Reviewer: Liu et al. present a data set of hygroscopicity measurements in the North China Plain, which is one of the most polluted regions in China. Hygroscopic growth factors for particles of 50 to 250nm in diameter were recorded with a High Humidity-TDMA. Since this instrument allows precise measurements at relative humidities higher than 90%, the extrapolation of the hygroscopic properties up to cloud droplet activation can be improved.

In this paper the time series and average values of the growth factors and hygroscopicity parameters (kappa) are presented. Moreover, the diurnal variation of the different parameters is described and well simulated using an aerosol box model. The manuscript represents a substantial contribution to scientific questions and is within the scope of ACP. I therefore recommend its publication after the following comments and suggestions for correction/improvement have been addressed. **Response:** Thanks for the comments.

GENERAL COMMENTS:

Reviewer: I agree with the other referees that this paper is unnecessary long because of repetitions and sometimes too detailed explanations. It could be worth to shorten a few paragraphs in the results section and I also recommend merging Sects. 2.2.2 and 2.2.3 and restructure as follows (it might be helpful to include a figure for better illustration):

1. Measured number size distribution of humidified aerosol particles (spectrum of number concentration versus mobility diameter) is transformed into growth factor distribution

2. Conversion into actual growth factor probability function (Gysel et al., 2009); normalization to unity

3. Conversion into kappa probability function (kappa-PDF, as e.g. displayed in Fig. 2) by using the definitions of Petters and Kreidenweis (2007) for kappa; keep it short as suggested by Referee #1 since this is already a common procedure (maybe mention only Eq. 5)

4. Description of the calculation of the ensemble mean growth factor and the mean kappa

5. Description of the different hygroscopicity groups (NH, LH, MH) !limits and calculation of GF_NH,LH,MH and nf_NH,LH,MH

6. Description of the calculation of sigma_GF The authors should also check the manuscript with regard to its language (especially articles, verb forms, and plural forms).

Response: We are grateful to Referee 3 for the detailed guide for restructuring the sections 2.2.2 and 2.2.3. In the revised paper, these two sections have been merged, shortened and restructured as suggested. Also, the results section has been shortened.

SPECIFIC COMMENTS:

Reviewer: *P 2996, L 13: "Leibniz Institute" must be without dash.* Response: The dash has been deleted.

Reviewer: *P 3000, L 11: Shouldn't it be "by solving Eq. (3) with (4)"?* **Response:** Yes. Thanks for pointing out this mistake, which has been corrected upon manuscript revision.

Reviewer: *P* 3000, *L* 7 and 12: *I* recommend writing the equations with a real fraction bar rather than with a slash. That would make them easier to read. **Response:** The Eq. (3) (P3000, L7) has been excluded in the revised paper. The Eq. (5) has been modified as suggested.

Reviewer: *P* 3000, *L* 14 and 16: It must be "20 \mathcal{C} " or alternatively "293 K". **Response:** This mistake has been corrected.

Reviewer: *Sect. 2.2.2: Please mention how S and RH are linked to each other.* **Response:** The link between S and RH has been explained in the revised paper.

Reviewer: *P 3001, L 7: It must be "TDMA".* **Response:** This typo has been corrected.

Reviewer: P 3002, Eq. 6 and 7: Are these calculations done for every single measured spectrum, with GF being the growth factor at size bin i and c(GF) the probability in bin i? Please make this clear.

Response: Yes. These calculations are done for every single measured spectrum. This has been clarified in the revised paper.

Reviewer: *P* 3011, *L* 3-7: This simply indicates that larger particles are more hygroscopic than smaller ones.

Response: This inappropriate sentence has been deleted.

Reviewer: *P* 3012, *L* 1-7: What about the autocorrelation of nf_MH and kappa_NH? If the authors do not want to show them in Fig. 4 they should at least write in the text how they behave qualitatively.

Response: This information has been added in the text.

Reviewer: *P* 3013, *L*. 6: Rose et al., 2010 also report diurnal variations of hygroscopicity and mixing state for another Chinese megacity region. Please compare the presented results with theirs.

Response: Our results regarding the diurnal variations were similar to that reported by Rose et al., 2011, ACP, which has been mentioned in our revised paper.

Reviewer: *P* 3014, *L*. 4: How do the authors use both the parameterizations of Low (1969) and of Young and Warren (1992) for their Köhler calculations? One parameterization should be enough. Otherwise please mention how they are combined in the calculations.

Response: Low (1969) provided a parameterization of van't Hoff factor as a function

of molality for $0.1 < \text{molality} < 5.5 \text{ mol} \cdot \text{kg}^{-1}$, while that for $10^{-5} < \text{molality} < 0.1 \text{ mol} \cdot \text{kg}^{-1}$ the parameterization was provided by Young and Warren (1992). In our study we combined the both parameterizations for a broader range of molality. This information has been mentioned in the section 2.2.1 in the revised paper.

This information has been mentioned in the section 2.2.1 in the revised paper.

Reviewer: *P* 3014, *L* 4-6: The points at the two highest RHs are not as well described by the kappa-K öhler model. Please comment on.

Response: Following the comments from Referee 2, we decided to omit the comparison of the LACIS data in this paper. This comparison will appear in another paper in the HaChi ACP special issue.

Reviewer: *P* 3014, *L*. 15-16: This sentence is difficult to understand. Do the authors mean "For large particle sizes, growth factors are as high as 1.6 at 90% and 4 at 99.5% RH"?

Response: This sentence has been revised as suggested.

Reviewer: *P 3014, L 29: Please include "factor kappa" after "hygroscopicity".* **Response:** This has been revised as suggested.

Reviewer: P 3015, L 7-8: Please also discuss Figs. 6a2-d2.

Response: A short discussion has been added for figs. 6a2-d2.

"Figure 6 (a2)-(d2) shows the average number fractions of three hygroscopic groups during daytime and nighttime, respectively. No significant variations of nf values were observed at three different RHs for both daytime and nighttime measurements. The nf_{NH} values measured at nighttime were significant higher than that during daytime, while the nf_{MH} were higher during the day. The number fractions of the transition group, nf_{LH} , were larger at smaller sizes (~14% at 50nm and ~6% at 100nm) but negligible for larger sizes (<3% at 200nm and 25nm)."

Reviewer: *P* 3029, *Tab* 1: Are the values in the table mean values +/- standard deviation?

Response: Yes. We added this information in the title of table 1.

Reviewer: *P 3034, Fig 3: What are the dashed lines?*

Response: The dashed lines represent the average value of each parameter over the whole campaign. This information has been added in the caption of Fig. 3.

Reviewer: *P* 3035, *Fig* 4: *Is the significance level* 0.01 *or* 0.1?

Response: The significance level is 0.01. The corresponding value of correlation coefficient is around 0.1.