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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Hygroscopic properties of the ambient aerosol in southern Sweden – a two year study" *by* E. O. Fors et al.

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We thank the referee for the useful comments. The specific questions are addressed separately below.

General comments: The use of two models (Kp and Kr) is not needed for this paper. Presently, the Kp value is used to report the hygroscopicity and Kr is used for the CCN activation prediction. I would suggest to use only one, Kp. If the authors think it is needed to have two models, please justify.

This is a good point. We have recalculated everything to Kp in the new version, and deleted the salt model part.

Specific comments:

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Line 19-21:“CCN predictions based on H-TDMA data underpredicted the activated CCN concentration with 7% for 1% water supersaturation” What does the 7% refere to? The sentence is not clear, please rephrase.

The text has been changed to “CCN predictions based on H-TDMA data underpredicted the activated CCN number concentration with 7% for a 1% water supersaturation ratio.” We hope that this makes it more clear.

Page 6606: Line 7: “Vavihill” is not a very well known place. Indication of the Vavihill location is explained later (line 14-16), and could be move in line 6.

This has been corrected.

Line 17: Why using PM10 inlet instead of PM1 inlet? DMPS stops at 857 nm.

This is simply because there was no PM1 inlet available. This should not affect the measurements. However, it is better to use a PM10 inlet than none at all, to prevent the instrument from getting contaminated with dust etc.

Line 25: “The aerosol was dried and charged with an 85Kr diffusion charger before it entered the first DMA (DMA1),..” The aerosol was charged by the diffusion charger. But how was it dry (Silica gel? Other system?) ? At which RH? Does the dryer need any maintenance or is it self-regenerating? How long the aerosol stays dry before entering DMA1?

The text has been changed to: “The aerosol was dried with a nafion drier and charged with an 85Kr diffusion charger before it entered the first DMA (DMA1), a Vienna type, 28 cm long, which was housed in an insulated box at a well defined temperature, typically 20 °C. The RH before DMA1 was always lower than 30%. The residence time between the nafion drier and DMA1 was approximately 1 s.”

Page 6607: Line 8-15: How long the aerosol was expose to the final RH before entering the DMA2 (Residence time of the aerosol in the humidifier)?

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It was also around 1 s. The text now includes the following: “The residence time after the humidifier was ∼1 s, after which the voltage in DMA2 was continuously scanned over sizes corresponding to diameter growth factors of 0.85 – 3.0, to ensure that no particles were missed.”

Line 20: A butanol CPC was at the exit of DMA2 (RH 90%). Did the CPC get trouble after some times behind the DMA2 (RH 90%) with condensation of water in the butanol? As the HTDMA is made to stay for a long period, why not using a water CPC instead?

Yes, in order to not loose CPC efficiency, we had to drain the CPC every week and refill it, to avoid an increasing amount of water in the CPC. However, with this routine it was no problem. A water based CCP would have been better, but was not available at the time.

Line 28-29: “For further details regarding the H-TDMA system, see Nilsson et al. (2009).” It is important to mention in this paragraph the main specification of the HTDMA. Some are given here, some are given later in the text and some are not given: -Temperature of HTDMA operation -Residence time at dry condition prior DMA1 -To which RH value it is considered to be dry? -Residence time at the target RH prior to enter DMA2 -Operating RH of the HTDMA

Temperature: The text has been changed to: “By ensuring a well controlled temperature at 20 °C, the DMA2 RH was kept at 90±0.1%.”

Residence time: Adressed above.

Dry RH criterium: Adressed above.

Residence time at target RH: Adressed above.

Operating RH of the HTDMA: We are not sure what is referred to here, the humidification is mentioned on page 6607 row 8. Row 16 on the same page mentions that the instrument was operated at 90% RH.

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Page 6608: Line 12-13: “To increase the comparability between different scans, the GF-PDFs were recalculated to 90% (Gysel et al., 2009).” One or two lines describing this method would be useful (Basically, it is calculating the kappa from the GF measured at a certain RH (between 88-92%), and from this kappa it is calculating the GF at 90% RH).

The text has been changed to the following: “To increase the comparability between different scans, the GF-PDFs were recalculated to 90% in TDMAinv, using the κ model described in section 2.4 (Gysel et al., 2009).”

Line 21: DMPS is measuring between 21.5 to 857 nm. Why not using then a PM1 instead of PM10 inlet?

This is simply because there was no PM1 inlet available. This should not affect the measurements. However, it is better to use a PM10 inlet than none at all, to prevent the instrument from getting contaminated with dust etc.

Page 6609: 2.3: CCN counter: 1) Why the aerosol was not dry prior to enter the CCN? Would that affect the closure between HTDMA and CCN?

This will not change the closure, since it is not a relative measurement like the H-TDMA. As far as we know, sligthy prehumidification of the aerosol will not affect the CCN concentration.

2) Was the CCN regularly calibrated like the HTDMA? How and how often?

The following text has been added: “The CCNC was calibrated in a laboratory environment before field deployment using ammonium sulphate particles with a DMA upstream the aerosol flow. The CCNC was set to a fix s, while the DMA selected a span of different sizes, to investigate at which size the selected particles activated. This procedure was repeated when the CCNC was returned to the laboratory during the summer of 2010. For high supersaturations, the old calibration was valid within 2% down to s=0.6. At s=0.25, the CCNC measured 7% higher s than indicated by the instrument, and at

0.2% the error was 14% in the same direction. In the field, the flows of the CCNC were monitored and checked on a weekly basis, but no salt measurements were conducted."

Page 6609 to 6613 -Paragraphs 2.4 to 2.6 are the theory descriptions (2.1, 2.2 and 2.3 are the instrumental descriptions). Theory needs to be reorganized. It could be rearranged as follow (The needs of 2 Kappa model is not obvious to me): 2.5 Kr model 2.6 Kp model 2.7 CCN closure method (here either Kr or Kp can be used, but the method does not depend on the Kappa used) 2.8 Parameterisation of CCN concentrations

The salt model has now been excluded, and the closure description rewritten. The suggested order was used (excluding the Kr model). We hope that this will make it clearer.

-Comments: surface tension used here is not provided. How the surface tension could explain this under prediction in the closure? -Parameterisation of CCN concentration is not too clear. Could that be explained by a simple formula? Or a simple illustrative figure?

The mathematical description has been rewritten, and examples of surface tensions effects have been included.

Page 6611: line 25: "In addition to the resolution issues of the hygroscopicity measurements, the closure will underestimate the activated CCN(s) concentration if there are particles present that are larger than the DMPS can detect." How the surface tension will affect the closure? A discussion would be welcome.

The following thext has been added to chapter 3.6: "When altering the surface tension, it was concluded that a surface tension of ∼55 mN/m is required to reach a perfect closure". We feel that a more detailed discussion on surface tension effects is a topic for another paper.

Page 6618: Line 7:"... and in a hygroscopicity closure study it was concluded that..." To which study this sentence refers to?

Actually it was not a published study, the data has only been presented at a poster so far, although we plan to publish this in the future. The text has been changed to the following for clarification: “During an intensive campaign at Vavihill in October 2008, Aerosol Mass Spectrometer (AMS) data was available from the measurement site, and in a hygroscopicity closure between H-TDMA and size resolved AMS data it was concluded”

Page 6620-6624: There is no description why the Kr model is preferred to Kp model to do the closure. Why two models are used in this paper? In table 3 and 8, Kp is presented and for the CCN activation model Kr is used. This is not clear to me, why to Kr and not Kp is used for this. Surface tension used should be mention as well.

The paper has been changed so that only Kp was used. Surface tension is now mentioned (72.8mN/m).

Typos:

Page 6603: Line 8: “et al., 2006) The light scattering of...” a dot is missing before the new sentence.

Corrected.

Page 6609 Line 15: ...”thesvalues”...spaces are missing.

For some reason this is only visible in the ACPD-version. We will make sure this is OK in the final version.

Figure 2a: In the caption it is once 2001-2010 and once 2000-2010. Check date in the text as well.

This has been corrected.

Figure 3: Ticks and number in the GF axis are not in phase. Would that be possible to use the same symbol as in figure 5 for the size selected code. In that way the figure can be read in B&W.

This is now corrected. A kappa-PDF has also been added, to exclude the Kelvin effect from the density functions.

Interactive comment on Atmos. Chem. Phys. Discuss., 11, 6601, 2011.

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