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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Light absorption properties of aerosols over Southern West Africa" *by* Cyrielle Denjean et al.

Anonymous Referee #2

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This paper describes the aerosol physical and optical properties observed during the DACCIWA campaign. The paper is based on in-situ measurements performed a-board the ATR-42. The paper is well written and the topic fits the ACP's scope. However, I have many remarks and some needs to be taken into account before this paper could be published in ACP.

Major comments

1. The title of this manuscript. I believe the title refers to the BB aerosols that were observed with really low SSA in comparison to all previous results. However, this part is described only on the 23th page. I would strongly recommend changing it to "aerosol optical properties overview during the DACCIWA campaign" or something similar.

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2. First major comments about the Mie code used for this study. So you stated few lines (P8 L237-245) about how you used the Mie code to retrieve the refractive index of aerosols (reverse method) based on their physical and optical properties. First of all you are using a Mie code for dust and BB aerosols. In fact you measure the asymmetry factor (which is not that good with the TSI nephelometer) and found out that the particles are far from spherical. You never stated the possible issues with it. Then you never say a word for the mixing state you used. I found a word about it later when you say that the mixing was external which was consistent with previous observations. Have you tested the case with internal mixing (either core shell or just coating) ? Moreover, what is the acceptable difference between measurements and calculation to stop the iterative process (5%, 10% more ???)? Is it just iterative process with an a priori k and n or it an optimal estimation method that will avoid any local minimum? Later on (P20-21, L548-556), you used the Mie code again but this time I believe not in a reverse mode. So you entered a k and n along with the size distribution and you get optical properties that you used to calculate a SSA. Which k and did you used? In Africa, there are many sources of dust and BB aerosols associated with many different k and n . . . How these calculations made with a Mie code, for spherical particles, prove that your aerosols are externally mixed ? You need here to prove it with a spheroidal code, for different mixing state.

3. Number concentration of coarse particles. The authors are showing number concentrations of particles from 1-5um. These concentrations are measured from the OPC-GRIMM. The concentrations are between 0 and 2.5 cm-3. Could you provide the reader the noise of this instrument regarding these large particles. Is it significant ?

4. During the field campaign, the ATR-42 performed vertical profiles at the beginning of each flight. These are used in Figure 3. On Figure 1, you highlighted the BB, dust and pollution plumes. How far are the vertical profiles from the plume observed ? I wonder how the variability of the vertical profile average is due to the distance to the actual plume. I had to wait until Figure 6 (P21) to have information about altitudes

at which you observed the different plumes. At P14 L366-370, P15 L398-399, you are showing that aerosols, within a layer located below 2.5km, are a efficiently mixed with anthropogenic emissions. Then on Figure 6 you are trying to interpret the optical variations throughout the vertical profile. From my understanding, if you are interested in “pure” BB or Dust particles than you should only show/interpret vertical profiles from 2.5km up to 4km.

Minor remarks

Page 2 L37 : I think something is missing to introduce properly the BB aerosols or just to skip a line here.

Page 2 L68 : It’s usually called MEE that stands for Mass Extinction Efficiency and its units is m2/g not g/cm3. In the table2’s caption you even called it extinction mass efficiency. Please be consistent throughout the manuscript. By the way how did you measure the mass concentration of aerosols ? Did you assume a density for each type ? And did you assume the same density for each mode ?

P3 L73-75 : Why do you introduce remote sensing data that you will never ever talk again ?

P3 L112 remove the ‘s’ at aerosol

P 5 When DACCIWA took place (month, year) ? What season was it (apparently during the monsoon period)?

P6 L 176 : the CPC MARIE model needs to be described here. There is no paper associated with this instrument and I was unable to find any specifications on internet. Is it working with a flow regulator or a critical orifice? How is it counting in comparison to any TSI CPC ? You used the CPC measurements to infer the Nfine but you never say anything about a comparison, in term of number concentration, with the OPC, UHSAS or the SMPS. As this instrument is not (yet?) considered as a reference, you cannot use it like a reference. You could use the calibration data for the size distribution (PSL

and oil) to prove that this instrument was measuring the same number concentrations than the OPC.

P6 L 187 Replace 525 by 550nm.

P10 section 2.3.2 : A figure showing the AAE versus the SAE would have been appreciated here.

P10 L282 : remove the 's' at the end of theses

P11 L 301 : I believe that the background is also without the detectable influence of Dust and BB as well as anthropogenic emissions.

P13 L334 : The AEJ is a synoptic flow. It is always present over West Africa at a specific location (between 10-20°N between 2-6km). The ATR flew between 3-11°N. Therefore, I don't see how you would have been able to observe it and why you would have been able to observe it for specific cases and not for the others.

P13 L 335 : there are two dots after Sahel.

P13 L356-357 : According to the Nfine vertical profile, the BB plume is observed from 2.5 – 4km. Your sentence isn't clear for me. Is this between the surface up to 4km or as suggested by the Nfine vertical profile ?

Figure 4 : I think you could do something in this figure to show the altitude of each SLR. You never mentioned that the different lines in Figure 4b were associated to all the plumes observed. Maybe the line width of each line could be coded as a function of the altitude? Obviously for dust plume one SD is significantly different from the others. Why ?

P15 L 388 : remove 'the' in front of plumes

P15 L 392-393 : This is impossible to see that on Figure 4. We could see something on Figure 4b but it could also be result of the CO concentration. . .

P15 L 395 – 396 : We must trust you about the fact that the smaller particles are observed within the lower dust plume. . .

P 15 L 401-406: Again you stated that below 2.5 km all the aerosol are mixed. You observed 3 dust plumes below 3km. I assume that these three samples where associated with the small particles. The BB plumes where observed above ∼2.2km. I'm not convinced that the location has anything to do but mainly the altitude. . . Most of the BB plumes have been observed close to big cities (Abidjan, Accra, Lome).

P15 L417-419 : The accumulation mode exceeds the amount of large particle. What is "large particle" here ? As there are no information about the mode the authors are referring to, it's hard to fallow. There is probably a need for a table that describe all the modes observed for each aerosol type. Anyway, is that surprising in number concentration?

P16 L 423. In this part you are talking about a phenomenon observed by colleagues during two specific days. Do they observe it during other days ? Could it happen during other days ? As you are not explaining the general mechanism there is no way for us to infer if this could have happen during the whole campaign. So when did you observed all plumes ? Was it during these specific days ? If not how do you know that this is always the case between the surface and 2.5km ?

P16 L430 : So the same dusty mode was observed during several campaigns over West Africa. From this observation you conclude that dust does not efficiently mix with other particles. Could you please explain ?

P16 L435 : Then, within the anthropogenic pollution plumes you observed a coarse mode. As the sites are nearby the coast you assume that it could be sea salt. Do you have any evidence for that? Could it be dust or road dust or pollens or any other large particles ???

P17 L458 : The strongest spectral dependence of SSA is observed for the lowest

absorption plume. Well from the Figure 5b this is not the case. Indeed, the largest SSA values for the BB aerosol at 440nm (Around 0.78) show a quite strong SSA at 660nm (around 0.74) and therefore quite a low spectral dependencies. The largest spectral depend are observed for both 'middle' SSA values at 440nm. Could you then remove the part right after that suggest similar results with the literature that are no more consistent with your results?

P18 L477 : I found it really odd for you to compare small SSA spectral dependencies observed over African cities using in-situ measurements with literature using AERONET measurements or even with plumes observed over European cities. The principle (column integrated versus in situ) of measurements as well as the pollutants (European polluted plumes are clearly different from African polluted plumes) have to be a bit similar to gain information. In this case arguing that what you observed is entirely different from these studies is not convincing.

P18 L 481 : During the NAMMA campaign, Omar et al. compare the extinction coefficients from the LIDAR and from the in situ measurements (assuming a dust LIDAR ratio). They found that the extinction was really close and then that no large aerosol was lost within the inlet. I'm sure you could do something similar here to estimate the losses for all cases.

P18 L484 : 'measurements are comparable to each other'. So I'd like to disagree with you. It depends on the event right ? Some events will be associated with uplifting of large particles and therefore the inlet cut off may play a major role OR some events could also be associated with uplifting of smaller particles and then the inlet cut-off won't be an issue anymore.

P19 clarify MEE versus MEC vs extinction mass efficiency vs extinction mass coefficient!

P19 : Another Mie test... So now you used a Mie code to estimate the impact of each aerosol mode ? Could you please explain what you did and how you did it ?

Âń We found MEC to be positively correlated with SAE (not shown) with measurement wavelengths (450–660 nm), which agrees with Mie theory. Âż Again, I don't understand the sentence. Are you talking about measured MEE vs measured SAE having the same Âń correlation Âż than the calculated one ? What about a straight comparison of SAE/MEE calculated and observed ? And how this Âń correlation Âż is relevant for your analysis ?

P19 L 509-511 : So the total and back-scattering coefficients have an error associated with the measurement principle. Did you correct the data fallowing Anderson and Ogren recommendations? What are the error associated with the measurements and then with the g calculation? Moreover, the g is also affected by the morphology of the particle.

P20 : Is this part 4 based on single SLR analysis ?

P20 L530 – 532 : On figure 6c there are no dots below 1500m and I cannot sea the NOx decrease that you are talking about.

P20 L 532 : You qualify it as a strong SSA variation (0.8 to 0.95) but since page 15 you told us that below 2.5km all the layers are mixed together. From the number concentration profile there are almost no dust at that altitude (below 1cm-3).

P21 L564 : Âń Figure 6 indicates markedly different processes affecting optical properties of biomass burning aerosols. Âż Which processes are highlighted by this figure ? To me, all BB profiles on Figure 6 are notably stable.

P21 L569 : Âń remote location Âż . Please define it. For me the anthropogenic plumes were also observed in remote location, don't you think ?

P21 L564 to P22 L 578 : I don't really understand the need for this paragraph. There are no new information and we also have to wait for further explanations.

P22 L589 – 591 Âń We did not find any correlation between the values of SSA and their spectral dependence, which suggests that the variability in SSA cannot be attributed

to different contributions of marine aerosol in pollution plumes. Âż So I'm not sure I do understand this statement. A correlation between SSA values and their spectral dependency is evidence that SS are not contributing much?

P22 L595 – 597 "The high absorbing properties (SSA∼0.81 at 550nm) of background aerosols is consistent with being a mixture of aged biomass burning and Atlantic marine aerosol. Âż Please explain.

And Âń Moreover SSA of background aerosol was lower than previously reported over the Southern Atlantic (Ascension Island) outside the fire season in Central Africa (Zuidem al., 2018), which supports this conclusion. Âż Now I'm missing something. You are comparing measurements performed over a small island, far from any anthropogenic sources or any natural sources of absorbing particles, to your results and found that aerosols you observed are more absorbing. Is that surprising at all ? Does that prove that you observed BB aerosols or rather anthropogenic aerosols ?

P22 L207 : A variation of SAE could be due to a size shift if you know that chemical composition, mixing state and morphology are similar. In this case you don't show any chemical results but you have the SD. Why using SAE to highlight the size variation ?

P23 L 611-613 Could you be more precise with the reference you cited ? Where were this studies perform and what were the particle diameter at the formation and after few hours ?

P23 L622 : Âń by the variability in composition of biomass burning aerosol Âż Please add a ref that prove that k is only linked with the aerosol chemical composition. Could you also show the spectral dependency of k ?

P25 L699 : You need to prove using chemical composition data that BB were not affected by the mixing with anthropogenic emissions (at least for the lowest SLR).

P26 L717 : You never show the background SSA spectral dependency.

P26 L 721 : Âń The large proportion of aerosols emitted from cities that resided in the

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ultrafine mode particles" Are you talking about African Cities or any city in general ? Do you have a reference? From your observations, you always have the background aerosol mixed with the city plume, right ? So you cannot tell what is coming from cities and what is coming from the background, right ? Or you made a difference between both SD ?

The appendixes need to be called in the main text.

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