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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Vertical characteristics of aerosol hygroscopicity and impacts on optical properties over the North China Plain during winter" *by* Quan Liu et al.

Anonymous Referee #1

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Hygroscopicity of aerosols is a key factor determining the direct and indirect climate effect of aerosols to some extent. The hygroscopicity also influences the chemical processes in the atmosphere and the development of PBL. Despite of many studies of hygroscopicity over last decades, very few of studies focused on the vertical distribution of this key parameter over Beijing region. This work presents a valuable direct observation of vertical profiles of hygroscopicity and analyses the corresponding impacts on optical aerosol depth and cloud droplet activation. The analysis is solid and the results are with interests to the community. I recommend this paper published in ACP with some minor revision.

Minor concerns:

1) In the 1st paragraph of introduction, authors correctly introduced the importance of hygroscopicity on the direct and indirect radiative forcing of aerosols. The importance of hygroscopicity is not only limited on these. Hygroscopic growth of aerosols can also directly influence the consistence of observations of aerosol mass and chemical compositions, leading to less robustness in the analyses of spatial/temporal variances and chemical mechanism studies (Chen et al., 2018). Therefore, the observation of hygroscopicity profile is critical for atmospheric science, with respect to scientific and measurement perspectives.

2) Earlier researches of the aerosol-PBL interaction worth the credit. For example, in lines 68-70, a previous comprehensive work, with combination of observations and modelling, nicely demonstrated the suppression effect of aerosol on the development of PBL and then enhance the pollution in Chinese megacities, including Beijing, Nanjing and etc. (Ding et al., 2016).

3) Equation 3. AMS also observes chloride, which is however not described in the Eq.3. How does chloride considered in the study? This could be important, because inorganic chloride usually present as highly hygroscopic.

4) Line 212. As described in the manuscript, AOD is calculated at a wavelength of 800nm. Is there a special reason of choosing 800 nm, instead of the conventional 550 nm, nor the 880 nm used of retrieve BC? And, for the AOD from AERONET, AOD at 800 nm is not directly available. Which wavelength of AOD from AERONET was used to compare against the aircraft observation-derived AOD should be described in the Method. Or, the method for converting AERONET AOD to a wavelength of 800 nm should be described in the Method.

5) Line 333. 'HGF increased from 1.2 to 2.1 by a factor of 1.8'. This description is corresponding to particles of what size?

6) This work uses kappa-Koehler theory to estimate the CCN number concentration. I just wonder that if authors also performed CCN observation on the aircraft. The comparison with direct CCN observations would be interesting to see.

7) line 430-431. 'but the results here show that the enhanced RH will increase both dry particle size and hygroscopicity through a variety of aqueous reactions and processes.'. This conclusion is not supported by the results of the presented study, we need cite other studies to support this statement here.

Technical corrections:

1) Line 33. Should be 'slightly increase'

2) Line 25-31. This sentence is too long and difficult to understand. Please rephrase it.

3) line 38. Please specify the meaning of 'boundary layer processing'.

4) line 259. Should be 'correctly'.

5) line 285-286. Effective diameter for dry or wet particles?

6) Line 348. Please specify here, it is the AOD of PBL or LFT?

7) line 436. 'The aerosols at higher level, which showed a smaller size and lower hygroscopicity,. . .'. As my understanding, this work seems show that hygroscopicity increase as altitude increases. Please check this statement.

8) Please give the full description of short-names before use them and in the caption of figures. This would improve the reading experience. For example, it is difficult to understand 'IRH_lp' in figure 4.

References:

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