## RESPONSE LETTER (EGUSPHERE-2024-1000)

Title: Retrieval of refractive index and water content for the coating materials of aged black carbon aerosol based on optical properties: a theoretical analysis

Dear Referee:

We have revised our manuscript based on your comments. The corrections and modifications have been included in the revised manuscript and the details are listed as follows. The responses are highlighted in blue font. The changes made in the revised manuscript are marked in red font.

Comments:

This study aims to compute the optical properties of morphologically realistic soot--water mixtures. The authors have done a nice job of summarizing the results of MSTM calculations. The modeled particles represent 3 different morphologies: pure soot, partly coated, and fully encapsulated. (These are termed CCM, PCM, and CAM). I would like to suggest that the authors modify their PCM to represent partial compaction.

Multiple studies have observed that partial compaction occurs for partially coated soot. These studies have recently been reviewed in Corbin, Modini, and Gysel (https:/ /doi.org/10.1080/02786826.2022.2137385) and in Sipkens and Corbin (https:./doi.org/10. 1016/i.carbon.2024.1 19197). The former study describes the physics of this restructuri ng and the latter study quantifies the relationship of coating to compaction. l recomm end that the authors modify their PCM model to reflect the fact that almost all labor atory and field studies have observed that partly coated soot is partly collapsed.

Response:

Thank you for your attention to our article and all these constructive comments. The compaction of soot is primarily influenced by internal mixing mechanisms such as condensation and evaporation processes. The degree of partial compaction can be assessed by considering the number of primary particles, effective density, and changes in coating volume. Soot will be partially compacted before being completely encapsulated. Regardless of the coating material, soot aggregates generally become fully compacted following a 5-fold increase in volume (Corbin et al., 2023; Sipkens and Corbin, 2024). Soot-aggregate restructuring may occur when individual particles change from a smaller fractal dimension to a larger one due to surface tension. It can also involve different particles experiencing collision or restructuring, or be influenced by the coating material, where some primary soot particles are entered into the coating during the compaction process. In addition, the higher fractal dimensions of partially-coated models in this paper can lead to compaction to a certain extent. The relationship of coating to compaction may be more complex in real atmospheric environments. More observations and additional modeling focused on restructuring under different coating components are needed. We have added the necessary changes in the manuscript:

"and hydrophobic BC aerosol becomes hydrophilic. Zhang et al. (2023) studied the collapse of particle soot structure and changes in coating composition during long-distance transport. The results showed that when the relative humidity (RH) is between 60% and 90%, it is conducive to forming secondary aerosol coatings on soot particles and facilitates the transition of soot from a partially coated state to an embedded state. Soot-aggregate restructuring is a complex phenomenon influenced by various factors, including the physical and chemical properties of the coating materials and the environmental conditions to which the soot is exposed. Soot compaction is mainly influenced by internal mixing mechanisms. Soot is partially compacted before full coating and typically becomes fully compacted after a fivefold increase in volume, regardless of the coating material (Corbin et al., 2023; Sipkens and Corbin, 2024)."

Furthermore, other detailed revisions are listed below.

| **LOCATION** | **REVISED MANUSCRIPT** | **ORIGINAL MANUSCRIPT** |
|---|---|---|
| Abstract | performs best | has the best performance |
| Introduction paragraph 2 | increased slowly | increase slowly |

| | | |
|---|---|---|
| Introduction paragraph 3 | cross-sections | cross sections |
| Section 3.1, paragraph 1 | Figure 2 | Fig. 2. |
| Section 3.1, paragraph 2 | decrease | decreases |
| Section 3.3, paragraph 1 | Figure 8 | Fig. 8. |
| | Figure 9 | Fig. 9. |

## References


Corbin, J. C., Modini, R. L., and Gysel-Beer, M.: Mechanisms of soot-aggregate restructuring and compaction, Aerosol Sci. Technol., 57, 89-111, doi: 10.1080/02786826.2022.2137385, 2023.

Sipkens, T. A. and Corbin, J. C.: Effective density and packing of compacted soot aggregates, Carbon, 226, 10, doi: 10.1016/j.carbon.2024.119197, 2024.

Zhang, J., Li, W. J., Wang, Y. Y., Teng, X. M., Zhang, Y. X., Xu, L., Yuan, Q., Wu, G. F., Niu, H. Y., and Shao, L. Y.: Structural Collapse and Coating Composition Changes of Soot Particles During Long-Range Transport, J. Geophys. Res.-Atmos., 128, 13, doi: 10.1029/2023jd038871, 2023.