

Major comments:

1) As the authors pointed, for the new BC, its shape is chain-like, not a spherical one, so how do you know this method is applicable for the measurement. How many parts of BC is newly generated and how many is old one is there a guess for that? Do you have some samples measured ASAP and others saved and wait some time to let them to be old one?

Response: Thank you very much for your comments. We discussed the uncertainties caused by using idealized core-shell model in section 5 of our new manuscript. We replaced the spherical BC particle with cluster-like aggregates using multiple sphere T-matrix (MSTM) method. The results show that the deviations between the idealized concentric core-shell model and the cluster-like aggregates are overall within 15%. For BC core smaller than 200 nm, the deviations are within 4%. So, the method is applicable for the measurement.

After emitted into ambient environment, a pure BC particle will soon be coated. The absorption ability of the coated BC particle will be enhanced due to lensing effect. the absorption coefficient (σ_{ab}) of the coated BC particle will be larger that of pure BC particle. In our method, we do not limit the BC-containing particle that it has to be core-shell structure, it can also be a pure BC particle as long as the calculated σ_{ab} matches measured σ_{ab} . So, we do not need to guess how many parts of BC is newly generated and how many parts of BC is old.

Sorry, we do not have sample measured ASAP and others saved and wait some time to let them to be old one. But according to the work of Peng et al. (2016), the aging time scale is ~ 4 hours.

Specific comments:

1) Line 16, “with in” should be “within”.

Response: We changed “with in” into “within” in our new manuscript.

2) Line 58, what's mean of “degree of MAC”?

Response: “The degree of MAC” actually means “the value of MAC”. We changed “the degree of MAC” into “the value of MAC” in our new manuscript to avoid ambiguity.

3) “... Mie model incorporated with core-shell configuration hypothesis was applied in this study to assess the limitation of the constant ...” should be simplified as “... Mie model with assumption of core-shell particles was ...”

Response: We changed “... Mie model incorporated with core-shell configuration hypothesis was ...” into “... Mie model with assumption of core-shell particles was ...” in our new manuscript.

4) Line 68, “Based on the detailed...” The word “the” should be deleted.

Response: we removed “the” in our new manuscript.

5) Line 73, “The measured BC particle mass size distribution (BCPMSD) was obtained from the field campaign conducted at the Zhangqiu Meteorology Station (36°42’N, 117°30’E), Shandong Province. This field campaign lasted for about 1 month, from July 23, 2017 to August 24, 2017. The Zhangqiu observation site is located in the North China Plain (NCP) and is surrounded by farmland and residential areas, representing regional background conditions of the NCP.” should be rewritten as “The BC particle mass size distribution (BCPMSD) was measured at Zhangqiu Meteorology Station (36°42’N, 117°30’E), Shandong Province, surrounded by farmland and residential areas and a typical site for regional background conditions of North China Plain (NCP). The field campaign lasted for about 1 month, from July 23, 2017 to August 24, 2017.”

Response: We changed this part into “The BC particle mass size distribution (BCPMSD) was measured at Zhangqiu Meteorology Station (36°42’N, 117°30’E), Shandong Province, surrounded by farmland and residential areas and a typical site for regional

background conditions of North China Plain (NCP). The field campaign lasted for about 1 month, from July 23, 2017 to August 24, 2017.” in our new manuscript.

6) Line 76, the last word “system” should be deleted.

Response: We deleted “system” in our new manuscript.

7) Line 77, “measurements to determine ...” should be “is used to determine ...”.

Response: We changed “measurements to determine ...” into “is used to determine ...” in our new manuscript.

8) Line 78, “The suburban measurement site”, the word “measurement” should be deleted.

Response: We deleted the “measurement” in our new manuscript.

9) Line 79, the word “the” before “Jianghuai Plain” should be deleted.

Response: We deleted “the” before “Jianghuai Plain” in our new manuscript.

10) Line 86 and 87, “All the measurements in the three sites were conducted in containers where ambient temperature was controlled within 24 ± 2 °C with a particle pre-impactor to remove particles larger than $10 \mu\text{m}$ from the input air stream.” should be rewritten as “All the measurements in the three sites were conducted in temperature (24 ± 2 °C) controlled containers, and a particle pre-impactor is used to remove particles larger than $10 \mu\text{m}$ from the input airflow.”

Response: The sentence was changed into “All the measurements in the three sites were conducted in temperature (24 ± 2 °C) controlled containers, and a particle pre-impactor is used to remove particles larger than $10 \mu\text{m}$ from the input airflow.” In our new manuscript.

11) Line 92, “developed by (Ning et al., 2013). The instrument setup was further improved by Zhao et al. (2019b).” should be “developed by Ning et al. (2013) and

improved by Zhao et al. (2019b)”.

Response: we changed “developed by (Ning et al., 2013). The instrument setup was further improved by Zhao et al. (2019b)” into “developed by Ning et al. (2013) and improved by Zhao et al. (2019b)” in our new manuscript.

12) Line 101, “that were used to represent air pollution conditions” should be deleted.

Response: “that were used to represent air pollution conditions” was deleted in our new manuscript.

13) Line 105, the variables of *k* and *ATN* should be italic.

Response: *k* and *ATN* were changed into italic in our new manuscript.

14) Line 108, “in this study” should be deleted.

Response: “in this study” was deleted in our new manuscript.

15) Beginning of line 115, word “from” should be “at” and the same for line 117.

Response: “from” was changed into “at” in our new manuscript.

16) Line 117 and 118, “with a measurement flowrate of” should be “with flowrate of”.

Response: “with a measurement flowrate of” was changed into “with flowrate of” in our new manuscript.

17) Line 123, “... through a constant MAC value” should be “under assumption of a constant MAC”.

Response: “... through a constant MAC value” was changed into “under assumption of a constant MAC”.

18) Line 130, “an appropriate model simulation is needed for representing a single BC particle’s optical properties.” What’s meaning of this sentence?

Response: This sentence means that a proper model is required to simulate the optical parameters, such as the MAC, absorption coefficient, and scattering coefficient, of BC-containing particles to a good approximation. To avoid ambiguity, this sentence was changed into “a proper model is required to simulate the optical properties of BC-containing particles to a good approximation.” in our new manuscript.

19) Line 131, “There are three widely employed mixing states that are used to represent the structure of BC-containing aerosols” should be “Three widely employed mixing states are used to represent the structure of BC-carried aerosols”.

Response: The sentence was changed into “Three widely employed mixing states are used to represent the structure of BC-carried aerosols.” in our new manuscript.

20) Line 133, “... chain-like aggregates composed of small spheres” should be “chain-like aggregates of small spheres”.

Response: “chain-like aggregates composed of small spheres” was changed into “chain-like aggregates of small spheres” in our new manuscript.

21) Line 139, “the spherical core and shell favor the Mie model” should be deleted.

Response: “the spherical core and shell favor the Mie model” was deleted in our new manuscript.

22) Line 140, “in this study” should be deleted.

Response: “in this study” at line 140 was deleted in our new manuscript.

23) Line 143, could you use other words for the section title?

Response: The section title was changed to “Simulation of MAC for BC-containing particle using Mie theory”.

24) Line 147, the word “frequent” should be replace by “common”.

Response: the word “frequent” was replaced by “common” in our new manuscript.

25) Line 150, “... at the wavelength of 880 nm, calculated using the Mie theory, has been presented” should be “... at wavelength of 880 nm are simulated with Mie scattering method.”

Response: “... at the wavelength of 880 nm, calculated using the Mie theory, has been presented” was changed into “... at wavelength of 880 nm are simulated with Mie scattering method.” in our new manuscript.

26) Line 151, “reported to vary with incident light wavelength” should be “dependent on light wavelength”.

Response: “reported to vary with incident light wavelength” was changed into “dependent on light wavelength” in our new manuscript.

27) Line 152~153, “as BC particles can be emitted from different fuels and conditions, RI cannot be observed directly, with both real and imaginary part of RI varying over a significantly wide range” should be “due to different sources of BC, both the real and imaginary part of RI varies over a significantly wide range”.

Response: “as BC particles can be emitted from different fuels and conditions, RI cannot be observed directly, with both real and imaginary part of RI varying over a significantly wide range” was changed into “due to different sources of BC, both the real and imaginary part of RI varies over a significantly wide range” in our new manuscript.

28) Line 157, “averaged values are illustrated ...” Do you mean “mean values ...”

Response: Yes, “averaged values” are actually “mean values”. To avoid ambiguity, “averaged values” was changed into “mean values” in our new manuscript.

29) Please rewrite paragraph between line 168 and 173 to make it simple and clear.

Response: The paragraph between line 168 and 173 was rewritten to make it simpler and clearer in our new manuscript.

30) Line 174, the first sentence “The detailed iterative procedure is illustrated in Fig. 2.” Should be reposition to the end of last paragraph, and the word “detailed” should be “deleted”.

Response: The first sentence at Line 174 was repositioned to the end of the paragraph and the word “detailed” was deleted in our new manuscript.

31) Line 175, “represented” should be replace by “shown”.

Response: “represented” was replace by “shown” in our new manuscript.

32) Line 175, “a simplified algorithm for deriving BCPMSD was proposed by considering Fig. 1 as a look-up table.” Should be rewritten as “a simplified algorithm was proposed to derive BCPMSD through a pre-calculated look-up table.”

Response: “a simplified algorithm for deriving BCPMSD was proposed by considering Fig. 1 as a look-up table.” was rewritten as “a simplified algorithm was proposed to derive BCPMSD through a pre-calculated look-up table.” in our new manuscript.

33) Line 195 and 196, words “finer mode” and “coarser mode” should be replaced by “fine mode” and “coarse mode”, please read through the whole draft to replace other similar words.

Response: “finer mode” and “coarser mode” was replaced by “fine mode” and “coarse mode” through the whole draft in our new manuscript.

34) Line 198, “The results indicate that with the boundary of 280 nm, two opposite deviation tendencies exist.” should be replaced by “the results show that there exist two opposite deviation trends before and after the turning point around 280nm.”

Response: “The results indicate that with the boundary of 280 nm, two opposite deviation tendencies exist.” was replaced by “the results show that there exist two opposite deviation trends before and after the turning point around 280nm.” in our new manuscript.

35) Line 247, “The variations in on ...” should be “The variation of ...”

Response: “The variations in on ...” was changed into “The variation of ...” in our new manuscript.

36) Line 247, “all MACs in the look-up table in Fig. 1 are the mean values as the imaginary part and real part of BC RI varied over a wide range.” What’s the meaning of this sentence mean, please rewrite?

Response: This sentence was rewritten as “for a MAC (880 nm) point at (D_{particle} , D_{BC}) of Fig. 1, it is actually a mean value averaged with respect to both real part of RI varied from 1.5 to 2.0 and imaginary part of RI varied from 0.5 to 1.1.” in our new manuscript.

37) Please rewrite the whole paragraph between line 247~260 to make it clear and simple.

Response: the whole paragraph between line 247~260 was re written in our new manuscript to make it clear and simple.

38) Line 454 to line 459, please rewrite caption for Figure 3 and make it easy to read. The same for the caption of Figure 4.

Response: The captions for Fig. 3 and Fig. 4 were rewritten in our new manuscript to make it easy to read.

Peng, J. F., Hu, M., Guo, S., Du, Z. F., Zheng, J., Shang, D. J., Zamora, M. L., Zeng, L. M., Shao, M., Wu, Y. S., Zheng, J., Wang, Y., Glen, C. R., Collins, D. R., Molina, M. J., and Zhang, R. Y.: Markedly enhanced absorption and direct radiative forcing of black carbon under polluted urban environments, *Proceedings of the National Academy of Sciences of the United States of America*, 113, 4266-4271, 10.1073/pnas.1602310113, 2016.