Responses to Referee's Comments

We appreciate careful reading and lots of valuable comments. We wrote referee's comments in black, our responses to comments in blue and italics, and the revised manuscript in green.

Anonymous Referee #2:

Single scattering albedo (SSA) is an important parameter for the aerosol radiative forcing calculations. However, previous studies have not paid much attention to it. Jo et al. 2017 manuscript has tested the sensitivities of SSA to the black carbon (BC) physical properties, the aerosol mixing state, the inclusion of brown carbon (BrC), and the dust size distribution. It concludes some interesting points on the relative roles of these factors on the SSA. Overall, this manuscript reads well and will add some merits to the aerosol community.

Major comments.

The paper concludes that "the external mixing assumption showed better performance than the model using internal mixing assumptions". I didn't see the evidence. At least from the Figure 6, while the model with the external mixing assumption underestimated the observed SSA, the model with the internal mixing assumption over-predicted the observed SSA. In addition, many studies have shown the BC aerosols in the real atmosphere are indeed internally mixed with organic aerosol and/or sulfate aerosol. Therefore the internal mixing assumption is physically more realistic than the external mixing assumption.

➔ ***Thank you so much for careful reading and valuable comments. We agreed with the reviewer's comment. In the real atmosphere, there is a good chance that aged BC particles are internally mixed with other aerosols. However, we think that the model with external mixing assumption shows better performance than that with internal mixing assumption in terms of global SSAs. Although the external mixing assumption underestimated them, it showed higher correlation (0.53) than the internal mixing assumption (0.14). Furthermore, the internal mixing assumption significantly underestimated SSA at 870 nm, but the external mixing did not. We surmise that Mie theory with internal mixing assumption could overestimate BC absorption enhancements by internal mixing in the real atmosphere as reported by Cappa et al. (2012). On the other hand, there could be a possibility that external mixing is dominant state in a global sense. recent measurement studies reported the dominant external mixing state in near-roads (Saha et al., 2018, ACP) or rural forested location (Bondy et al., 2018, ACPD).***

Cappa, C. D., Onasch, T. B., Massoli, P., Worsnop, D. R., Bates, T. S., Cross, E. S., Davidovits, P., Hakala, J., Hayden, K. L. and Jobson, B. T.: Radiative absorption enhancements due to

the mixing state of atmospheric black carbon, Science (80-.)., 337(6098), 1078–1081, 2012.

Saha, P. K., Khlystov, A., and Grieshop, A. P.: Downwind evolution of the volatility and mixing state of near-road aerosols near a US interstate highway, Atmos. Chem. Phys., 18, 2139-2154, https://doi.org/10.5194/acp-18-2139-2018, 2018.

Bondy, A. L., Bonanno, D., Moffet, R. C., Wang, B., Laskin, A., and Ault, A. P.: Diverse Chemical Mixing States of Aerosol Particles in the Southeastern United States, Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2017-1222, in review, 2018.

This study conducted many cases (over 10, for example, see the table 5), which results in many acronyms. This makes it confusing to read the paper. So I suggest making an extra table (like table 3) to explain the names of these cases.

➔ We added the Table A1 in the appendix section for the case description as follows.

Cases	Description
GEOS_E	BC input parameters from GEOS case, external mixing assumption
OP_E	BC input parameters from OP case, external mixing assumption
BB_E	BC input parameters from BB case, external mixing assumption
BBR_E	BC input parameters from BBR case, external mixing assumption
BBHR_E	BC input parameters from BBHR case, external mixing assumption
GEOS_H	BC input parameters from GEOS case, homogeneous internal mixing assumption
GEOS_C	BC input parameters from GEOS case, core-shell internal mixing assumption
OP_H	BC input parameters from OP case, homogeneous internal mixing assumption
OP_C	BC input parameters from OP, case homogeneous internal mixing assumption
GEOS_BR_E	BC input parameters from GEOS case, external mixing assumption, brown carbon
GEOS_DI_E	BC input parameters from GEOS case, external mixing assumption, dust size distribution from Zhang et al. (2013)
GEOS_BR_DI_E	BC input parameters from GEOS case, external mixing assumption, brown carbon, dust size distribution from Zhang et al. (2013)
BB_BR_DI_E	BC input parameters from BB case, external mixing assumption, brown carbon, dust size distribution from Zhang et al. (2013)
BBR_BR_DI_E	BC input parameters from BBR case, external mixing assumption, brown carbon, dust size distribution from Zhang et al. (2013)
BBHR_BR_DI_E	BC input parameters from BBHR case, external mixing assumption, brown carbon, dust size distribution from Zhang et al. (2013)

Minor comments

Page 6, line 19. Can the authors briefly explain how they calculated the BrC/OC ratio here so that the readers would have a basic idea without reading the reference?

➔ *We added the text as follows*

They calculated the BrC/OC ratio from biomass burning and biofuel emissions using the relationship of absorption Angstrom exponent and modified combustion efficiency and from aged aromatic SOA.

Page 9, line 9. Can the authors give a reference for choosing 0.012 micrometer here?

➔ ***0.012 micrometer is adopted from OPAC (Hess et al., 1998). We added the reference in the text.***

Page 10, line 7. Please change "between" to "of". And also change that on the line below.

➔ ***We changed the text.***

Page 15, line 10. The value of 0.949 is the mean value?

➔ ***Yes, it indicates the mean value. We added the text as follows.***

The mean SSA of the model (0.949) was higher than that of the AERONET (0.897) by 0.052.

Page 16, line 15. This line reads odd. I don't follow that.

➔ ***We changed the text as follows.***

The calculated AODs were decreased by 34 – 37% when we used internal mixing rather than external mixing assumptions. The main reason was the decrease of the aerosol numbers with the increased size of each aerosol, which was consistent with previously published results by Curci et al. (2015).

Page 17, line 20-21. This sentence reads odd too.

➔ ***We changed the text as follows.***

The 870 nm SSA decreased by 0.017 when we used the higher refractive index (BB_BR_DI_E), the absolute magnitude of which is larger than the 440 nm SSA decrease of -0.011 (Table 6).