Responds to Referee #2:

We do appreciate the referee's valuable and constructive comments and suggestions, which have helped us improving our work. We have addressed all the concerns item by item as below and revised the manuscript accordingly.

General comments:

Comment 1: *What are the wavelength and angular integration angles for the forward scattering visibility meter? How are forward scattering and visibility related in this study? Is that implicit in equation 1? The details should be explained. Clearly the forward scattering can be modeled via Mie theory and the PNSD but that is not necessarily visibility.*

Response: We thank the referee for the constructive comments. Details about the forward scattering visibility meter have been added to Sect. 2.2.

We agree with the referee that the forward scattering is not necessarily visibility. As a matter of fact, the Vaisala FD12 visibility meter detects the amount of light scattered by a small measurement volume at angle 33º, where the differences among the scattering phase functions of particles at different sizes are minimized. The detected forward scattering signal, which varies linearly with the visibility, is finally converted to visibility by proprietary algorithms, based on extensive calibration against a well calibrated Vaisala's MITRAS transmissometer (Wiel Wauben, 2011). Briefly, the amount of scattering measured in this way is empirically linked to the extinction coefficient (K_{ex}),taking into consideration of the relationship between the amount of forward scattering and the extinction of the scattering medium. This is also implicit in the equation 2 of the modified manuscript, namely, the initial equation 1.

Undoubtedly, there is certain error in the measured extinction coefficient (reported of no less than 10% by Crosby (2003)), since light absorbing has not been measured but presumed with an empirical constant single scattering albedo.

References:

Wiel Wauben.: Evaluation of the Vaisala FD12P 1.91S firmware with insect filtering, Technical report (TR-316), De Bilt, 2011. Available at: http://www.knmi.nl/knmi-library/knmipubTR/TR316.pdf, last access: 20 February, 2012.

Crosby, J. D.: Visibility sensor accuracy: what's realistic? in: 12th Symposium on Meteorological Observations and Instrumentation, Long Beach, CA, 13 February 2003, 2003.

Comment 2: *A common way of presenting visibility or extinction or scattering coefficient as a function of RH is to present it as a ratio, e.g. the extinction coefficient at a given RH divided by the low RH extinction. To some extent this has been done with* $K_{ex\text{-}vol}$*. However the effect of varying PNSD remains. It would be valuable to separate the RH effect from the PNSD effect.*

The value of $K_{ex\text{-}vol}$ *is theoretically related to the ratio of coarse to fine, or fine to* $PM_{2.5}$*, or other volume or mass ratios. This has been shown in many studies. Clearly with the Vaisala meter data you cannot do size separation. You could do and present this from the PNSD and Mie results.*

Response: This is really an insightful comment. We appreciate the valuable and constructive suggestions of the referee. We have revised the manuscript accordingly in the Sect. 4.3.2 and 4.4. As we can see that the parameterization results have indeed been improved by taking into account of the effect of the coarse fine ratio ($f_{c/f}$) on the light extinction. The influence of the $f_{c/f}$ on light extinction needs to be considered if the PNSDs are of highly spatio-temporal variation.

Although the correlation among K_{ex}, RH and aerosol volume concentration is theoretically presented in Fig. 4 (b), it can be clearly seen that the K_{ex} varies sharply with the aerosol volume concentration at a specific RH. We have tried to eliminate the influence of aerosol volume concentration on the variation of K_{ex} by introducing the concept of aerosol volume extinction coefficient (K_{ex-vol}) in Sect. 4.3.2. However, the effect of varying PNSD just goes with what the referee has suggested, and it can be theoretically attributed to the effect of varying coarse fine ratio on the K_{ex-vol}. Hence, the parameter of coarse to fine volume ratio ($f_{c/f}$) is used to represent the variation of PNSD patterns.

Obviously, a fixed $f_{c/f}$ is applicable to various PNSD patterns, thus it would be impractical to estimate the influence of different particle sizes, or rather the coarse fine ratios, on the K_{ex} by combining the Mie Model and all possible PNSDs in our work. In a simple way, we just conduct a sensitivity study between the $f_{c/f}$ and the K_{ex-vol} on basis of limited available data. Specifically, the $f_{c/f}$ is derived from the in-situ measured PNSDs, with 1 μm taken as the critical diameter between fine and coarse particles. Descriptions can be found in Sect. 4.3.2 and Fig. 6 of the modified manuscript.

Results show that the K_{ex-vol} decreases notably with increasing $f_{c/f}$, suggesting that light extinction per unit volume is largely contributed by fine particles rather than by coarse particles. Since the calculated volume concentrations of fine and coarse particles are comparable, the dominant role of fine particles in contributing to light extinction is confirmed. This is also in accordance with Yuan's study (Yuan et al., 2006), in which it is stated that visible lights are mainly scattered by fine particles, since scattering generally contributes to most part of extinction, which can also be supported by the measured high single scattering albedo in the NCP (Ma et al., 2011; Yan et al., 2008b).

The absolute difference of the K_{ex-vol} with respect to varying $f_{c/f}$ is determined by RH. Higher the RH is, larger the absolute difference of the K_{ex-vol} is. To a great extent, a higher hygroscopicity of fine particles at higher RH might be responsible. Those highly hygroscopic particles are mainly in the fine mode, which means, they would make an even larger contribution to the K_{ex-vol} at lower $f_{c/f}$. This is also the main reason for the larger difference of K_{ex-vol} with different $f_{c/f}$ ranges under higher RH conditions.

Last but not least, there certainly are some uncertainties in the analysis of $f_{c/f}$ impacts on K_{ex-vol}. One is the lack of sufficient $f_{c/f}$ and PNSDs samples to draw a general conclusion. The other might be the narrow range of in-situ $f_{c/f}$. Results given here might just be a general correlation between $f_{c/f}$ and K_{ex-vol} in the NCP.

Reference:

Ma, N., Zhao, C. S., Nowak, A., Müller, T., Pfeifer, S., Cheng, Y. F., Deng, Z.Z., Liu, P. F., Xu, W. Y., Ran, L., Yan, P., Göbel, T., Hallbauer, E., Mildenberger, K., Henning, S., Yu, J., Chen, L. L., Zhou, X. J., Stratmann, F., and Wiedensohler, A.: Aerosol optical properties in the North China Plain during HaChi campaign: an in-situ optical closure study, Atmos. Chem. Phys., 11, 5959–5973, doi:10.5194/acp-11-5959-2011, 2011.

Yan, P., Tang, J., Huang, J., Mao, J. T., Zhou, X. J., Liu, Q., Wang, Z. F., and Zhou, H. G.: The measurement of aerosol optical properties at a rural site in Northern China, Atmos. Chem. Phys., 8, 2229–2242, doi:10.5194/acp-8-2229-2008, 2008b.

Yuan, C.-S., Lee, C.-G., Liu, S.-H., Chang, J.-C., Yuan, C. and Yang, H.-Y.: Correlation of atmospheric visibility with chemical composition of Kaohsiung aerosols. Atmos. Res., 82: 663–679, 2006.

Comment 3: *The results in this study should be compared to results of one or two previous studies of visibility or extinction vs. RH and aerosol mass or volume conc. It would be interesting to see if the relationships you observed in the N China Plain with its perhaps unique aerosol size, chemistry, refractive index, coarse fine ratio are similar to other locales.*

Response: We thank the referee for this comment. Previous studies on the correlations of light extinction or scattering with particle sizes, RH or chemical compositions have been compared with results in this study (Yuan et al., 2006; Cheng et al., 2008a; Zhang et al., 2010), in support of the conclusions drawn from our observations and sensitivity studies.

References:

Cheng, Y. F., Wiedensohler, A., Eichler, H., Su, H., Gnauk, T., Brüggemann, E., Herrmann, H., Heintzenberg, J., Slanina, J., Tuch, T., Hu, M., and Zhang, Y. H.: Aerosol optical properties and related chemical apportionment at Xinken in Pearl River Delta of China, Atmos. Environ., 42, 6351–6372, 2008a.

Yuan, C.-S., Lee, C.-G., Liu, S.-H., Chang, J.-C., Yuan, C. and Yang, H.-Y.: Correlation of atmospheric visibility with chemical composition of Kaohsiung aerosols. Atmos. Res., 82: 663 – 679, 2006.

Zhang, Q. H., Zhang, J. P., and Xue, H. W.: The challenge of improving visibility in Beijing, Atmos. Chem. Phys., 10, 7821–7827, doi:10.5194/acp-10-7821-2010, 2010.

Comment 4: *Number concentration in general is not closely related empirically or theoretically to extinction or scattering unless limited to the optical subrange of diameters as you mention briefly. It is not used in the parameterization results and thus fig 2b could be eliminated.*

Response: We agree with the referee and have removed Fig. 2 (b).

Comment 5: *There are numerous redundant paragraphs and sentences that could be eliminated or cleaned up to make the manuscript shorter and more readily readable.*

Response: We thank the referee for the helpful suggestions. Sentences that describe a number of locations and $PM_{2.5}$ mass concentrations measured there have been eliminated in the introduction. Also the description of aerosol number concentration (Fig. 2) in Sect. 4.1 has been removed. We have cleaned up several unnecessary descriptions of the occurrence frequency distribution of RH in Sect. 4.3.1. In Sect. 4.3.2, we have removed some repeated contents regarding the effect of PNSD pattern on the extinction coefficient.

Comment 6: *Numbers given in the manuscript are not generally needed to more than two or three significant figures.*

Response: Thank you. We have revised the manuscript accordingly.

Specific comments by page and line number:

Abstract line 13

... with the parameterization scheme agree well with the ***directly*** *measured values.*

Response: Thanks and we have revised accordingly.

Page 31364 line 25

I suggest you limit the list of cities and $PM_{2.5}$ to two or three in the NCP. Since visibility is the focus of the paper adding the average visibility values that accompany the $PM_{2.5}$ averages would be useful.

Response: We thank the referee for this suggestion. We have limited the list of cities and $PM_{2.5}$ to three in the northern China. On the other hand, we have provided the annual mean (2003 ~ 2007) visibility in Beijing (Zhang et al., 2010). We also have added the daily mean mass concentrations of PM_1 and PM_{10} and horizontal visibility at two northern sites, Xi'an (Shen et al., 2009) and the Longfengshan regional atmospheric background station (Wang et al., 2010).

References:

Shen, Z. X., Cao, J. J., Tong, Z., Liu, S. X., Reddy, L. S. S., Han, Y. M., Zhang, T., and Zhou, J.,: Chemical Characteristics of Submicron Particles in Winter in Xi'an, Aerosol Air Qual. Res., 9 (1): 80 – 93, 2009.

Wang, P., Che, H. Z., Zhang, X. C., Song, Q. L., Wang, Y. Q., Zhang, Z. H., Dai, X., and Yu, D. J.: Aerosol optical properties of regional background atmosphere in Northeast China, Atmos. Environ., 44, 4404 – 4412, 2010.

Zhang, Q. H., Zhang, J. P., and Xue, H. W.: The challenge of improving visibility in Beijing, Atmos. Chem. Phys., 10, 7821–7827, doi:10.5194/acp-10-7821-2010, 2010.

Page 31365, line 11

*Hygroscopic growth ~~would~~ increase**s** aerosol extinction coefficient by enlarging ~~the~~ particles ~~size~~ by uptake of liquid water. On the other hand, hygroscopic growth decreases aerosol extinction ~~coefficient~~ by lowering the refractive index, since ~~uptaked~~ **the** water **that is taken up** has a smaller refractive index compared to other aerosol components.*

Response: We have revised the manuscript accordingly. Thanks.

Line 17

*… nificant degradation in visibility, as ~~have~~ **has** been observed in some field campaigns…*

Response: Thanks and we have revised accordingly.

Page 31366, line 7

The discussion of the parameters that control light extinction or visibility reduction by *particles needs to be presented more clearly and in order of priority. For a dry aerosol, its light extinction is:*

1. first and foremost, related to aerosol mass loading (for a reasonable, average range of size distributions),

2. secondarily to the aerosol size distribution,

3. and then to refractive index, shape, density.

In the atmosphere, variable RH has a marked effect, on aerosol extinction through hygroscopic growth through uptake of water by the water soluble compounds commonly found in the aerosol. This effect is often as dominant as the size distribution effect. For a given, fixed size distribution extinction is directly related to mass loading of the aerosol in its dry state. Hygroscopic growth (and refractive index) are dependent on the chemical composition and mixing state of the aerosol.

Response: We appreciate the referee's helpful suggestion. The details about the parameters that control light extinction or visibility degradation by particles have been presented in the introduction section as below.

For dry particles with fixed size distribution, light extinction is directly related to the aerosol mass loading. The second important parameter that controls light extinction is aerosol size distribution, followed by aerosol refractive index, particle shape and density. Under ambient conditions, RH has a marked effect on light extinction through hygroscopic growth of particles, which is a key factor in visibility degradation. It is thereby of great importance to understand the correlation between low visibility, aerosol loading, size distribution, as well as aerosol hygroscopic growth.

Page 31368, line 3

State the initial ***RH*** *value for the PNSD.*

Hennig reference not in list.

Response: During the Haze in China (HaChi) field campaign, the measurement of PNSDs is guaranteed to be conducted at RH below 30%, where most ambient aerosols show no substantial change in particle size (Charlson et al., 1984). This has also been described in Sect. 2.2 as "A combined system of Twin Differential Mobility Particle Sizer (TDMPS, Leibniz-Institute for Tropospheric Research (I*f*T), Germany; Birmili et al., 1999) and Aerodynamic Particle Sizer (APS, TSI Inc., Model 3320) is used to monitor the PNSDs ranging from 3 nm to 10 μm under dry condition (RH < 30%) every 10 minutes.".

Thanks and we have added Hennig's reference in list.

References:

Charlson, R. J., Covert, D. S., and Larson, T. B.,: Observation of the effect of humidity on light scattering by aerosols. In: Ruhnke, L.H., Deepak, A. (Eds.), Hygroscopic Aerosols. A. Deepak, Hampton, VA, pp. 35-44, 1984.

Birmili, W., Stratmann, F., and Wiedensohler, A.: Design of a DMA-based size spectrometer for a large particle size range and stable operation, J. Aerosol Sci., 30(4), 549–533, 1999.

Hennig, T., Massling, A., Brechtel, F. J., and Wiedensohler, A.: A tandem DMA for highly temperature-stabilized hygroscopic particle growth measurements between 90% and 98% relative humidity, J. Aerosol Sci., 36, 1210–1223, doi:10.1016/j.jaerosci.2005.01.005, 2005.

Eqn 1

Visibility was ***monitored*** *~~detected~~ with a forward scattering measuring visibility meter (Model FD12.....*

Give reference for eqn (1) and distinguish between visibility and visual range.

Middleton (Vision through the Atmosphere), see:

http://amsglossary.allenpress.com/glossary/search?id=visual-range1.

Response: Thanks for the helpful suggestion. We have revised the manuscript and added related references for the empirical equation. We have also discussed the difference between visibility and visual range.

Reviewer: *To match the ten-minute PNSDs data, one-minute meteorological parameters were also averaged into ten-minute averages when missing data less than 40 %.*

I don't understand what is meant by: "when missing data less than 40 %."

Response: We have rephrased this vague sentence as "… when the missing data in the ten-minute interval less than 40% of those that should be observed in the corresponding ten minutes."

Page 31369, eqn 3

Is "gf" the same as "f(D_p,RH)" in eqn 2?

Response: Yes, the *gf* here is just with the same meaning of the size-resolved hygroscopic growth factor, $f(D_p, \mathrm{RH})$. For clarity, we have replaced it with f in the manuscript.

$$RH = \frac{f^3 - 1}{f^3 - (1-\kappa)} \cdot \exp\left(\frac{4\sigma_{s/a} \cdot M_w}{R \cdot T \cdot D_p \cdot f}\right)$$

Line 15

The discussion about determination of the hygroscopic growth factor is very condensed. A sentence relating to the method and reference to it should be included e.g., Novak (or more recent reference) who presents the cumulative size distribution

estimate of hygroscopic growth.

Nowak, A.: Das Feuchte Partikelgroessenspektrometer: Eine Neue Messmethode Zur Bestimmung Von Partikelgroessenverteilung (<1 μm) und Groessenaufgeloesten Hygroskopischen Wachsumsfaktoren Bei Definierten Luftfeuchten, Doctoral Thesis, Leibnitz Institute for Tropospheric Research, Permoserstr. 15, D-04303, Leipzig, Germany, 2005.

Response: We agree with the referee and have added some important information and references in the manuscript. .

Actually, the briefly mentioned four-mode fitting method for determining the $f(D_p,RH)$ is a part of Ma's paper (in preparation). It is based on the maturely developed and widely used traditional fitting methods for the submicron particles. The differences between the modified four-mode fitting method and traditional fitting methods include two aspects. One is that the modified method can also be applied to the parameterization of supermicron particles. The other is that the fitting results using the modified method are supposed to meet the requirements that it can not only reconstruct the particle number size distribution, but also the aerosol surface area and volume distributions. In other words, the closures of aerosol number, surface area and volume concentrations could be achieved between the reconstructed PNSDs and the measured ones.

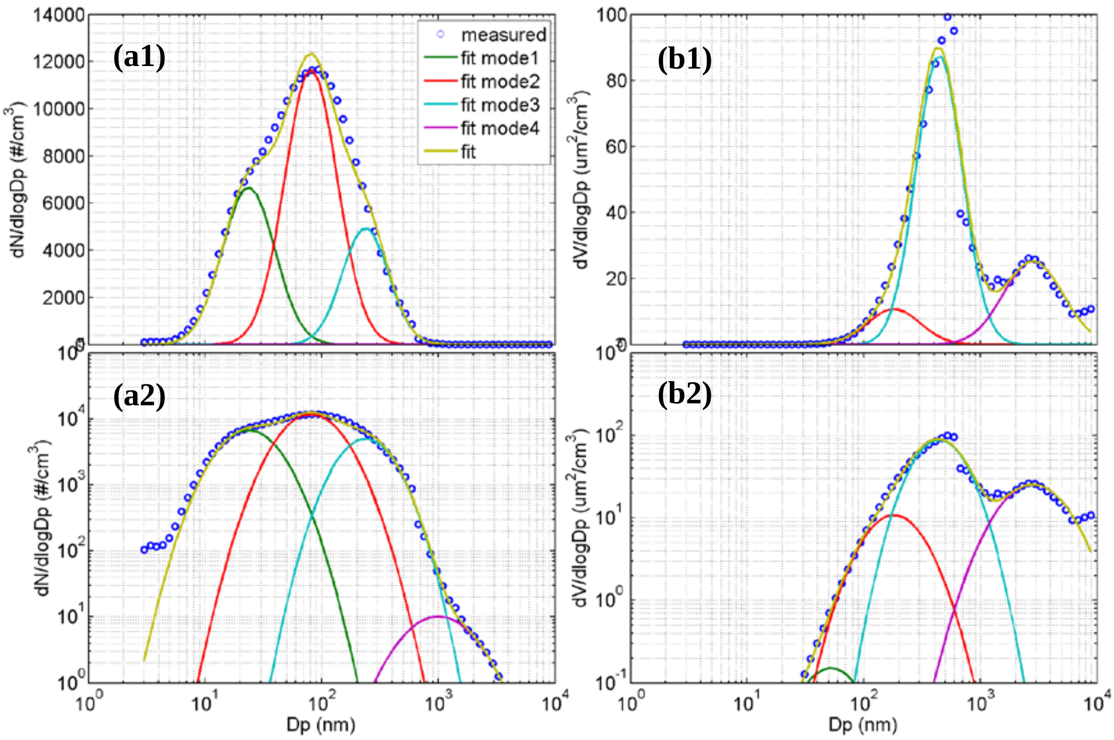
The HHTDMA-measured hygroscopicity parameter κ of particles with diameters of 50 nm, 100 nm, 200 nm and 250 nm at RHs of 90%, 95% and 98.5% can be used to deduce the corresponding κ for each of the four modes of the reconstructed PNSDs. This is mainly based on the assumption that aerosols in a specific mode have common sources or have experienced similar aging processes. Therefore, the corresponding hygroscopicity parameter κ in one mode should be the same due to the same chemical compositions. Considering the primary chemical composition in the coarse mode is nearly hydrophobic, the κ for this mode is assumed to be 0. Consequently, with the corresponding contribution of each mode to the κ of a specific particle size, the mean size-resolved κ for aerosols with diameters in the range of 3 nm ~ 10 μm can be estimated from the known κ of each mode.

$$\kappa\left(D_p\right)=\frac{\sum_{i=1}^{4}\kappa_i\cdot N_i\left(D_p\right)}{\sum_{i=1}^{4}N_i\left(D_p\right)}$$

Where κ_i represents the κ of the i mode, $N_i\left(D_p\right)$ stands for the number concentration of dry particles (with diameter of D_p) in the i mode.

Accordingly, the size-resolved hygroscopic growth factors at different RHs can be derived from the size-resolved κ using the κ-Köhler theory (Petters et al., 2007).

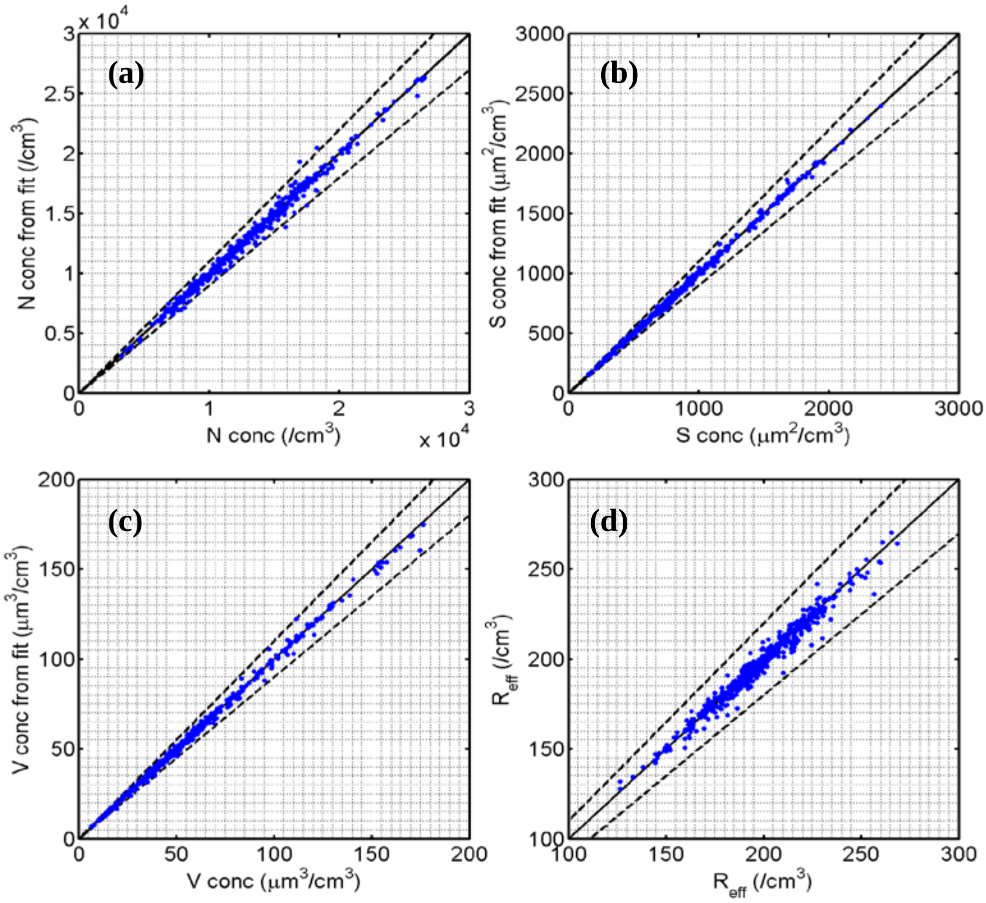
Here we can only provide the following results for reference. Nonetheless, some directly related descriptions have been added into the manuscript.



Supplied Fig. 1. *Modified four-mode fitting results of aerosol (a1-a2) number and (b1-b2) volume concentrations with the mean particle number size distribution (PNSD) at linear and log scales, respectively. Dots stand for the measured values, and four colored lognormal lines in each panel correspond to the four lognormal fitting modes; the yellow curve of each subplot represents the corresponding final fitting result.*

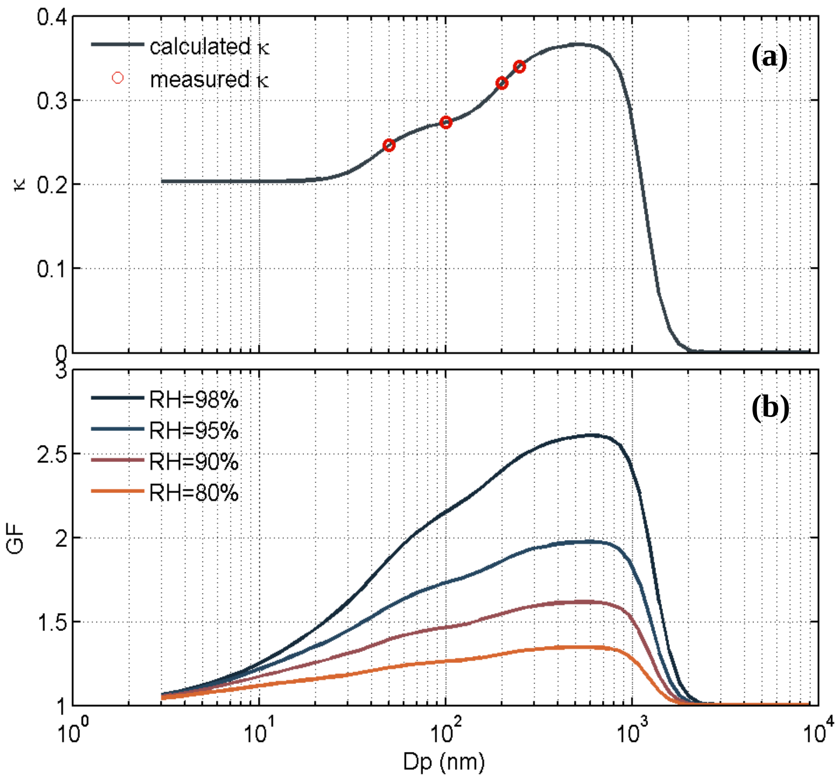
To evaluate the efficiency of the fitting results, the closures of total aerosol number, surface area and volume concentrations, and effective radius between that calculated from the reconstructed and in-situ measured PNSDs are presented in supplied Fig.2.

Evidently, the closure results are satisfying, with the difference no more than 10%.



Supplied Fig. 2. *Closures of total (a) aerosol number, (b) surface area and (c) volume concentrations, and (d) effective radius calculated from the reconstructed and measured PNSDs. The dark solid line stands for the 1:1 line, and dashed lines in each panel represent the corresponding 10% relative deviations.*

Combining the reconstructed PNSDs and HHTDMA-measured hygroscopicity parameter κ of particles with dry diameters of 50 nm, 100 nm, 200 nm and 250 nm at RHs of 90%, 95% and 98.5%, the hygroscopicity parameter κ of each mode is determined and the size-resolved κ within the size range of 3 nm ~ 10 μm is calculated. Then the size-resolved hygroscopic growth factors at a specific RH can be derived from the size-resolved hygroscopicity parameter κ.



Supplied Fig. 3. *Derived (a) size-resolved hygroscopicity parameter κ and hygroscopic growth factors (GF, equivalent to $f(D_p,RH)$) at 80%, 90%, 95% and 98% RH. Red circles in Fig.3 (a) represent the HHTDMA-measured mean κ values.*

During the HaChi campaign, the HHTDMA-measured mean *κ* values of particles with the four diameters are 0.25, 0.27, 0.32 and 0.34, respectively (Liu et al., 2011). The derived size-resolved *κ* and hygroscopic growth factors (at RHs of 80%, 90%, 95% and 98%) are illustrated in the supplied Fig. 3.

The size-resolved hygroscopic growth factors used in our work are also obtained from the size-resolved *κ*. Undoubtedly, uncertainties of the size-resolved hygroscopic growth factors would exist in the four-mode fitting method, *κ* assumption for the coarse mode and the temporal variation of the measured *κ* values. However, it has been demonstrated to be applicable in our study.

References:

Liu, P. F., Zhao, C. S., Göbel, T., Hallbauer, E., Nowak, A., Ran, L., Xu,W. Y., Deng,

Z. Z., Ma, N., Mildenberger, K., Henning, S., Stratmann, F., and Wiedensohler, A.: Hygroscopic properties of aerosol particles at high relative humidity and their diurnal variations in the North China Plain, Atmos. Chem. Phys., 11, 3479–3494, doi:10.5194/acp-11-3479-2011, 2011.

Petters, M. D. and Kreidenweis, S. M.: A single parameter representation of hygroscopic growth and cloud condensation nucleus activity, Atmos. Chem. Phys., 7, 1961–1971, doi:10.5194/acp-7-1961-2007, 2007.

Line 21

Give full reference year for Ma, 2011a or 2011b

Response: We have revised it as: (Ma et al., in preparation).

Page 31370, line19

The formula for f is awkward. Better if spelled out e.g., f = 2.75 at 100nm and 99.5%RH for ammonium sulfate.

Response: Thanks and we have revised accordingly.

It is not clear how the growth factors shown in figure 1 at sizes greater than 10 or 2 um were obtained. The values seem large.

Response: Thank you very much for this comment. Actually, it is this version of figure 1 derived from previous limited chemical data instead of the right one as has been seen by editors in the initial manuscript, that was uploaded by mistake during the proof-reading before published on ACPD. We have corrected it.

Page 31371, line1

… for determining the optical equilibrium refractive index for dry particles …

I don't understand the meaning of 'optical equilibrium'. Can those words be deleted with no loss of meaning?

Response: Thanks. We have deleted those words and all the expressions of 'optical equilibrium' in the manuscript.

Page 31372, line 7

The refractive index for pure water is … ~~(Seinfeld and Pandis, 1998)~~.

Reference not needed.

Response: Thanks. This reference has been deleted.

Page 31373, eqn 9

What are the integration limits? 20 nm to 10um? Use diameter rather than radius since diameter generally used in discussion.

Response: We thank the referee for the useful comment. The integration limits are from 3 nm to 10 μm. The equation has been revised into the following format, with the radius replaced by diameter:

$$K_{ex} = \int_{3\,nm}^{10\,\mu m} \sigma_{ex}\left(D_p\right) n\left(\log D_p\right) d\log D_p = \sum_{D_p=3\,nm}^{10\,\mu m} \sigma_{ex}(D_p)\cdot dN$$

Page 31376, line 3

.... the ambient **RH** PNSDs ...

Add RH just for clarity.

Response: Thanks. RH has been added into the manuscript.

figure 3

Was the regression forced through zero?

More than 3 significant figures not needed in $\boldsymbol{R^2}$ *value.*

Response: Yes, the regression was forced through zero. It is considered that the K_{ex} calculated from ambient RH PNSDs and measured visibilities should be theoretically equivalent to each other, namely, a satisfying closure.

We also have limited the significant figures of R^2 to 3.

Page 31378, line 10

*.... are **less than** ~~within~~ 100 ....*

Response: Thanks and we have revised it accordingly.

Line 24

The crossed area ...

I don't see a cross hatched or otherwise marked area in fig 4, though I understand what you mean in the sentence.

Response: We appreciate the referee for the useful comment. The crossed area has been marked in Fig. 4.

Page 31379, line 20

*... Kex **per unit** ~~at unit~~ aerosol volume concentration ....*

Response: We have corrected it.

Page 313181, eqn 10

The (1-RH) term and similar empirical formulas for this relationship should be referenced. E.g., F. Kasten, P. Winkler, K. Carrico.

Response: Thanks. Several related references have been added.

Page 31382, line 2

*I believe you mean to refer to the coefficients in **eqn 10** and table 3.*

Response: Yes, we do mean that. We appreciate the referee for pointing out the careless mistake. Since we have added two more equations in Sect. 2.2 and Sect. 3.1, the initial Eq. (10) has been correspondingly revised to Eq. (12).

Line 17

By my estimate one sigma of the values are distributed approximately ± a factor 0f 1.5 from the 1:1 line. I would put the result in quantitative statistical terms rather than “near”.

Response: We thank the referee for the constructive suggestion. Results reveal that the scattered dots are all distributed approximately ± 0.23 from the 1:1 line. Corresponding revision has been done in the manuscript.

Page 31392, tables 2 and 3

Round the numbers presented and limit to two or three significant figures. Rearrange and add to the columns to provide more meaningful statistics.

Mean, median, std. dev., 10% and 90% values.

10% and 90% values are more valuable than maximum and minimum. You can equally well choose 5% and 95% or ±1 or ±2 sigma values.

I suggest median as a measure of skewness of the data distribution. If the distribution is reasonably Gaussian you can say that in the text, page 31373.

Response: We appreciate the helpful comment. According to the suggestion, we have provided the median, 5% and 95% values in Table 2. Considering all the median values of the listed PNSD parameters are smaller than mean values, we have not mentioned whether the distribution is reasonably normal distribution or not.

Page 31393, table 3

Most statistical packages calculate a 90 confidence or one standard deviation value to fit coefficients. It would be valuable to add those to the table for the fit coefficients.

Response: We agree with the referee that more valuable information for the fitting coefficients should be put into Table 3. The parameterization has been revised, taking coarse to fine volume ratio into account. Both of the two- and three-factor parameterization schemes have been proceed at three specific confidence levels of 1σ, 90% and 95%, respectively. The corresponding regression results have also been given in Table 3.