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# *Interactive comment on* "Particle hygroscopicity and its link to chemical composition in the urban atmosphere of Beijing, China during summertime" *by* Z. J. Wu et al.

**Anonymous Referee #2**

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## General comments

This manuscript describes aerosol hygrosocpicity determined under subsaturated conditions in Beijing, China during June 2014. The hygroscopicity parameter ($\kappa$) is calculated from measurements throughout the study and a closure analysis, using the size-resolved chemical composition measured by an aerosol mass spectrometer, is presented.

Overall, this study presents consistent results with previous work with careful attention to analysis. However, there is little effort in demonstrating the additional

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Discussion Paper

knowledge gained from this study. This is not the first HTDMA study in Beijing, but there is no comparison to previous campaigns or to other studies in urban environments (e.g. Meier et al. (2009), Juranyi et al. (2012) and Yeung et al. (2014)). I recommend that the manuscript be accepted on the condition that a more in depth comparison with other studies is included and that the specific comments listed below are addressed. This manuscript also needs careful proofreading for grammar mistakes before it should be accepted for publication.

**Specific comments**

Page 11501, line 14
Why did you estimate a particle density of 1500 kg m$^{-3}$? An average, or time-varying, particle density could be easily calculated using the chemical composition measured by the AMS in conjunction with the BC mass measured by the PAX.

Page 11501, line 23
Reference to the work of Lanz et al. (2007) would be appropriate.

Page 11503, line 17
Justification should be provided for why 0.1 was chosen for $\kappa_{SOA}$. Kammermann et al. (2010) determined $\kappa$ to be $> 0.2$ for aged organics from HTDMA measurements at Jungfraujoch, whereas Wex et al. (2009) determined $\kappa$ of laboratory generated SOA to be $< 0.1$ and Yeung et al. (2014) found urban $\kappa_{org}$ to be up to 0.29.

Page 11503, line 18
There is no equation 4 in the cited paper. Please update the reference.

Page 11503, line 25 and Table 1
What are the references for the $\kappa$ shown in Table 1? According to Petters and Kreidenweis (2007), $\kappa$ for ammonium sulphate is 0.53. Was the $\kappa$ for ammonium

bisulphate measured by the authors?

Page 11504, line 15
The hygroscopic growth factor was measured, from which the hygroscopicity parameter was determined. The statement should be revised to reflect this.

Page 11506, line 15
Why do you limit the size range for detectable mass to be ± 5 nm when you integrate over ± 50 nm? It seems that these should be consistent.

Page 11506, lines 22–24
You should include a sensitivity analysis to estimate the uncertainties associated with the assumption that BC is uniformly distributed across particle size.

Page 11507, lines 1–2
Sun et al. (2012) have shown that this assumption is wrong since POA tends to be emitted at smaller sizes than the aerosol upon which SOA condense. Again, a sensitivity analysis could be used to estimate the uncertainties associated with this assumption if actual estimations cannot be made.

Page 11507, lines 15–20
Have the authors ensured that the results are not unduly biased by restricting data to times when ammonium nitrate is below 20% and organics are greater than 50%? For example, this is likely reducing the number of night time data points included in the analysis, making the fit only representative for day time data points. A statement should be included in the text pointing this out.

Page 11507, lines 21–23
Although it is mentioned later, it should be emphasized here that these studies were

all performed under supersaturated conditions for CCN measurements.

Page 11508, lines 21–23
"The water soluble fraction of 50 nm new particles is 42%." Is this statement referring to the chemical composition, i.e. 42% of the particle is water soluble by mass? Or is it the number fraction of the hydrophilic mode? If the former, was this determined through Eq. 3? If the latter, is this before the nucleation event? In any case, this should be clarified. These results are consistent with the findings of Shantz et al. (2012), and reference should be made to this work.

Page 11508, line 6
The authors should include a discussion that compares their findings with other similar studies. This should detail the additional knowledge that their study contributes on top of the numerous other urban HTDMA studies that have previously been conducted.

Page 11508, lines 26
It is also possible that these are less hygroscopic primary aerosol that have coagulated to form larger particles.

Page 11509, lines 7–9
This statement is confusing since 250 nm particles have a surface area that is larger than 100 nm particles but smaller than 350 nm particles. Are the authors referring to the surface area concentration?

Page 11509, lines 11–15
These results are very interesting although hard to interpret. It would be difficult to believe that the particles suddenly converted from externally- to completely internally-mixed. Even if the hydrophobic-mode grew through condensation of soluble chemical compounds such as sulphate and ammonium, there would still be a contribution from

the hydrophobic core. This would show up as an increase in HGF from 1.1 up to 1.8 until the soluble components eventually dominate the hygroscopic growth. Do the authors have any insight?

Page 11509, line 23
Please include uncertainties associated with the listed $\kappa$ and the statistic used to represent these. This could be the 25th and 75th percentile or 1.5 times the interquartile distance or 1.95 times the standard deviation, etc.

Figure 2
Volume fraction would be a more appropriate right axis for the left figure.
Clarify the meaning of the whiskers on the right figure.

Figure 4
What is the RMSE of these fit?

Figure 5
All the data from the literature are from studies conducted at supersaturated conditions. HTDMA data, such as those included in Jimenez et al. (2009), would be more appropriate.

**Technical corrections**
As mentioned in the general comments, there are numerous grammatical errors in the manuscript which should be corrected before the article is resubmitted.

Page 11499, line 7
This should be “mass spectrometric”.

Page 11500, lines 17, 18, 20

Ammonium sulphate in the subscript is incorrect.

Page 11508, line 17
The time in the figure would suggest 9.50a.m.

Page 11508, line 28
This should be “the hydrophobic mode appeared again”.

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