

Interactive comment on “Coarse mode mineral dust size distributions, composition and optical properties from AER-D aircraft measurements over the Tropical Eastern Atlantic” by Claire L. Ryder et al.

Anonymous Referee #2

Received and published: 4 September 2018

Ryder et al. discuss airborne measurements of Saharan dust performed between Cabo Verde and the Canary Islands in August 2015 with focus on several aspects of the dust, for example the coarse mode size distribution. I think the paper is interesting and fits well into the scope of ACP. Overall, the paper is in a useful shape but there are many, mainly minor, things the authors should improve before the paper is ready for final publication.

[In the following, e.g. page 6 and line 44 is referred to as p6l44.]

C1

General comments:

Abstract: Maybe one sentence with results for the MBL could be added.

On p3l6 you define coarse and giant mode dust. However you do not follow this definition, e.g. at p7l15, p9l32, p12l27, p25l25. Please make sure that the paper is self-consistent.

Often the citation type, e.g. '(Ryder et al., 2013)' vs. 'Ryder et al. (2013)', is not correct.

You did not define the flight legs. At p11l5 you mention 'R2' for the first time, but you did not introduce this properly. In Fig. 4 an undefined 'P2' etc appears, probably also referring to flight legs. I suggest to add a proper introduction of the nomenclature and to add a table (maybe in the supplement) with more details about the flight legs considered in the paper (e.g. name of leg, start time, end time, duration, height, etc.).

You write SSA in the text but use $\omega_{0.550}$ in the figures. Please use only one of these.

Sometimes for the imaginary part values a 'i' was added after the value, sometimes not. This should be made consistent, preferably removing 'i' everywhere because the 'imaginary part' is a real value; see also your definition at p8l18.

Often, the main text refers to the wrong table number.

Specific comments:

p1l24: In my view 'during' should be replaced by 'at'.

p1l28: 'constituting up to 40% of dust mass': As you mention this number in the abstract, it should also be mentioned in Sect. 3.3.

p2l3f.: It is unclear what 'this complex evolution' refers to. Suggestion: '... to capture correctly both the dust composition and the size distribution including their changes during transport in order ...'

C2

p3l27: 'preceeding the AER-D flights' comes a bit surprisingly. Please reformulate without referring to AER-D which is introduced only later.

p3l33: I think 'however' could be removed here.

p4l1: 'Mie theory conversion': it is not very clear what is meant. Please reformulate.

p5l7f.: 'The dust events sampled 550 nm AODs from 0.4 to 0.8' should be reformulated.

p5l19: 'aerosol structure' is a bit unclear. You probably mean the vertical distribution (structure) of the aerosol.

p5l20: 'nearer the ...' could be replaced by 'closer to the'.

p5l26: 'Figure 1b' does not exist.

p5l28: 'flight' could be added before b920 and b924.

p7l3: The wavelength list may be a bit confusing. Maybe you can just write the wavelengths in parentheses after the instruments?

p7l25: 'aerosol' should be replaced by 'particle' to make the sentence more general. Particles with 6.2mm are usually not aerosol particles but much more likely some kind of hydrometeors.

p8l18: PCASP and CDP do not operate at 550nm. This should be mentioned here including your assumption that the refractive index does not change between 550 nm and the instrument's wavelengths.

p8l28: You could write ' ... in two different ways, resulting in different sizing metrics.' This would help the readers in the subsequent paragraph.

p9l3f.: Were the particles rotated such that one dimension is minimized and the other maximized? Or were x and y measured for each imaged particle without such rotation?

p9l6: '... though diameters will be lower than an area-equivalent diameter for example, if the particle is an ellipse.' looks wrong. For example, assume $x=1$ and $y=2$. Then

C3

$D_{XY}=(x+y)/2=1.5$. The area-equivalent diameter however is $D_{area}=(1*2)^{0.5}=1.414$ which is smaller than 1.5. This could be a reason why also the mean XY method somewhat overestimates the 'real' particle size.

p9l8: I wonder if there is a reason why you don't use the mean XY method (instead of the CC method) for the CIP15 in this discussion paper?

p9l12: Which flight leg length do these 10^{-5} cm^{-3} correspond to, approximately?

p9l20: It is unclear what '... errors due to bin size from ...' means. Please reformulate this sentence.

p9l28f.: 'as expected when the particles are non-spherical (section 3.2)' could be replaced by 'as excepted for dust'.

p10l9f.: This looks quite similar to p9l10ff. Maybe you could bring both together or at least refer here to the previous text (e.g. 'Therefore, we remove, as mentioned, cases where fewer ...').

p10l17: 'of around 0.2 to 1 μm ' should be replaced by 'smaller than 2-3 μm ' when considering Fig S1.

p11l5: 'R2', 'R5' are not defined.

p11l15: The areas of the ellipses were larger than the areas of the particle 2D projections because you used circumscribed ellipses. How large is this difference? Why didn't you use the area of the projection itself to determine the area-equivalent diameter?

p12l29: Shouldn't '0.0001' be replaced by '0.0005'? Otherwise I don't understand this description.

p13l1: 'Figure 8b' shows something else.

p13l9: 'between 0.0015i to 0.0025i' doesn't fit to the mode value of 0.001.

C4

p13l11: Why do you use 'volume fraction' here and 'number fraction' for the external mixing case (p13l30)? How big is the difference between both cases?

p15l16: I suggest to briefly discuss the difference from Marenco et al., who find maximum AODs of 2.0.

p15l28: 'each flight leg': As Fig. 5 shows only a single leg inside the SAL for each flight I assume that there was only one flight leg in the SAL for each flight? However, then Fig. 2 and 5 seem to not fit to each other as mentioned in a separate point below. In general, the legs should be described better.

p15l33: I do not really understand this sentence. Would the absence or presence of the coarse mode not always have an effect on the overall shape of the size distribution?

p16l1: 'peak volume concentration' is unclear. I suggest to write 'The peak of the volume distribution during ...'.

p16l8f: 'Figure 5b; green, orange and red'

p17l3: ' may be aligned horizontally in the atmosphere ... ': I suggest to add here a reference to Ulanowski et al. (2007), DOI:10.5194/acp-7-6161-2007, who made some simulations on this topic (see e.g. Fig. 9 of that paper).

p18l10: How does 'Particles sized over 20 μm diameter were detected in 100%' fit to Fig. 8b which shows that there are cases with $D_{\text{max}}=20\mu\text{m}$?

p18l14: 'Figure 8c' does not exist.

p19l4: particles

p19l10: 4643 has probably too many significant digits. I suggest 'around 4600'.

p19l12: 'decreases' is maybe the wrong word here. I suggest 'is lower'.

p19l15: 'PM2.5' is not defined. As it is used nowhere else, I suggest to just write 'the accumulation mode'.

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p20l16: 'as they only include iron when detectable as single-iron particles': As far as I understand this sentence, 'they' should be replaced by 'we' and 'detectable as single-iron particles' by something like 'iron was the dominant component of a particle'.

p22l17: There is one 'is' too much.

p22l28: 'coarse mode present' could be replaced by 'coarse particles'.

p22l29: 'so' could be removed.

p23l1f: The sentence could be improved by removing 'same' and adding 'also' after 'mode'.

p23l4: 'as dominate' is unclear.

p23l7: 'RI' is not defined.

p23l10: Suggestion: 'The variability of the optical properties of dust in the SAL is probably mainly determined by ...'.

p23l14: 'the variability of the' should be inserted before 'optical'.

p23l26: I suggest to write 'the variation of the SSA as function of composition, represented by k_{550} ', because this order is more logical and also better fits to Fig. 13 considering that the vertical axis usually shows the dependent variable ($y=f(x)$).

p24l1: 'optical property' could be replaced by 'SSA' to be more specific.

p24l13ff: It is not clear how this fits to p13l29f where you write that you use the same size distribution (only number-weighted) for all components. In addition, you could consider a size dependency not only in case of external mixtures but also in case of internal mixtures.

p24l21: 'In contrast to Fennec observations of the full PSD and associated optical properties over the Sahara,' could be removed. Maybe the information about the location could be added somewhere on line 22.

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p24l30: I suggest to delete 'during August 2015' and to add instead a new sentence like 'The flights were performed in August 2015 between Cape Verde and the Canary Islands.'

p25l7: 'to be' could be removed.

p25l14: 'Deff for the SAL the mean (minimum, maximum) was' should be reformulated.

p25l26: 'giant MBL mode particles' could be reformulated.

p25l30: calculate

p26l6: 'slightly lower' is an understatement because the 'base value' of the aspect ratio is 1.0. Then your value is only about half of the literature value.

p26l6: 'and quartz' could be removed when considering Fig. 11.

p26l28: 'was extremely scattering' should be replaced by 'was only very weakly absorbing'.

p26l33: I suggest to start a new sentence after 'dust' and to write 'Particles larger than expected from sedimentation processes alone are found.'

Table 1: The reference style is not consistent.

Table 1: During 'SALTRACE' also the 'CAS-DPOL' instrument was used, measuring upto $50\mu\text{m}$ (Weinzierl et al., 2017).

Table 2: The 'General Flight Aims and Conditions' do not very well fit to Table 1 of Marengo et al. Furthermore, you write 'b923', and Marengo et al. 'B923'. Maybe this could be more harmonized between both papers.

Table 4: Negative latitude values don't make sense here.

Table 4: Longitude and latitude values for b923/b924 do not fit to Fig. 1.

Table 6: Sometimes you write 'D_eff' and sometimes 'd_eff'.

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Table 6: With 'derived RI' you mean the refractive index you iterated to fit the optical measurements? If yes, 'iterated RI' would be more specific.

Table 7: What means 'assuming internal mixing' here? In my understanding, the mixing state (internal/external mix) is only relevant for optical calculations but not for the derivation of the refractive index from filter samples.

Figure 4: What is 'SLRs'?

Figure 5a: The $dV/d\log D$ value for b924 (green) at the largest three size bins is more than ten times higher than the corresponding average value shown in Fig. 2. However, there are only five flights and SAL flight lags. How do these figures relate? How did you calculate the average in Fig. 2? See also my comment on p15l28.

Figure 6: You write '6(a)' while there is no '6(b)'.

Figure 7: The dashed lines are not very well visualized and the description is missing in the legend (at a reference to p17l12 should be added).

Figure 9: 'Aspect ratios histograms as a function of number fraction of particles' is not clear. You mean 'number fraction of particles as function of aspect ratio'?

Figure 10c: It looks like there is a height dependence of the fraction of $D > 5\mu\text{m}$ particles within the SAL. I think this height dependence should be briefly discussed in Section 3.3.

Figure 11: Relative 'n particles' for '10.0 to 40.0' shows no big difference between 'b920 R2' and 'b928 R2', so it is a bit unclear why you mention here 'B928 R2 (top right) contained giant mode MBL particles.' which should also be true for b920.

Figure 11: The last sentence could be 'Errorbars are counting uncertainties.'

Figure 13: 'size-specific RI is used': Is this explained in the main text?

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