concentrations during the whole measurement period were detected.

2 and 3) Old text: "A few days resembled Helsinki May 1998 measurements. During the measurement period, new particle formation events similar to the ones observed in Hyytiälä forest field station were observed and the growth factors and their temporal variations during these events resembled the ones detected in Hyytiälä (Hämeri et al., 2001b). These new particle formation events have been described in Väkevä et al. (2000)."

Will be replaced with: The growth factors on the first days of the measurement campaign are very scattered, as are the growth factors in Helsinki in May 1998. On the 20th and 21st of February, on the other hand, the data resemble measurements in Helsinki in December 1999 - when externally mixed particles were observed. During the measurement period, new particle formation events similar to the ones observed in the Hyytiälä forest field station were observed (the similarity is based on the DMPS data). Unfortunately valid TDMA data is available for one of these days only - the 19th of February. The temporal variations in the hygroscopic properties of 10 nm particles during the nucleation event day were very similar to the nucleation event days in Hyytiälä. The growth factors are low in the morning prior to the nucleation event, they gradually increase just before and during the nucleation and decrease again in the afternoon (Hämeri et al., 2001b). The new particle formation events have been described in more detail by Väkevä et al. (2000).

4) The necessary figures will be added.

5) Old text: "During the nucleation event days in forest site the less hygroscopic mode is pronounced as a function of size (Table 3). This is probably due to the condensation of less hygroscopic organic compounds during the formation and growth events (Kulmala et al., 2001)."

Correction: The sentences will be left out completely.

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6) New text that will be added: The background of the growth factor classification is based on the earlier work for larger particles by other researchers [e.g. Swietlicki, et al 1999]. The atmospheric aerosols are generally classified into four classes. Using the observations presented in this paper our aim was to investigate if similar classification is practical also for the nucleation mode particles. Some of the growth factor classes were obvious when studying the data sets: e.g. hydrophobic 10 nm particles were observed during the nucleation events at the coastal site (GF=1). During the occasions of externally mixed particles in downtown Helsinki at winter time 1999, the less hygroscopic 10 nm particles had growth factors ranging between 1.0 and 1.1 and the more hygroscopic particles between 1.2 and 1.4. Also when externally mixed particles were observed at the coastal site the more hygroscopic mode had growth factors in the range 1.2-1.4 or higher. Those particles with growth factors higher than 1.4 were classified as the sea salt, due to their hygroscopic properties resembling NaCl particles. Thus we suggest that the classification of nucleation mode particles is also based on four categories with the following values: the non hygroscopic particles, with growth factor 1; the less-hygroscopic particles with growth factors ranging between 1.05 and 1.2; the more hygroscopic particles, with growth factors 1.2-1.4; and the sea salt particles, with growth factors larger than 1.4.

7) Generally the resolution of TDMA measurements depends on the width of the DMA transfer functions and the way the DMA2 voltage scan is undertaken. If the DMA2 voltage is changed in steps, the smallest resolvable feature in the TDMA spectrum must be wider than two times the size of the step.

With the UFTDMA system running with 1 to 10 aerosol to sheath flow rate ratio the growth factors smaller than 0.95 and larger than 1.05 can precisely be told apart (for 10 nm particles in mobility diameter). Thus resulting into the resolution of +- 0.05 in growth factors. Consequently this is also the best resolution with which internal / external mixing can be resolved.

In the end, however, the analysis of TDMA data is subjective just as the Referee stated.

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The person performing the analysis makes the final choice whether to accept the results of the analysis or not. Often the existence of shoulders, and similar features, in the TDMA spectra become evident when analysing a long time series: A shoulder can in some cases be interpreted as fluctuation in the ambient concentration of the particles, and thus be discarded. On the other hand, if the shoulder is seen to evolve into a clearly distinguishable peak for some time period, and then to degrease into a shoulder again, the person performing the analysis will not question the existence of externally mixed particles.

Interactive comment on Atmos. Chem. Phys. Discuss., 1, 379, 2001.