**Atmospheric
Chemistry
and Physics
Discussions**

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 #3

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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.

GENERAL COMMENTS:

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).

SPECIFIC COMMENTS:

P 2996, L 13: "Leibniz Institute" must be without dash.

P 3000, L 11: Shouldn't it be "by solving Eq. (3) with (4)"?

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.

P 3000, L 14 and 16: It must be "20°C" or alternatively "293 K".

Sect. 2.2.2: Please mention how S and RH are linked to each other.

P 3001, L 7: It must be "TDMA".

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.

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

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.

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.

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.

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

P 3014, L. 15-16: This sentence is difficult to understand. Do the authors mean "For

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large particle sizes, growth factors are as high as 1.6 at 90% and ∼4 at 99.5% RH"?

P 3014, L 29: Please include "factor kappa" after "hygroscopicity".

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

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

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

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

REFERENCES:

Rose, D., Gunthe, S. S., Su, H., Garland, R. M., Yang, H., Berghof, M., Cheng, Y. F., Wehner, B., Achtert, P., Nowak, A., Wiedensohler, A., Takegawa, N., Kondo, Y., Hu, M., Zhang, Y., Andreae, M. O., and Pöschl, U.: Cloud condensation nuclei in polluted air and biomass burning smoke near the mega-city Guangzhou, China – Part 2: Size-resolved aerosol chemical composition, diurnal cycles, and externally mixed CCN-inactive soot particles, Atmos. Chem. Phys. Discuss., 10, 26841-26890, doi:10.5194/acpd-10-26841-2010, 2010.

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