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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.

Anonymous Referee #2

Received and published: 15 March 2010

General comments:

This paper discusses a new approach of using hygroscopicity and cloud condensation nuclei (CCN) measurements to determine the mixing state of the aerosol. Data from a hygroscopicity tandem differential mobility analyzer were used to show how this new approach could be used for size-selected aerosol hygroscopicity measurements at relative humidities less than 100%. The majority of the paper focused on data analysis of size-selected CCN spectra measurements at a variety of supersaturations. A few hypothetical case studies of various mixtures were used to demonstrate how the

method works and then the concept was applied to data from a field campaign in polluted Beijing. It is hoped that this new method will have a place in future modeling studies.

The figures are excellent and the paper is well-written and concise. The analysis tool presented is novel and useful for future studies. This work is of high quality and merits its publication in Atmospheric Chemistry and Physics. Please consider these minor comments and revision suggestions prior to publication.

Specific comments:

Abstract: Please include 1-2 sentences early in the abstract presenting an introduction to the concept and why we want a hygroscopicity distribution. Explain why it is needed, why it is useful.

Introduction: Out of 38 references, 21 references are self-citations (i.e. one or more of the co-authors from Su et al. is also a co-author on 21 references). It would be beneficial to include a short paragraph describing some of the recent work performed in HTDMA and CCN studies and the evaluation of kappa by research groups other than the co-author list. As a suggestion the paragraph could be located between lines 24 and 25 on page 1006.

Concept and methods: I agree with the notation ambiguity discussed in the short comment by M. Gysel. I will not include detailed comments here, since M. Gysel presented a nice description outlining the issues with the notation.

Page 1010, lines 17-18: It is written: "By applying Eq. (5), the normalized cumulative wet particle size distribution function N*(Dw) can be converted into N*(kappa). Figure 1 shows an exemplary. . .". You present an equation, say you can convert one N* to another and then present Figure 1. It is not entirely clear how you go from N*(Dw) to N*(kappa). It may indeed be straightforward but a few words of explanation will make this clearer. Include a reference if needed but this should be clarified before moving

onto Figure 1.

Page 1010, lines 21-22 and page 1016 line 11: both of these sections discuss size-selected aerosol data. If this data is size-selected by a DMA, there is usually a doubly-charged particle mode resulting from this size-selection method. The method of size-selection as well as potential errors arising from these doubly-charged particles should be noted in the text.

Page 1011, lines 1-8: This section could be reworded so that it is clearer. Soon after Figure 1 is introduced, you could include another sentence explaining in a general sense what this figure tells us about mixing state. When I look at the graph, what general features am I looking for to tell me something about the mixing state? After that, go into the details with the examples that are written (i.e. that a small percentage may be externally mixed and that there may be a lognormal mode of sulfate-organic-soot mixtures). A simple sentence explanation would definitely help with the understanding. You could also explain how other types of mixtures might look different than this graph, if this is known. Lastly, please explain how the steep increase at kappa=0.5 tells us that it's lognormal, even if it seems obvious.

Page 1016, lines 16-17: The comparison between figure 8 and figure 5 is difficult to see. Please add further explanation. Or do you perhaps mean figure 6 rather than figure 5?

Page 1010, lines 18-23 and page 1016, lines 11-14: you mention a field campaign in Beijing. A separate paragraph or very short section outlining the field campaign would be useful. You could make this field campaign section "Section 2" and shift all other sections down, as a suggestion. In this section, include the name of the campaign, where and when it occurred, the main aerosol sources and which instruments are used in this work (including size-selection methods). Please include here the list of references already published about this campaign, indicating there are more details contained in that work. Then on page 1010 and 1016, simply refer to this section. As

an additional point, on page 1011 lines 5-6, there is a list of 6 references for "externally mixed soot particles", this list of references could be moved to this new short field campaign section and simplified on page 1011 line 5-6 by referring to the new field campaign section.

Page 1026, Figure 1: Since this is a one-day average, please include error bars or indicate what the standard deviation was. How much variation in these measurements occurred over that day? How many measurements are in this average?

Page 1032, Figure 7: When you average CCN spectra over the entire campaign, does this mean that the spectra did not change much throughout the campaign? How many measurements are in this average? What time frame is averaged over? Did you not see differences with wind direction, or diurnal patterns? Consider including error bars or indicate the standard deviation, demonstrating that it did not change significantly over the averaging period. Also consider indicating an error bar on at least one of the lines in Figure 8.

Technical corrections:

Page 1006, line 23: If you use the word "fitting" here, it seems like you might need further explanation in the introduction, such as what is being fit to what. This is discussed later in the manuscript so I would suggest changing "by fitting" to "from".

Page 1007, line 13 and page 1020, line 3: "Krejci et al., 2004" is 2005 in the reference list. Please fix this discrepancy.

Page 1008, lines 1-2: Petters et al. (2009a) do not imply combustion aerosols are kappa=0.01; there is only a small percentage that have kappas that low (this was the lowest kappa measured). This sentence implies that "aerosol combustion products have kappa=0.01". Please reword this, perhaps "For atmospheric aerosols, the range of kappa typically varies from as low as 0.01 for combustion aerosol particles. . .". Also, insoluble aerosols may have kappa values very close to zero.

Page 1008, lines 2-3: Since Petters and Kreidenweis (2007) was the first paper to suggest values of kappa, please include this reference here.

Page 1008, line 8: change the comma at the end of this line to a colon.

Page 1007, line 19: the factor, i, is not the “van not Hoff factor”, but “van’t Hoff factor”.

Page 1011, equation (7): consider referencing Petters and Kreidenweis (2007) for this equation.

Page 1013, lines 17-18: remove semi-colon or bracket here “. . .particle shape, etc.; (Rose. . .”. If you remove the semi-colon, close the bracket at the start of line 17.

Page 1013, line 22: “Petters and Kreidenweis, 2008” is not in the reference list.

Page 1014, lines 11-12: change to “Three idealized distributions of. . .” or “Three hypothetical distributions of. . .”

Page 1015, lines 8-9: By referring to “several field measurements”, it implies “several field campaigns” but I believe what is intended here is that it was several measurements during one field campaign. Please specify the location of these “several field measurements” and consider slight rewording, such as simply “several measurements during a field campaign in China” as an example. Since it seems Rose et al. 2008b may not be published in ACP, do not hesitate to add a few sentences of description from that study as you see fit.

Page 1016, line 21: spelling mistake in the word “hygroscopicity”

End of Section 4 or in the conclusions: please add one sentence stating that this analysis is only performed for one study in a polluted environment. Mention that future work is needed to verify this technique with other data such as from marine and rural locations.

Page 1020, line 28-31: please move this reference to the next page, page 1021, line 12.

Page 1021, line 10: please label this reference as “2009b”

Page 1025, Table 2: please refer to this table in the text somewhere, such as page 1008 (where the concepts are first introduced) or put this table as an appendix.

Page 1031: It should be mentioned in the caption somehow that the 3 red lines all lie on the same line (as does the 3 green lines).

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