

To reviewers:

Dear reviewers, thank you very much for reviewing the manuscript and providing us the constructive comments and suggestions. With respect to your comments, necessary revisions of the paper have been made. We will respond to your comments carefully point by point; details of the revisions can be referred to the revised version of the manuscript.

Relevant changes of the revised manuscript are listed in the last page.

Reviewer #1:**Anonymous Referee #1**

I found the revised manuscript to adequately address most of reviewers' concerns. One point I like to add to authors' response to the major comment #3 of the reviewer #1. Authors argue that RH, rather than emissions and other factors, is the most important factor that leads to low SSA in winter and high SSA in summer. However, according to recent studies by Sun et al. [2015], the aerosol composition (as led by emissions) has strong seasonal variability. They found concentration of organic carbonaceous aerosols in Beijing is much higher in winter than other seasons due to enhanced coal combustion in winter. Those high level organic aerosol could also corresponding to a high level black carbon aerosol in winter, which is a strong absorbing aerosol and can lead to low SSA values. So the effect of RH on the seasonal variability of aerosol optical properties (including SSA, Asp,) is somewhat overstated in the present manuscript. There still needs further leverage and discussion about other influencing factors for aerosol optical properties.

Reference:

Sun, Y. L., Wang, Z. F., Du, W., Zhang, Q., Wang, Q. Q., Fu, P. Q., Pan, X. L., Li, J., Jayne, J., and Worsnop, D. R.: Long-term real-time measurements of aerosol particle composition in Beijing, China: seasonal variations, meteorological effects, and source analysis, *Atmos. Chem. Phys.*, 15, 10149-10165, doi:10.5194/acp-15-10149-2015, 2015.

R: Thank you very much for your comments and suggestions. We agree with you that temporal variations of aerosols and trace gases emissions play important roles in the seasonality of the aerosol optical properties, including AAC, SC, EC, SSA, and so on. As discussed in the manuscript, high level of emissions in winter to a great degree directly leads to the largest AAC, Bsp, SC and EC in this season.

Author response to major comment #3 of the reviewer #1 is mainly to explain the considerable influence of high RH on the aerosol scattering coefficient (rather than SSA) **in summer**. Because large PBL height and precipitation, as well as the lowest air pollutant emissions in summer are all in favor of a smaller SC (similar to AAC or Bsp) in this season. However, the actual SC in summer is substantially larger than that in autumn, in which pollutant emissions are higher. The high RH in summer was thought to be the major reason leading to larger SC. Therefore, the response to major comment #3 of the reviewer #1 was not a statement to emphasize that RH was the most important factor leading to low SSA in winter and high SSA in summer. And the authors do not deny the importance of the emissions either.

Discussions on the variations of SC, AAE and SAE have been included in last version of the manuscript. To avoid overstating the importance of RH on SSA, more discussions on the seasonality of SSA (low in winter and high in summer) have been added to the 3rd paragraph of Section 3.1 in the current version of revised manuscript. These statements also figure out the importance of emissions on

the variation of SSA. ASP and RH are highly correlated with each other, which could also be reflected in Fig. 2f, Fig. 5c, Fig. 5d and Fig. 9a, implying that RH might have considerable influence on the aerosol forward scattering coefficient hence SC. Corresponding statement has been added to the revised manuscript (4th paragraph of Section 3.4).

Reference recommended here has been cited in revised manuscript.

I also made out of some editorial corrections listed below.

12: useful to reducing -> useful for reducing

R: Corrected.

21: followed -> follow

R: Corrected.

21-22: please rephrase the following sentence in a clearer way: "the ranges around their averages ..."

R: The sentence has been rephrased in revised manuscript to make it much clearer.

63: the observations -> observations

R: Corrected.

63: the observed -> observed

R: Corrected.

65: among countries in East Asia and even the world -> worldwide.

R: Corrected.

66: aerosols -> anthropogenic aerosols

R: Corrected.

89: substantial observation-based studies mentioned -> intensive observation-based studies

R: Corrected.

99: Conclusions -> conclusions

R: Corrected.

108: wavelength dependent -> wavelength-dependent (and elsewhere of the manuscript)

R: Corrected throughout the manuscript.

160: as followed -> by

R: Corrected.

176: It's -> It is

R: Corrected.

177: single wavelength -> single-wavelength, or monochromatic

R: Corrected.

184: back scattering -> backscattering

R: Corrected.

199: winter times -> winter

R: Corrected.

200: temporal trend -> temporal variability

R: Corrected.

200: SSA's -> that of SSA

R: Corrected.

202: the other -> other

R: Corrected.

370: is more -> are more

R: Corrected.

400: long distance -> long-distance

R: Corrected.

Relevant changes in revised manuscript:

Result and discussions: Add discussions of aerosol optical properties in 3rd paragraph of Section 3.1 and 4th paragraph of Section 3.4.

In Acknowledgements: Add one more foundation number. And thank the reviewers for their constructive and valuable comments.

References: References listed and recommended in reviewers' comments were cited in the text and listed in References section in revised manuscript.

Corrections: Grammar and editorial corrections are made throughout the manuscript according to reviewer's suggestion.