Review of "Numerical quantitation on the effect of coating materials on the mixing state retrieval accuracy of fractal black carbon based on single particle soot photometer"

General comments

In this study, the authors used closed-cell model (CCM) and coated-aggregate model (CAM) to retrieve three types of coatings, i.e., sulfate, non-absorbing OC and BrC on black carbon (BC) and investigate their potential impact on the optical properties of BC. It is good that the retrieval uncertainties are also quantified and discussed. The study underscored the importance to consider the coating material when measuring the mixing state of BC and estimating the absorption enhancement (Eab) and radiative forcing (RF). The potential contribution of this study is within the scope of AMT. However, the current version lacks some descriptions of important details and further discussions. It is behind publication quality. Therefore, I recommend that substantial revision needs to be done before considering publication.

Major comments:

Definitions of some terms, i.e., Dc, Dp, and mixing state, are not clear in the introduction which causes confusing at the very beginning. However, some of them are very well described in the method section. Please consider reorganizing.

The effect of complex morphology is not very well discussed. Although it is mentioned in the abstract, introduction and methodology, it is not emphasized in the results and discussions. Please consider reshape the manuscript accordingly.

The results section is like experiment report. This should be revised by adding logical linkage between different paragraphs, rather than only listing descriptions of the figures one by one. The authors should reshape this part.

A big concern is that some results are apparently affected by the leakage points; however, the author didn't give enough explanation for such missing data, which needs to be discussed, and an improvement should be considered and/or done. Would it be possible that some of the similar results between sulfate and OC coatings, and their difference from the BrC coating, mainly due to the amount of data points? If yes, this is technical issue which must be well addressed before discussing the scientific questions and drawing conclusions.

The authors used two models and showed the differences between them. As a technical paper, this is good but not enough. It would be necessary to discuss the similarities and differences between their results, and model limitations, respectively.

The conclusion part needs a rewrite after evaluating and/or resolving the issue of leakage points. In addition, the conclusion is not only repeating the results and summarizing the main findings but also discussing the main limitations and the importance of this study in the field of atmospheric science and /or broader field, and proposing future work if possible, etc.

Minor Comments:

Line 50: The definition of Dc is unclear here. Please revise. How does the Dp/Dc represent mixing state? Please explain it here. Please define the mixing state in this study. Otherwise, refer the readers to the method section.

Line 57 and 62: Please remove the full names of Dc and Dp but just keep the abbreviations. Please do it throughout the manuscript.

Line 63-65: The current descriptions for light and heavy coatings are unclear. Please add more.

Line 189: Define real and imaginary components of refractive index, and give references.

Line 202: Please give the reasons for that SP2 will lose data in the retrieval of the mixing state of BC with BrC coating.

Line 204-206: Remove the figure caption, which should only be shown with the corresponding figure. Please do it for all the figure and table captions embedded in the main text.

Line 212: This statement is not accurate: not all the retravel results of BrC coating are obviously different from the other two coatings. Only 1/3 of the results, i.e., Fig 2 e) and f) show the obvious difference, which is huge and interesting. Please revise and give the explanation.

Fig 1: c) and d) why there are some data gaps, especially for Df=2.6? What are the differences between light and heavy coatings? d) Change Y scale to keep consistency with the other three.

Fig 2: Keep consistency of Y and X scales; change color codes to better distinguish sulfate and BrC.

Fig 3: Keep consistency of Y and X scales; It is hard to compare Fig 2 and 3 due to the criteria chosen for showing the results. Please try to keep consistency and if it cannot be maintained, please explain the reasons and/or limitations.

Fig 6: The legend is the same as Fig 5 rather than Fig 4. Please revise.