

Interactive comment on “Optically effective complex refractive index of coated black carbon aerosols: from numerical aspects” by Xiaolin Zhang and Mao Mao

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This manuscript uses the multiple-sphere T-matrix method to evaluate the following effects on the refractive index of a mixture of black carbon with sulfate or with slightly absorbing aerosol. The effects are: shell/core geometry, BC position inside coating and size distribution. The obtained refractive indices are then compared to the ones calculated using simpler approximation such as the volume weighted averages or effective medium theory. The results shown are interesting and some of them are new. In one or two place the text would need to be clarified and some significant references are

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missing. I have tried to suggest to add these references where the reader would benefit from knowing the work that has been done before. With some clarification and minor changes, this manuscript is suitable to be published in ACP after these modifications have been reviewed. Here are my suggestions: Abstract lines 19-21 please simplify the following sentence that needs to be rewritten: “However, in accumulation mode, the coated BC optically effective ACRI is dominantly influenced by particle chemical compositions and shell/core ratio, although it shows slightly sensitive to BC geometry, BC position inside coating and particle size distribution.”

✓ We have revised accordingly. (Page 1, line 19-20: “However, in accumulation mode, the coated BC optically effective ACRI is dominantly influenced by particle chemical compositions and shell/core ratio.”)

Page 2 line 15: together with the reference to Shiraiwa et al 2010 you can add: Cui et al. 2016 and Peng et al 2016 (which is already in the ref. list)

✓ We have revised it accordingly. (Page 2, line 13)

Page 4 line 16: There is one ‘:’ too many in “ based on Sorensen. [2001].”

✓ We have revised accordingly. (Page 4, line 14: “The k_f of BC is assumed to be 1.2 based on Sorensen [2001].”)

Page 9, Section 3.2 When discussing the role of size distribution, you should mention the important work of Bond et al 2006 and in particular discuss your results in the light the Figure 4b of this paper, that will enrich this paragraph.

✓ We have mentioned this important work of Bond et al. [2006]. (Page 9, line 4-5: “As demonstrated in Bond et al. [2006], particle size distribution affects coated BC absorption properties and its BC absorption amplification due to weakly absorbing coatings.” Page 9, line 23-25: “This is consistent with the results of Bond et al. [2006], which suggest that the VWA for refractive index is unrealistic, leading to unphysical results and overestimating particle absorption.”)

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Page 9-10 Section 3.3 This is more than a standard sub-section, you propose here an approximation to correct for the erroneous values given by a simpler method such as Volume Weighted Average. You could indicate it in the sub-section title.

✓ We have revised accordingly. (Page 9, line 26: “3.3 A new assumed ACRI parameterization for heavily coated BC as a correction for the VWA approximation”)

Page 11, I recommend that line 31 you replace the acronym MSTM with multi-sphere T-matrix method.

✓ We have revised it accordingly. (Page 12, line 4)

Page 12 line 24 replace “are still relatively poor” with “still show poor agreement”

✓ We have revised accordingly. (Page 12, line 27).

Page 19 caption of Figure 3, please indicate that you mix BC with sulfate in the results of this Figure.

✓ We have revised accordingly. (Figure 3)

Figure 4: if these results are obtained with BC-sulfate mixing, please indicate it in the Fig. caption.

✓ We have revised it accordingly. (Figure 4)

Page 22, Figure 6. How do you results compare with the ones of Fig. 4b from Bond et al, JGR 2006?

✓ We thank the suggestion from the reviewer, and have read this famous paper carefully. The Fig. 4b of Bond et al. (JGR, 2006) depicts the absorption amplification of BC due to coating at different shell-core size regions, whereas the Fig. 6 of our manuscript shows retrieved optically effective ACRI at different size distributions and shell/core ratios. Nevertheless, we have mentioned this famous work of Bond et al. (JGR, 2006), and compared the VWA results for refractive index. (Page 9, line 4-5: “As demonstrated

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in Bond et al. [2006], particle size distribution affects coated BC absorption properties and its BC absorption amplification due to weakly absorbing coatings.” Page 9, line 23-25: “This is consistent with the results of Bond et al. [2006], which suggest that the VWA for refractive index is unrealistic, leading to unphysical results and overestimating particle absorption.”)

Page 23 Figure 7; please indicate that the parameterized method is described by Eqs 7 & 8 in your main text. References: 1. Cui X, et al. (2016) Radiative absorption enhancement from coatings on black carbon aerosols. *Sci Total Environ* 551-552:51–56. 2. Bond, T. C., G. Habib, and R. W. Bergstrom (2006), Limitations in the enhancement of visible light absorption due to mixing state, *J. Geophys. Res.*, 111, D20211, doi:10.1029/2006JD007315.

✓ We have modified it accordingly. (Figure 7)

Please also note the supplement to this comment:

<https://www.atmos-chem-phys-discuss.net/acp-2018-1279/acp-2018-1279-AC2-supplement.zip>

Interactive comment on *Atmos. Chem. Phys. Discuss.*, <https://doi.org/10.5194/acp-2018-1279>, 2019.

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