Reply to RC1

This study reported field measurements results of the chemical speciation, hygroscopicity and CCN properties of ambient particles at a suburban site in the central North China Plain (NCP). The probability density function of the hygroscopicity parameter kappa-PDF was then derived from measurement data and showed only a singular hygrophilic mode which was very different from profiles observed in other regions of the NCP (that were normally bi- or tri-modal). Among the possible factors affecting aerosol hygroscopicity (the mixing state, chemical composition and particle size), particle size was identified as the key factor influencing the particle CCN activation. This study explored the aerosol microphysical properties in a region that was not previously studied and the results can be useful when compared with existing data to understand aerosol aging and its impact on particle microphysics and the climate. The topic is relevant to the scope of the journal of Atmospheric Chemistry and Physics and should be considered for publication.

(1) The tile may be changed to "Characterization of aerosol hygroscopicity, mixing state, and CCN activity at a suburban site in the central North China Plain" to reflect the unique location of this study.
Re: It's a good suggestion, the title has been revised. Very thanks.

(2) Section 4.1, Lines 317-321: While it's been shown that aging of BC will enhance its hygroscopicity and CCN activation, the actual determination of the GF of aged BC could be challenging (see, for example, Torsten et al., Environ. Res. Lett., 2011) as the DMA mobility size change may be marginal. A few chambers studies on soot SOA from anthropogenic VOCs may provide some insights here (Guo et al., ES&T, 2016 and Qiu et al., ES&T, 2012). In general, the knowledge on particle morphology is useful, and in principle, ACSM and DMA data can be combine to retrieve morphology information.
Re: Thanks for your suggestion and the recommended references. We read the recommended papers carefully and indeed found a more comprehensive interpretation for the enhanced hygroscopicity. The related text has been revised as "This suggests that the particles were highly aged and internally mixed at XT during this campaign. Coating of sulfates and secondary organics during the aging process changes the structure of BC and makes it grow, which can significantly enhance the hygroscopicity of particles (e.g., Zhang et al., 2008; Jimenez et al., 2009; Tritscher et al., 2011; Guo et al., 2016).

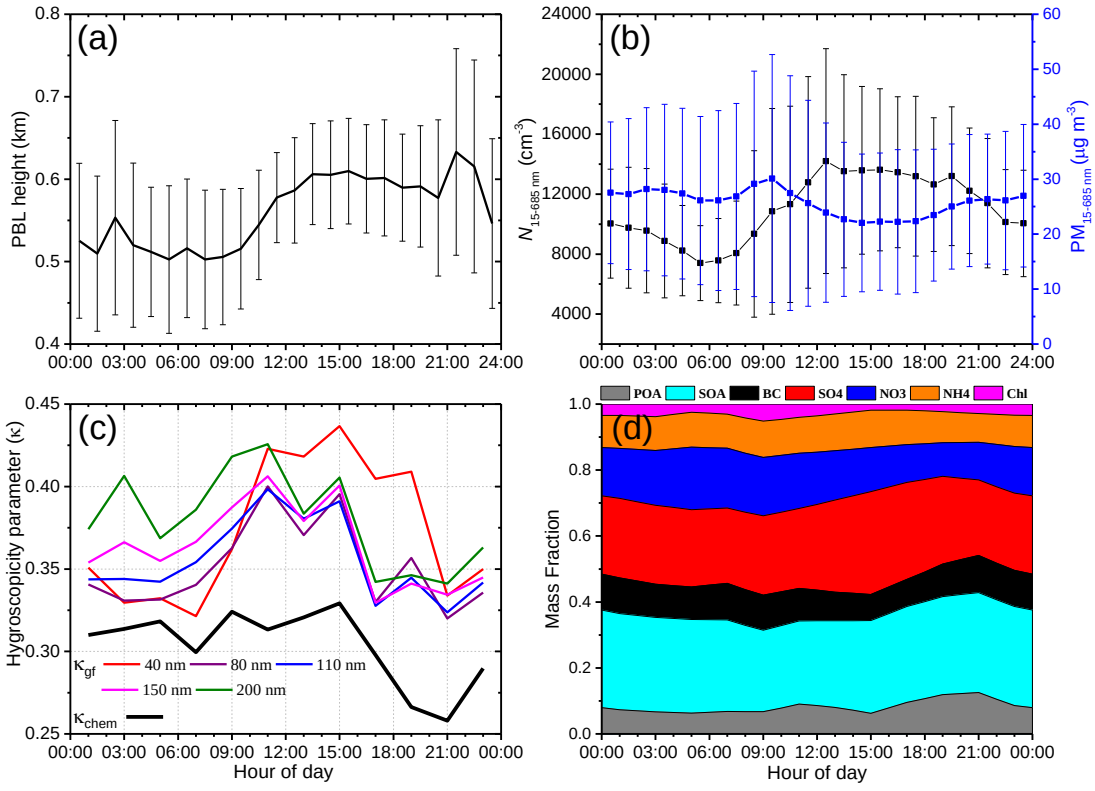
(3) Section 4.1, Lines 347-351: As pointed out by recent studies, amines may contribute significantly to the NPF events (e.g., Zhang et al., Chem Rev., 2015). Several studies have shown that amine compounds in aerosol phase can be hygroscopic, sometimes even at event low RH (e.g., Gomez-Hernandez et al., ES&T, 2016; Chu et al., PCCP, 2015; Qiu and Zhang, ES&T, 2013). Since the

reported field measurements took place in a local with heavy industrial activities, it is possible that amine may contribute significantly to the hygroscopicity of the 40-nm particles

Re: This is a good point interpreting the hygroscopicity difference of 40 nm particles with other size particles. According to the recommended references, the text has been revised as "40 nm particles were always more hygroscopic than 80 nm particles at XT, especially in the daytime, which was also different from other sites. This is likely because the coating effect of sulfates and secondary organics is more significant on smaller particles (Tritscher et al., 2011; Guo et al., 2016). Furthermore, since the field measurements took place in a local with heavy industrial activities, it is possible that amine contributes significantly to the hygroscopicity of 40 nm particles. Several studies have shown that amine compounds in aerosol phase can be hygroscopic, sometimes at even low RH (Qiu et al., 2012; Chu et al., 2015; Gomez-Hernandez et al., 2016).".

(4) Section 4.3: It would make more sense to merge Figures 6&7 as the discussions on the two figures are closely related.

Re: It's a good suggestion, we have merged them, as:



Indeed, the merging makes more sense. It is more clear to note that the increase of hygroscopicity parameter (κ_{gf}) in the morning was synchronous with the particle number concentration ($N_{15\text{-}685\ nm}$), but was not with the PBL height, further suggesting the impact of photochemical reactions on aerosol hygroscopicity.

(5) Section 4.4: It seems odd that kappa was not derived from CCN data as described by Petters and Kreidenweis (2007). A side-by-side comparison of kappa values derived from HTDMA, chemical speciation and CCN may be more straightforward. Also, CCNderived kappa values can also provide basis for comparison with other studies that may only had CCN results.
Re: Yes, we will obtain more information about aerosol hygroscopicity if kappa from CCN data can be derived. However, it needs to connect DMA and CCNc to measure the size-CCN number concentration. Unfortunately, we only measured the bulk CCN number concentration in the campaign. We will do the work in the future campaigns.

References:

Chu Y., Sauerwein M. and Chan C.K.: Hygroscopic and phase transition properties of alkyl aminium sulfates at low relative humidities, Phys Chem Chem Phys, 17, 19789-19796, https://doi.org/10.1039/c5cp02404h, 2015.

Gomez-Hernandez M., McKeown M., Secrest J., Marrero-Ortiz W., Lavi A., Rudich Y., Collins D.R. and Zhang R.: Hygroscopic Characteristics of Alkylaminium Carboxylate Aerosols, Environ Sci Technol, 50, 2292-2300, https://dx.doi.org/10.1021/acs.est.5b04691, 2016.

Guo S., Hu M., Lin Y., Gomez-Hernandez M., Zamora M.L., Peng J., Collins D.R. and Zhang R.: OH-Initiated Oxidation of m-Xylene on Black Carbon Aging, Environ Sci Technol, 50, 8605-8612, https://dx.doi.org/10.1021/acs.est.6b01272, 2016.

Qiu C. and Zhang R.: Physiochemical Properties of Alkylaminium Sulfates: Hygroscopicity, Thermostability, and Density, Environ Sci Technol, 46, 4474-4480, https://dx.doi.org/10.1021/es3004377, 2012.

Tritscher T., Juranyi Z., Martin M., Chirico R., Gysel M., Heringa M.F., DeCarlo P.F., Sierau B., Prevot A.S.H., Weingartner E. and Baltensperger U.: Changes of hygroscopicity and morphology during ageing of diesel soot, Environ. Res. Lett., 6, https://dx.doi.org/10.1088/1748-9326/6/3/034026, 2011.