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Atmospheric Measurement Techniques Discussions

Interactive comment on "A New Method for Calculating Number Concentrations of Cloud Condensation Nulcei Based on Measurements of A Three-wavelength Humidified Nephelometer System" *by* Jiangchuan Tao et al.

Anonymous Referee #1

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The authors present a study where they determined the number of cloud condensation nuclei (CCN) using a new method based on nephelometer measurements. They claim that this method is more convenient and cheaper than traditional measurements. Several studies have been published over the last 10 years that show that humidified nephelometer measurements can be used to infer CCN concentrations. They make several assumptions and use of various additional parameters. The apparent difference of the current study is the fact that no measurements of the particle number size distribution (PNSD). The manuscript contains several obscure sections and mistakes

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(grammar, typos). In addition, the method is poorly described and compared to previous work. Several sections are not well organized. A major revision considering my detailed comments below might help to improve the manuscript such that it may be considered for publication. In addition, the complete manuscript should be carefully proofread.

Major comments 1) Applicability of the new method The caveats of the new method should be made clear in the abstract and conclusions. It is mentioned that it cannot be applied for externally mixed aerosol and particle populations with many large particles (e.g. dust, sea salt). Are there situations when delta(kappa) is too large/small that this bias will influence N(CCN)? Does the shape of the aerosol distribution play a role? Would, for example, multiple modes affect the Angstrom coefficient such that it exceeds 1.5?

2) Comparison to previous studies I suggest adding a table listing previous studies that have used optical aerosol parameters to infer N(CCN). This table should include the parameters that were used (PNSD etc), air mass characteristics (aged or not), caveats of the method and comments on results/findings. This way, the necessity of measurements for various air masses will be more obvious and the applicability of the new method will be clearer. For example, the difference to the methods by Kuang et al. and Brock et al. to the current method is not fully clear.

3) Clarity of method application a) While Figure 3 is somewhat helpful, it should be extended to be the central figure of the manuscript. Labels can be added to the arrows explaining in detail what is done in each step, e.g. a reference to the respective equation would be helpful.

b) The comparison to measured N(CCN) is useful and necessary in order to validate the new method. However, a few more details about the CCN measurements are needed. At what supersaturations were they measured (l. 116)? It is known that CCN measurements are most uncertain at low supersaturations. What supersaturation was

chosen for the comparison?

4) Clarity of language At several places, the text is not clear or even wrong and should be revised. Examples include:

l. 57: Aerosol hygroscopicity is defined as the ability of an aerosol particle to take up water. Hygroscopicity is not a function of particle size.

l. 68- 72: It should be clarified which combination of parameters is best suited and which problems/deviations (from what?) might occur.

l. 143: 'and can determines 'kappa' with A' is unclear

l. 174: This text is hard to follow. At the very least, add numerical ranges for the various parameters. It would be even better to connect this discussion to a figure (either an additional one or existing one)

l. 198: '. . .which reveals that particles. . .' – I do not understand this fragment

l. 214: Do you mean '..due to size-dependent hygroscopicity'?

l. 284 – 294: This paragraph should be rewritten as I cannot follow the line of thought. For example, you start with 'On one hand, the variation of kappa(c) can be quite large...' and continue later 'On the other hand, the influence of kappa(c) cannot be ignored. . .' These two sentences should introduce opposing facts, but they do not.

5) Structure Essential information should be given as early as possible in the manuscript:

a) The Angstrom coefficient should be defined in the introduction or in Section 2.

b) Caveats of the method should be pointed out throughout the paper

c) It is highly confusing that in Section 2 delta(kappa) is introduced as being 0.2 and only in Section 3 a lengthy discussion of this value is given and sensitivity studies are performed. A more thorough discussion of reasons and conditions of large or

small delta(kappa), respectively, should be added in the context of the applicability and accuracy of the new method. How would the results change if not a constant delta(kappa) but the exact difference for each data point in Fig 5 is used? Can we learn something from the resulting (dis)agreement as a function of A?

6) Formatting All parameters should be expressed in equations and should be formatted and numbered as such. For example, l. 101 and the definition of fRH (l. 106).

7) Figures

a) The caption of Figure 2 cannot be understood without reading the text. At the very least, the parameters should be spelled out and a reference to an equation in the text should be added.

b) What are the grey bars in Figure 4?

c) The grey symbols in Figure 6 overlap with many other symbols. Maybe choosing open symbols would improve clarity.

Minor comments

l. 64: Add references for the 'common use'.

l. 66: This sentence needs work: 1) word missing after 'carbonaceous'. 2) What is meant by 'most important hydrophobic'?

l. 135/6: S is not included in the equation

l. 164/5: Is this a result based on the literature or the current data set? If the former, add references.

l. 191: AR(sp) can only be 0 if N(CCN) or if sigma(sp) is infinitely large. Is either of this a realistic situation?

l. 245: What 'microphysical properties' are you referring to here? 'Composition' is a chemical property.

l. 247: ‘more sensitive’ as compared to which other parameter?

l. 249: Later and in Figure 2, the range of A is up to approx. 1.5, not 15

Technical comments

l. 2: ‘Nuclei’ misspelled

l. 94: an inlet . . . consisting of . . . an inline . . .

l. 109: AR has not been defined before.

l. 128: campaigns

l. 154: indicates

l. 159: wavelengths

l. 171: increases

l. 179: remove ‘as’

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