

General comments:

This paper analyses the effect of the simplified hypothesis underlying the SP2 data processing used to determine the mixing state of black carbon. In particular, the authors tested the impact of using different coating materials with different refractive indices (sulphates, organic carbon and brown carbon) and of giving the coated BC particles different shapes (ranging from more fractal-like to a core-shell model) on the mixing state. The mixing state is defined as the diameter ratio between the BC core and the whole BC particle, and is calculated from SP2 measurements using the usual retrieval method. This method uses Mie theory and assumes a core-shell morphology and a fixed refractive index. The authors identified biases resulting from these simplifications, particularly for thinly coated BC. BC coated with BrC also exhibited higher inaccuracies due to its absorbing properties. The authors further investigated subsequent errors in radiative forcing and absorption enhancement. Since the SP2 is the only online instrument that can measure the coating thickness of BC-containing particles at a particle-by-particle level, the methodology to process its mixing state data is crucial for interpreting the results. This study provides valuable insights into errors in the BC mixing state resulting from core-shell and fixed refractive index assumptions. Furthermore, the results suggest that a more accurate characterisation of BC optical and radiative properties would be achieved by considering more complex morphologies and variable refractive indices. The tests and experiments conducted in this study are robust and well described. However, the good scientific quality of the paper is still suffering from a significant number of grammatical errors. Some of them are listed below. I would strongly recommend that the authors carefully review the entire manuscript in terms of English writing, before publication.

Specific comments:

L 14. I would add particles : coated black carbon particles (BC)

L 14. "optical properties"

L 16. "the coating material"

L 16 "diverse"

L 21. "are used to study optical properties..."

L 27 "be up to 6.15 times higher than"

L 33-34 This sentence is not clear since human = anthropogenic. Please reformulate.

L 36 "optical absorption properties"

L 39 "BC particles are usually"

L 40 "BC particles can be coated by various"

L 42: "through condensation and coagulation"

L 47 "one of the most effective online instrument that can measure"

L 57 It would be useful to precise that the change in the Gaussian pattern is due to the different refractive indices between the coating and the core.

L 58 : Please provide references for the refractive indices mentioned here.

I.59 : I would start a new sentence from the word “since” to add clarity.

I.60 “by assuming spherical particles and using BC density ...”

I.64 “into bare-to-thinly coated”

I. 69 The work package is a bit weird here, please reformulate

I 74. “sulfate or organics”

I. 79 “the measurements of the SP2 are usually...”

I. 83 “ are built to represent”

I. 84 “can be classified using the lag time”

I. 100” is the gyration radius”

I. 100 formatting of the ith

I. 109 Please don’t start a sentence with “and”

I. 112 “are built” . That would be nice to add a schematic of the typical shapes of these two different models.

I. 135 “For the quantification”

Formula 6 : Please define what is X^2 . More generally, it would be better to introduce each before its corresponding definition (equations 9, 10, 11,12,13), as the authors did for i.e. equation 7.

L 150-151 This sentence is not grammatically correct, or something is missing maybe ?

L 152 “the precision in the estimated typical optical”

I. 163-164 Keep the same structure, either first variable and then definition as the beginning of the sentence or the other way around

I. 176 “the variation of complex refractive”

I. 178-180 The sentence starting with “while” is not grammatically correct.

I. 184-187 The sentence starting with “as can be” is not grammatically correct.

I.189 “more compact and the retrieval”

I. 189 “BC volume fraction due to a smaller amount”

I. 192 “SP2 has a better performance”

I.193 . This sentence is not clear to me. Please reformulate.

I. 198 “from about 200 to 400 nm, as shown by Liu et al.”

I.201 “missing data points of retrieved”

I.202-203 Not only that but it will also lead to a bias toward size ranges of coated BC that the SP2 is able to characterize when considering the ensemble of BC particle.

Figure 1 : This is good to include a schematic to show the corresponding morphologies of BC but I don't really understand what values of D_c/D_p and $D_{c,v}$ each of the representation refers to. Maybe move the images more to the corners, ie. Maximum value of D_c/D_p ?

Figure 3 : The $D_{p,v}/D_{c,v}$ in vertical on the right hand side is a bit difficult to understand. Maybe move to the left, add a space between it and the y-label, and increase the font? Same for the column titles, increase font and space between title and figures

Figure 4 : Describe what is the dashed line on the violins

Caption of Figure 5 : "...and the corresponding core-shell model, , represented for different values of $D_{p,v}/D_{c,v}$."

Caption of Figure 6: Same as previous comment

I. 207 "to the coating components, thus the"

I. 211 move the "compared with the BC refractive index" to the end of the sentence

I. 212 "on the other hand, when the soot"

I. 215 Do you mean Cappa study, by "this study" ? Then citation needs to be done properly : Cappa et al found ...

I. 215 : The sentence starting with "The enlargement" is not clear to me. Please reformulate.

I. 220 This was already said I193, so maybe change to " that confirms..."

I. 230 "between sulfate and OC could explain their similar D_p/D_c "

I. 231 : If "could" is used for the first part of the sentence, then one would use "may have caused" or so

I. 240 A higher accuracy than for other coating materials ?

I. 242 "The coupling effect [...] would lose" : not grammatically correct. Would lead to ...

I. 247 "Three distinct regions coloured in"

I. 248-250 : It would be nice to put that in the Figure caption

I. 254-256 : If last part of tge sentence refers to the distribution width , to which characteristic of the distribution is the beginning about ?

I. 273 : Don't start a sentence by "And"

I. 279 : "by the higher number of missed data points"

I. 283 : Maybe introduce the lensing effect earlier when the authors first mention it.

I. 295-296. I am not sure to really understand this sentence.

I. 304 " E_{ab} values"

I. 306 "about 6.14 times larger than " ?

I. 321 : Don't start a sentence by "And"

I. 322 : It seems to me that Compact and fractal don't match together

l.357 : “overestimated or underestimated”

l.366 : “B C” remove space

l. 371 : Maybe introduce which coating material have been tested before using “these three components”

l. 373 : Is there a reason to use “As” in this sentence ?

l. 377 : “thickly coated by BrC are more numerous” maybe ?

l. 381 : Please introduce RE in the beginning of the sentence

l. 377 : Need to precise that E_{ab} was studied as a function of the diameter D_c to understand the "at first", and the numbers that were cited in this sentence.

l.396 : “The oversimplification [...] is inappropriate” This part of the sentence is not very clear, could you reformulate please ?