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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Technical Note: Hygroscopicity distribution concept for measurement data analysis and modeling of aerosol particle hygroscopicity and CCN activity" *by* H. Su et al.

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General comments: In this publication the authors suggest a new concept to describe the hygroscopic distribution of aerosol particles resulting from hygroscopic tandem differential mobility analyzer (H-TMDA) data or the measured CCN efficiency spectra. The technical note is a relevant contribution to the research field and the authors clearly show the advantages of introducing the new method to describe the external mixture of the aerosol particles. Data on the particle water uptake would be made more useful for researchers if presented in more detail than made in most studies. This would facil-

itate the comparison of results found in different studies using the H-TDMA and CCN counter and the comparison of the results from CCN counter and H-TDMA measurements made in parallel. Furthermore, it would allow better interpretations of the effect on particles of atmospheric processing based in the particle water uptake, and provide more detailed information about hygroscopic properties to feed into circulation models.

The main concern regarding the work is weather the data was inverted before using the data – taking into account the effect of the DMA transfer function, etc. From the text it is not clear weather this is considered or not. There are some indications that the data was inverted before applying the approach here described, but it is not obvious weather this was done both for the H-TDMA data and the CCN counter data. If this was considered, the authors need to write this more specifically, describe how this was done and point out the importance of this. If data was not inverted, it would improve the work considerably to do this. At least the authors need to comment on how this would affect the results and make some quantification of the effect.

Below some specific comments are given.

Introduction: In the introduction previous attempts to parameterize the rate of external mixture from CCN counter measurements are discussed. Since this work focus on H-TDMA data, as much as on CCN counter data, I think a discussion about previous studies that have made attempts to describe the rate of external mixture from the particle hygroscopic growth measured by the H-TDMA would be in place. For example, in the inversion algorithm presented in the work by Stolzenburg and McMurry (1988) multiple hygroscopic modes could be fitted and a parameter describing the broadening of each mode given. This is also the case in the recent work by Gysel et al. (2009). I suggest that these studies should be mentioned and discuss the advantages with the concept here introduced. Furthermore, in several previous studies presenting H-TDMA data attempts to describe the rate of external mixture have been made by making bi- or tri-modal fits of the wet distribution, describing the growth and particle fraction of each mode separately (references in Swietlicki et al., 2008).

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Page 1008, row 8: The notations N(kappa) and N*(kappa) are confusingly similar and since the absolute number concentration is not used I suggest not to introduce this quantity N(kappa).

Page 1008, row 19: Van not Hoff factor → Van't Hoff factor

Page 1009, row 7-9: The authors argue that the kappa-distributions can be described by log normal distributions based on the fact that particle size distributions are log-normal. For me it is not clear why this is. However, later it is shown that this is a good hypothesis. In Stolzenberg and McMurry (1988) normal distributions were used to describe the shape of each hygroscopic mode.

Page 1009, row 15: "For a homogeneously mixed, i.e., fully internally mixed aerosol population, sigmag=1". This is true if the data have been inverted.

Page 1011, row 11-.. : If easily done it would be really interesting to se a comparison of the kappa-functions derived from H-TMDA and CCN counter measurements made in parallel for aerosol with some external mixture. This would show how useful the concept is when comparing the particle's water uptake at sub and super saturations, possibly giving information on limited solubility, varying osmotic potential etc.

Page 1011, eq. 7: In Petter and Kreidenweiss (2007) this approximated form of the Köhler equation is recommended to be used for kappa >0.2 only. For lower ïĄń an error is introduced using the approximation, especially for small particles activating at high supersaturations. The approximate form of the Köhler equation is in many studies used also for kappa <0.2, but a comment about this would be in place, and a short note about which effect this have on the derived kappa-distribution.

Page 1011, section 2.3: In this section it is not explained how monodisperse particles are selected before fed into the CCN counter. Most often this is made with a DMA, but it is not described in this section.

Page 1013, row 5: "Method I is easier to interpret. . ." Seems like a subjective comment.

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Page 1013, row 25: Here I guess that the reference here should be Rissler et al (2005) - if refereeing to CCN predictions.

Page 1014, row 6-12: Svenningsson et al. (2008) made an attempt to separate the effect of the DMA transfer function with the effect of low solubility and external mixture in CCN counter data. I suggest referring to this work.

Page 1014, row 19-22: Specify what is meant by "ideal measurement conditions". Fully internally mixed particles/instant dissolution/only singly charge particles or "ideal" DMA's?

Page 1016, row 21: hygrocopicity → hygroscopicity

Page 1017, row 1-.. : This size dependence is most often observed in atmospheric studies.

Page 1020, row 28: Wrong order of references.

References:

Gysel, M., McFiggans, G.B., Coeb, H.: Inversion of tandem differential mobility analyser (TDMA) measurements, Journal of Aerosol Science, 40, 2, 134-151, 2009.

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Rissler, J., Swietlicki, E., Zhou, J., Roberts, G., Andreae, M. O., Gatti, L. V., and Artaxo, P.: Physical properties of the sub-micrometer aerosol over the Amazon rain forest during the wet-to-dry season transition – comparison of modeled and measured CCN concentrations, Atmos. Chem. Phys., 4, 2119–2143, 2004.

Stolzenberg, M. R. and McMurry, P. H.: TDMAFIT user's manual, PTL Publications No. 653, Particle Technology Laboratory, Department of Mechanical Eng., University of Minnesota, Minneapolis, MN, USA, 1988.

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Svenningsson, B., Bilde, M.: Relaxed step functions for evaluation of CCN counter data on size-separated aerosol particles, Aerosol Science, 39, 592 – 608, 2008.

Swietlicki, E., Hansson, H.-C., Hämeri, C., Svenningsson, B., Massling, A., McFiggans, G., McMurry, P.H., Petäjä, T., Tunved, P., Gysel, M., Topping, D., Weingartner, E., Baltensperger, U., Rissler, J., Wiedensohler, A., Kulmala, M.: Hygroscopic properties of submicrometer atmospheric aerosol particles measured with H-TDMA instruments in various environmentsâĂŤa review, Tellus 60B, 432–469, 2008.

Interactive comment on Atmos. Chem. Phys. Discuss., 10, 1005, 2010.