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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Contrasting ambient fine particles hygroscopicity derived by HTDMA and HR-AMS measurements between summer and winter in urban Beijing" *by* Xinxin Fan et al.

Anonymous Referee #2

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In this manuscript, Fan et al. measured the hygroscopicity and chemical composition of the size-resolved aerosols at several locations in northern China, and calculated the hygroscopic parameter (κ) based on both the hygroscopic growth factor from HTDMA measurement (κ_gf) and the chemical composition from HR-AMS measurement (κ_chem). By comparing κ_gf and κ_chem, this study demonstrates clear and undisputed evidence of possible bias in estimating aerosol hygroscopicity using the chemical mixing rule. Moreover, Fan et al. provides reasonable insight on the influence of atmosphere process and aerosol mixing state on the calculation of aerosol hygroscopicity. The manuscript is well organized and written. I will recommend the publication of this manuscript in ACP, as long as the following comments are properly addressed. Note

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that comments 4-6 are just suggestions. (1) A major discovery of the paper is that κ_chem calculated using the mixing rule cannot reflect the aerosol hygroscopicity. For example, it is found that the κ_chem in summer is underestimated at noon, overestimated at late peak hours, and substantially consistent with k_gf at midnight. Though I think the results should be correct, I am not fully convinced by some of the interpretation. (a) Why the external mixing of BC and POA with other components during the late peak hour will result in overestimation of κ_chem? (b) According to the author's argument, aerosols both at noon and at midnight have core-shell structure, but why the κ_chem/k_gf is quite distinct? More detailed interpretation and discussion are necessary. (2) L259, "Since a size-resolved BC mass concentration measurement was not available during the campaign, we use the bulk mass fraction of BC particles measured by the AE33 combining with size-resolved BC distribution in Beijing reported by Liu et al. (2018) to estimate κchem." As far as I know, the instrument to measure the size distribution of BC in Liu et al. (2018) is a SP2, which gives the BC core diameter. It is necessary to explain how to convert this size distribution of BC core to the size distribution of ambient aerosols. (3) L227 and fig. 3. "the concentration of the hydrophilic mode increased quickly around noontime and in the early afternoon (12:00-16:00)", which is explained by a transformation of the particles from externally to internally mixing state. However, I have different opinion. From Fig. 3a, it is evident that 40 nm particles after 12:00 were dominated by new particle formation (NPF). Therefore, the decrease of hydrophobic mode could be attribute to the extremely large amount of hydrophilic particles from NPF overwhelmed all other particles. (4) It will be better if the authors can discuss more on the similarities and differences of the hygroscopicity calculation at different sites. (5) There have been several studies revealing the uncertainty of calculating hygroscopicity using the mixing rule, but few can provide proper solution. Is it possible for the authors to propose parameterized modification on the κ_chem to reduce the uncertainty? If so, this paper will be enormously improved and will be far distinct from other studies. For example, should we use lower BC density value during the rush hours? (6) For several times, the current manuscript cited Zhang

et al. (2017), which is one of the previous studies done by the same group on the same topic. Therefore, it is appropriate to make a clear statement of the unresolved issues in the previous paper or what improvement has been made to this study so that the reader can easily understand the novelty of this paper.

Other minor comments: (1) fig. 2 is not reader-friendly. Please work out some way to make the information more clear. (2) fig.3. There are totally 12 sub-figures here. Please consider naming each sub-figures rather than the current way (which is not clearly demonstrated). (3) L150 and L160, the full term and the abbreviations of probability density functions (PDF)should be provided the first time in the text. (4) Fig. 5, L266, should be “slopes of linear fits and correlation coefficients”.

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