

***Interactive comment on “Hygroscopic properties of aerosol particles at high relative humidity and their diurnal variations in the North China Plain” by P. F. Liu et al.***

**Anonymous Referee #1**

Received and published: 3 March 2011

This manuscript describes the hygroscopic properties of the aerosol during summer-time in the North China plain. Hygroscopic growth for RH values between 90 and 98.5% are presented. Parameterizations of hygroscopic properties are carried out, and the diurnal variation of the aerosol is discussed and compared to modeled values. The data in the paper is of good quality (validated both with salt measurements and with inter-comparison to LACIS) and the fact that the HH-TDMA provides data for RH>90% is very nice, as this region is often left for speculation regarding solubility etc. in CCN closure studies which connect H-TDMA measurements at 90% with CCNC data. This makes the data especially relevant.

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I recommend this paper to be published after modifications and clarifications described below.

General comments:

\*) My main comment is that the paper is unnecessarily long. Certain parts could be excluded and in some cases a figure says more than a thousand words. It is better to focus on interpretation in the text, and only briefly describe the numbers in a figure or a table. If the description is too long, one tends to miss the main points. There are also a number of strange formulations that need to be rewritten. I recommend that you make an effort to shorten the manuscript, at least chapter 2, and I will give specific recommendations in the following detailed comments.

\*) You use the term “CCN activity” a couple of times in the text, but you never explain what you mean by it. Please do so.

Detailed comments:

Page 2992, row 6: “dry diameter between 50 – 250 nm”, should be “dry diameters between 50 and 250 nm”.

Page 2992, row 18: Delete “, indicating a diurnal...”. It is essentially what you said in the first part of the sentence.

Page 2992, row 22: “The high degree of...” This sentence is strange. You haven’t really defined “high”. I suggest simply writing that the fraction of NH particles was higher during night time.

Page 2993, row 27: “To understand...” I know what you are trying to say with this sentence, but it needs to be re-written, and preferably divided into two (or more) sentences. E.g. “the aerosol hygroscopic properties are very crucial since they describe the interactions of aerosol particles with water vapour” makes no sense, and what do you mean by “the CCN activity of aerosol particles and their number-size distribution”? Which size distribution are you referring to?

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Page 2992, row 15: Use either “kappa” or “a single-parameter Köhler model”, but not both in the same sentence. I prefer the second alternative.

Page 2994, row 5: delete “(but less than..)”. It is true also for  $RH > 100\%$ .

Page 2994, row 6: “water uptake, hence” should be “water uptake, and hence”.

Page 2994, row 17: There are several other descriptions of aerosol hygroscopicity and CCN modeling, recently overviewed in Rissler et al. (2010).

Page 2294, row 23: “by a factor of 4-6”. Explain that this factor is linearly proportional to the number of soluble entities per dry volume (scaled for water molar mass and density in the case of Petters’ kappa). This is helpful information when interpreting changes in kappa. Because I presume that the “increased hygroscopicity parameter” is kappa or  $\rho_{ion}$  (which is exactly the number of soluble entities per dry volume unit).

Page 2294, row 25: “validations of the...”. If you count CCN closure studies as a validation, then there are a lot of reports. But if you are talking about only H-TDMA data, then you are correct. Please clarify.

Page 2995, row 10: “The heterogenous..”. I do not understand this sentence. Firstly you say “The heterogenous mixtures”. Which mixtures are you talking about? Typical ambient aerosol particles? Then you say “hence, detailed hygroscopic properties provide important information on the aerosol mixing state”, but there is no causality here as far as I can see? Please rephrase this.

Page 2996, row 4: Delete “in this paper as well”.

Page 2997, row 27: “The direct humidification has its technical limits as well.” Please explain what you mean.

Chapter 2.2.2. This subchapter can be deleted altogether. It is enough with a reference to Petters and Kreidenweis, as it is all described there.

Page 3002, row 18: You can delete the reference to Sjogren. Possibly a reference to

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the ZSR assumption would be in order, but this follows from basic physics.

Page 3003, row 1: missing a superscript “3” after GF in the equation, it looks like?

Chapter 2.2.3 in general could be significantly shorter. You can refer to Gysel et al. (2009) regarding the inversion and that would be enough. You do not need to write equations 6,7, 9, 10, 11 and 12. It would be enough to state that you recalculated GF-PDFs to kappa\_PDFs, that you use 3rd moment average values etc. I realize that you put effort into this, but my opinion is that it is a bit too much for this paper.

Page 3004, row 1: Why were the fluctuations lower for higher RHs? Also this subchapter could be described with a few sentences. Simply state your RH precision in the measurements, that GFs were recalculated using kappa and that the GF-PDFs were recalculated using the gamma-model (with reference).

Page 3009, row 18 “via kappa-Köhler model” should be “via the kappa-Köhler model”.

Page 3009, row 28: Delete “The aerosol mixing state will be discussed in the following sections”.

Page 3010, row 18: Delete “In other words, hygroscopicity...”. This is already stated a number of times before.

Page 3010: “Significant hygroscopic diameter growth behaviors were observed”. What does this mean?

Page 3013, row 9: Delete “we will present a...”

Page 3013, row 13: Delete this sentence.

Page 3014, row 7: Delete “i.e. the variance was low”. You already said this in the first part of the sentence.

Page 3016, row 24: “It is worth to note that...” Is this because of higher contents of mineral dust?

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Page 3018. You use “thus” both on row 20 and 22. Looks a bit strange.

Page 3020, row 12: “We should also notice that..”. I do not understand what you mean.

Page 3020, row 16: What do you mean by “more direct”?

Page 3020, row 29: “formation”. Maybe this is OK, but I would prefer “condensation”, since it is a continuous process, from gas phase to particle phase. If this is what you mean?

Fig.1 The star appears to be red, and not magenta, as it specified in the figure text.

References:

Rissler, J., Svenningsson, B., Fors, E. O., Bilde, M., and Swietlicki, E.: An evaluation and comparison of cloud condensation nucleus activity models: Predicting particle critical saturation from growth at subsaturation, *Journal of Geophysical Research*, 115, D22208, 2010.

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Interactive comment on *Atmos. Chem. Phys. Discuss.*, 11, 2991, 2011.