Atmos. Chem. Phys. Discuss., 15, C7493–C7501, 2015
www.atmos-chem-phys-discuss.net/15/C7493/2015/

Atmospheric Chemistry and Physics Discussions
Open Access

ACPD
15, C7493–C7501, 2015

Interactive Comment

Interactive comment on "Size distribution and optical properties of mineral dust aerosols transported in the western Mediterranean" *by* C. Denjean et al.

Anonymous Referee #2

Received and published: 1 October 2015

General Comments

This is a clearly-written and presented article showing key results of dust size distribution and optical properties measured over the Mediterranean during the ChArMEx/ADRIMED aircraft field campaign. The results add to the body of data building up to document dust properties and how they may change with transport, which can contribute to model and satellite retrieval validation and improvement. In particular the authors present results showing the minimal impact of pollution on dust properties, and retention of coarse mode particles which they attribute to turbulence in the dust layer. I recommend that this article is published, subject to some minor corrections, mainly concerned with further information on inlet impacts on sampling and size distributions, and some additional clarifications and additions to the figures.

Specific comments

21609

L17 “Moderate light absorption” – which do you mean, moderate to light, moderate, or light? These are all different!

L25 “assumed similar” would be better than “assimilated” here

21610

L5-7 – and global transport of dust in general as well?

Introduction – please give an overview of what is contained in each following section at the end of the introduction.

Figure 1:

Is it possible to change the aspect ratio of the figure so the landmasses appear more in proportion? Currently it appears squashed east-west.

Some flight tracks/colours are not visible. Do some flight tracks overly others? E.g. F35, F38? If so describe this in the caption.

21613

On what basis were the non-dust flights removed from the analysis?

L20-25 – what spatial distance is covered during a vertical profile?

Table 1 – I believe times should be in UTC for ACP papers.

Section 2.2.1 – It would be useful to define what the authors refer to by ‘nominal size’ here.

ACPD

15, C7493–C7501, 2015

Interactive Comment

21615

L10 – “possible errors in the FSSP sizing were assumed to be 30% of the particle diameter” – this sentence is confusing – do you mean errors in number concentration as a function of size? Please explain.

L14-15 – again, what do you mean precisely by ‘particle sizing?’

21618 L16 -21619, L7 – This (i.e. excluding data) is an interesting approach to the problem of scattering response vs size. It would be interesting to mention whether including the omitted data made much difference to the resulting size distribution? I.e. perhaps this approach is overly cautious. The authors may be interested in a method of including error bars in refractive-index corrected particle size based on the scattering-size response, which can be represented by freely available software described in Rosenberg et al. (2012) and also discussed in Ryder et al. (2015) and the associated ACPD discussion. This allows the data in the region omitted in this paper to be included, but with appropriate error bars.

Figure 3 – what do the horizontal error bars for FSSP represent? What are the sizing errors for the other instruments?

21620 L1-2 – why was deff calculated separately for coarse and fine fractions? It would make sense to provide one value for the entire size distribution, or at least to provide this value in the data analysis as well.

Section 2 – what is the instrumental error on the nephelometer and CAPS instrument?

21620

L18-21 – what were the errors between calculated & measured scattering and extinction of the final values? How many cases were there?

21621

L1-3 – what is the reference for these cut-offs? If no previous published work is avail-

ACPD
15, C7493–C7501, 2015

able on these values, data & evidence should be provided here for them.

L6-9 – some of these errors, particularly the 0.04 on the single scattering albedo (SSA), are relatively large. The authors say they are within the range covered by the measurement uncertainties, but do not state their values. Therefore the authors should provide values for measurement uncertainty of scattering and extinction, and on SSA as a result.

Section 2, inlets

More discussion of this point is required. Firstly the GRIMM is measuring a size distribution behind the AVIRAD inlet with a 12 micron cut-off, yet the authors present a size distribution from this inlet up to a nominal size of 32 microns, and what looks like a corrected size of around this value in Fig 3b. If the cut-off value of the inlet is accurate, then the size distribution beyond 12 microns should not be used. Secondly the nephelometer also measures behind the AVIRAD instrument, cutting off at 12 microns, while the CAPS measures extinction behind the community inlet cutting off at 5 microns. This difference should be stated explicitly. How do the authors deal with this discrepancy, e.g. in calculating SSA and in comparing to the mie calculations from the size distributions? A short description of this is provided but it needs more explanation & description of their method.

21662

L1-12 – could the dust masses also be tracked via the SEVIRI imagery, and were they in agreement with the age and source locations from HYSPLIT?

21622 L19 – 700hPa is more mid-atmosphere than ‘upper’ atmosphere.

Figure 1 – the squares give the impression that the source regions were very definite and refined. In reality this is probably quite unlikely given the uncertainty in hysplit back trajectories. Please give some measure of spatial uncertainty for each of the sources. Several tools such as ensembles and matrices are now available on HYSPLIT

ACPD
15, C7493–C7501, 2015

to provide such information easily.

Figure S4 – it is extremely difficult to make out the wind barbs from these plots. Please improve the readability of the figure – I suggest plotting fewer wind barbs.

21624 L10 – what method was used to calculate the value of Zb? Was it done by eye? Likewise for Zs. What do you use Zs to infer? Looking at the profiles in Fig S6, it would often appear that Zb should be at a lower altitude on some occasions – e.g. around 300m in F32 rather than 1km. Likewise, the reason for the altitude of the zs line is not clear, for example in F30 and F31 there is little change in wind direction at the line. Please provide information on how Zb and Zs were chosen. This has been done previously in a systematic way, for example, in E.Jung et al., 2013, JGR, doi:10.1002/jgrd.50352, where layers are referred to as 'marine boundary layer,' 'intermediate layer,' and 'Saharan air layer.'

Fig S6 – both the blue lines appear similar in colour (different shades of dark blue). Please change the colour. Potential temperature axis is not readable due to too many numbers on the x-axis.

21625

L4 – F31 does not appear to be a single homogeneous layer.

L10 – McConnell et al. (2008) angstrom values were >0 over the source region (figs 5a and c)

Fig 6 – One would assume that the locations of the profiles in Fig 5 correspond to the stars in fig 1. I.e. expect the F32 profile to be at Minorca. The F38 track is not visible on Fig1. Why then do the end points of the trajectories in Fig 6 not correspond to the profile locations?

Figure 7 – have the categories shown here been created purely based on the altitude of measurement, or do they relate to the placing of lines zb and Zs in Fig 5 in any way?

ACPD

15, C7493–C7501, 2015

21627

L4 – ‘indiscriminate of’?

L4-6 – it is surprising that the intermediate dust shows a greater coarse mode than the elevated dust – based on Fig 5 it seems that there were more coarse particles in the elevated layer. It would be useful to show Fig 7 a and b normalized by total number and volume respectively, so that the relative differences in size distribution can be seen. Then fig 7c could be shown as a separate figure, enlarged for clarity – it is quite difficult to see some of the detail and different lines here.

L22 – what do you mean by ‘good’?

L23 – Please clarify what is meant by Deff,c here – is this deff of particles d>1 micron, or deff of mode 4 in table 3?

L27 – ‘uncounted’ – do you mean, ‘fewer particles larger than 10 um were counted’?

Figure 8 – presumably one SLR equates to one data point. How do you deal with data from the vertical profiles? Are they averaged over an altitude range depending on the vertical structure? What do the error bars represent?

Figure 8 – adding in horizontal lines at 1.5 and 3km to represent and differentiate the different dust altitude categories shown in Fig 7 would be useful. It would also be useful to add in some measure of size as an extra plot – e.g. ratio of Ncoarse to Nfine, or deff coarse/deff fine.

21629

L9 – ‘these layers’ – do you mean the higher altitude layers?

L1-14 – the variation of optical properties with height is worthy of a bit more discussion. It appears that nr and ni are independent of altitude, there is some evidence for a decrease in SSA beneath 3km, and beneath 3km g decreases while kext increases. The latter (g and kext) are consistent with an increase in the proportion of accumulation

ACPD

15, C7493–C7501, 2015

Interactive Comment

mode particles relative to the coarse particles – which is why it would be useful to add a size metric to this figure.

21630

L2-5 – There is not strong evidence here that the transport conditions affect the optical properties of the dust layer – in fact based on Fig 8 and the discussion in the preceding paragraphs of the paper, I would argue the opposite. The results presented here would suggest that transport altitude/air mass encounters affects the resulting vertical structure, but I would be doubtful if more than that can be claimed. Additionally, nothing is known about the dust size distribution or optical properties at uplift, which may have been different in each case.

91630

L17- do you mean 'upper 3km'? If not please define what sort of size you mean when referring to 'pollution particles.' Again, it may be helpful to the reader here to include some measure of number concentration in the figure (e.g. ratio of N coarse/Nfine, or sub-divide the fine mode into ratio of number concentrations).

L25-26 – 'Deff,c of the dust plume did not show any systematic dependence on altitude' – on the contrary there does seem to be a small shift to smaller values of deff above 3km. What are the mean & standard deviation values of deff in these 2 altitude ranges, and can you provide evidence that there is no systematic change?

Figure 10 – please include deff for the coarse mode in this figure or supply 2 plots to include it. Due to the limited settling velocity of fine mode particles, deff,f would not be expected to change much on the timescales shown, whereas deff,coarse might be expected to change significantly.

21632

L26 – a value of 0.64 for kext seems at the high end compared to values shown in Fig 8e. How do the authors reconcile the choice of this value? What are the uncertainties

ACPD
15, C7493–C7501, 2015

on the SSA values calculated from the chemical composition?

Can the chemical data provide any information on composition as a function of size? For example, generally the authors assume that dust is present at all particle sizes and subsequent conclusions (e.g. Fig 10 is discussed as dust, albeit being fine mode). What evidence is there that dust is present in all size ranges? Likewise, can the chemical data be used to support the conclusion that more pollution was present in intermediate compared to elevated dust layers?

Figure 11 – Please clarify how effective diameter is provided for each dataset in the figure. For example, the Fennec data represent effective diameter for the full size distribution. It is likely the case for the other campaigns. Therefore it would be better to show the ADRIMED data as deff for the full size distribution in order to compare like with like. Additionally it should be noted that the other campaign data points are averages of many individual cases, while the ADRIMED data points each represent 1 SLR (?) (or profile?). This is appropriate due to the focus of this paper on the ADRIMED measurements, but the authors should also provide one mean data point for the campaign with error bars so that it can be easily represented in future studies/publications. This is useful and important data and it should be provided in a way that allows it to be taken forward easily.

21634

L10-14 – can the authors speculate on whether this is greater than expected up/downdraft values over the Atlantic, and whether this might also help explain (or not) why Fig 11 intriguingly suggests that larger particles are transported over the Mediterranean more effectively than over the Atlantic?

Final comments:

What were the AODs of the sampled cases?

What were the AODs in the polluted regions out of dust plumes? (I.e. how strong were

ACPD
15, C7493–C7501, 2015

levels of background pollution?) Since the pollution appears to have negligible effect on the dust properties, it would be useful to know whether this is because pollution levels were low in general in the area/time period, or conversely if loadings of pollution were moderate-high, and still not impacting the dust layer properties. I see this is discussed briefly in the conclusion but it would merit a mention in the results section as well.

Interactive comment on Atmos. Chem. Phys. Discuss., 15, 21607, 2015.