

Anonymous Referee #4

Received and published: 7 December 2016

Review of “The surface aerosol optical properties in urban areas of Nanjing, west Yangtze River Delta of China” by Zhuang et al., 2016.

This manuscript provides an in depth analysis of aerosol optical properties spanning several years using surface observations of aerosol optical properties in Nanjing, China. While the results presented in the manuscript are valuable to the community, the organization and presentation of the manuscript is overwhelming. Therefore, I recommend publication with major revision.

To Referee #4:

Dear reviewer, thank you very much for reviewing the manuscript and providing us the constructive comments and suggestions on our study. We have learned a lot from your advices. With respect to your comments, necessary revisions of the paper have been made. We will response 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.

Major Comments:

1. As previously mentioned, presentation of results in the manuscript is overwhelming. Specifically, listing Bsp, AAC, EC, etc., values over and over again is very confusing. These numbers are listed in tables, and I suggest that the authors refer to them that way, rather than listing in the manuscript.

R: Thank you very much for your comment and suggestion. We agree with you that so many aerosol optical properties over and over again in the manuscript would make readers confuse and it would be more readable by presenting them in a Table. Lines 70-92 in Introduction are almost the same as lines 345-367 in Results and Discussions section. The numbers listed in former lines are mainly aimed at introducing the research progresses of observed aerosol optical properties over China while in latter lines: they are listed in the table and used to make comparisons with our observations. With respect to your suggestion, lines 70-92 have been rephrased and shortened in revised manuscript to avoid duplication and confusing. Additionally, a new table (Table 3 in revised manuscript) has been created to list the frequencies of the aerosol optical properties in (original) lines 288-293 to make them more readable. Further, lines 499-502 (original lines in old version of the manuscript) in Conclusions section have also been rephrased.

2. Observations like this are of great benefit to the community, but I feel the seasonal and diurnal observations are of great importance to the modeling community. I think these findings could be highlighted more as a useful resource to aerosol modelers and discussed in the conclusion. It would be particularly valuable if the authors could parse out the optical properties at a monthly scale, which could be directly read by a model, for example.

R: Thank you very much for your comments.

We agree with you that the seasonal and diurnal observations are of great importance to the modeling community especially when investigating the aerosol radiative forcing and climate effects. Large bias would be found if the model could not well address the seasonality or diurnal variations. Xu et al. (2016) indicated that the aerosol direct radiative forcing would be underestimated both at the TOA and

surface by 2.0 and 38.8 W/m², respectively, if the diurnal variation were not taken account. Large bias of the aerosol forcing resulting from uncertainties of the aerosol season or diurnal variations would subsequently lead to considerable uncertainties of the climate responses to the aerosol. Analysis on the season and diurnal variations of the aerosol optical properties in this study to some extent are valuable to the modeling-based researches on the aerosol climate effects. Corresponding discussion has been included in Conclusions section of the revised manuscript. Influences of the seasonal and diurnal variations on the aerosol climate effects would be addressed and tested in further study using numerical models.

We also agree with you that the monthly aerosol optical properties are valuable to the climate models. However, much longer observation is needed to ensure the representativeness of the properties in climatology because the monthly values might have substantial inter-annual variability due to serious pollution episodes (suddenly and unpredictable) as presented in Zhuang et al. (2015). We will keep your advice and take this issue into account in the further study based on a much longer measurement. Here, we would like to recommended the readers a research (Che et al., 2015), which listed the monthly scale columnar aerosol optical depth and angstrom exponent based on a 12-year observations over China.

Reference:

- Xu H., J.P. Guo, X. Ceamanos, Roujean J.L., M. Min, D. Carrer: On the influence of the diurnal variations of aerosol content to estimate direct aerosol radiative forcing using MODIS data, *Atmospheric Environment*, 141, 186–196. doi:10.1016/j.atmosenv.2016.06.067. 2016.
- Zhuang, B. L., Wang, T. J., Liu, J., Ma, Y., Yin, C. Q., Li, S., Xie, M., Han, Y., Zhu, J. L., Yang, X. Q., and Fu, C. B.: Absorption coefficient of urban aerosol in Nanjing, west Yangtze River Delta, China, *Atmos. Chem. Phys.*, 15, 13633–13646, 2015.
- Che, H. Z., Zhang, X. Y., Xia, X., Goloub, P., Holben, B., Zhao, H., Wang, Y., Zhang, X. C., Wang, H., Blarel, L., Damiri, B., Zhang, R., Deng, X., Ma, Y., Wang, T., Geng, F., Qi, B., Zhu, J., Yu, J., Chen, Q., and Shi, G.: Ground-based aerosol climatology of China: aerosol optical depths from the China Aerosol Remote Sensing Network (CARSNET) 2002–2013, *Atmos. Chem. Phys.*, 15, 7619–7652, 2015.

Minor Comments:

1. Lines 81 – 102. It would be easier to interpret and compare values presented in this paragraph as a table.

R: Thank you for your suggestion. This part has been rephrased in revised manuscript.

2. Line 29. What is Bsp?

R: It's the aerosol back scattering coefficient. Necessary statement has been included in revised manuscript.

3. Line 30. What is AE?

R: It's the aerosol Ångström exponent. Necessary statement has been included in revised manuscript.

4. Line 35. What “could be further deteriorated”?

R: It's atmospheric visibility. The sentence has been rephrased to make it more clear in revised manuscript.

5. Lines 38 – 39. Please provide a reference.

R: Two references have been provided in revised manuscript.

6. Line 42. This sentence requires several more references.

R: Several more references have been included in revised manuscript.

7. Lines 59 – 60. How can the bias in Zhuang et al., 2013a be explained by Holler et al., 2003? One study was 10 years prior to the other.

R: Thank you for your question. Reference Holler et al. (2003) been cited here is not to explain bias in Zhuang et al., 2013a but mainly point out the possible reasons to result in uncertainties of the aerosol radiative forcing. To avoid ambiguity, statements on Holler et al. (2003) have been move to line 54 (line 56 in revised manuscript) after the sentence " Forster et al. (2007) summarized ...".

8. Lines 69 – 70. Please provide a reference.

R: Two references have been provided in revised manuscript.

9. Lines 133. What does ATN stand for?

R: It's light attenuations. Necessary statement has been included in revised manuscript.

Technical Comments:

1. Line 56. Radiative.

R: The word has been corrected.

Relevant changes in revised manuscript:

Author affiliations: #1 and #3 are merged together. The last one is changed to "Department of Climate and Space Sciences and Engineering, University of Michigan, Ann Arbor, Michigan, USA"

In third paragraph of Introduction: Introductions on the aerosol optical properties in lines 70-91 in original manuscript are rephrased and shortened to avoid duplication and confusing, based on the reviewers' comments and suggestions.

In first paragraph of Section 3.2: To make the text more readable, frequency values are listed in a new table (Table 3 in revised manuscript) and corresponding statement has been rephrased according to reviewers' comments.

In fourth paragraph of Section 3.4: Add more discussion on the effect of RH on the aerosol optical properties.

In third and fourth paragraph in Conclusion: According to reviewers' comments, discussions on the importance of the aerosol optical properties seasonal and diurnal variations have been added. Additionally, frequency analysis was shortened.

In Acknowledgements: The foundation number was changed in revised manuscript.

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

In Figure captions: Fig. 8's caption was changed according to reviewers' comments.

Tables: Add a new table (Table 3) to summary the frequencies of the aerosol optical properties. Add a table caption in Table captions section. Table 3 in original manuscript is changed to Table 4.

Figures: Redraw Fig. 9b based on reviewers' comments.

Others: Correct the grammar, cite more references and re-organize some sentences throughout the manuscript according to reviewers' comments.