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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Measurement report: Balloon-borne in-situ profiling of Saharan dust over Cyprus with the UCASS optical particle counter" *by* Maria Kezoudi et al.

Anonymous Referee #2

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General comments:

This paper presents new results from a balloon-borne sensor, UCASS, demonstrated and evaluated in dust aerosol during a field campaign in Cyprus. The results demonstrate the usefulness of the instrument and its ability to explore the nature of dust aerosols in the atmosphere. The paper performs a comparison of the instrumental UCASS data against in-situ aircraft observations and ground-based remote sensing. This is a challenging task and the authors present valuable conclusions with regard to the retrieved size distributions, the importance of vertically-resolved information and the ability of UCASS to provide extinction coefficients. The paper is well-written and

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Discussion paper

well presented, and I recommend publication following the minor corrections listed below.

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Title: I suggest removing ‘Measurement Report’ or rewording it in to the rest of the title – having it at the start of the sentence with a colon implies that it is a particular type of article/publication at ACP, which is not the case.

Abstract

L1-2 – is this the first publication of UCASS measurements? What is novel about the new measurements/data collected? This should be clearly communicated here or later in the abstract.

L13-14 – “An overestimation of the extinction coefficient of a factor of two was found for layers with particle number concentrations that exceed 25 $cm-3$.” An overestimation of lidar or UCASS? Please provide an indication/quantification of the fraction of layers/instances where this disagreement is found, so the reader can put the differences into context.

An additional sentence should be given at the end of the abstract to sum up the overall abilities of UCASS and it’s potential to provide future measurements and/or insights into environmental data.

Introduction

Paragraph 1 – Stocker et al. (2013) is missing from the reference list. Citing Stocker twice for this broad paragraph should be avoided – many other papers cover these topics and could be cited here.

L37 – “The main zones of cyclogenesis. . .” – this sentence is unclear.

L61 – “with the exception of wing-mounted probes” -> “with the exception of airborne wing-mounted probes”

L81-82 – are these diameters optical diameters?

L100 – please give the particle concentration in cm-3 as this is more interperable and in line with units used in the abstract.

L101 – Equation n_i=C_i/V – should V be lower case as defined in the previous sentences?

Section 2.1 – is it possible to retrieve data from the UCASS descent as well as the ascent?

L114 – please confirm that effective diameter is calculated over the full measured size range (several previous observational studies have selected only part of the size range).

Equation 4 – why is i summed up to the value of 10?

L145 – is this a CIP15?

L148 – insert 'optical diameter' for the CAS

L149-150 – "For the comparison to UCASS observations, CAPS measurements were opted to overlap with the UCASS sampling range from 0.79 to 13.90 μm in diameter." This sentence is unclear, please reword.

L145-152 – Please add information about the processing applied to the CAS and the CIP. For the CAS, how were refractive index assumptions treated? For the CIP, how was size defined?

L145-152 – how was data in the size overlap region between the CIP and the CAS dealt with? Is one instrument selected in preference to the other?

L154-159 – it is not clear whether UCASS data is being used to evaluate GARRLiC/AERONET/SKYNET or the other way round.

L190 – "aerosol volume concentration" – is this as a column mean?

L201-202 – what resolution is the GDAS meteorological data at?

L208 – “south-western” -> “southwesterly”

L239 – should be ‘left’ panel?

L 258 – “between 4.5 and 5.5 km height” – this doesn’t seem to reflect the figure – the main concentrations seem to be between ∼3-5 km, as indicated by the grey shading.

L263 – the figure does not look like an average ratio of 0.92 in the dust plume (3-5km) – with UCASS concentrations around 45 cm-3 and aircraft around 20 cm-3, the ratio appears closer to 0.5.

L255-267 – the authors should discuss the fact that the concentrations from aircraft & UCASS differ significantly above 5km and the possible reasons to explain this. The same behaviour also appears in panel b – in both cases UCASS drops to zero while the aircraft still measures particles.

L268-272 – “While the number concentration exceeds 20 cm−3 in this layer, the higher concentrations above 30 cm−3 as measured during the first launch were now found only at around 4 km and just below 5 km height. The descent of the larger number concentrations to lower heights is indicative of gravitational settling of particles in the uppermost part of the dust plume during transport.” – Fig 4b does not support either of these sentences. While the transition from fig 4a to 4b suggests that overall concentrations have dropped, the heights with concentrations > 30cm-3 appear to have increased from ∼3-5 km to ∼4.5-5.5 km.

L302 – “between 10 and 50 cm-3” – is this total number concentration or dN/dlogD? If it is the latter, the numbers do not seem to match up with those on the y-axis for the data.

L305-307 – this seems a rather unfair criticism of the data. If one was to draw an envelope around the error bars for the aircraft data, the UCASS data, even for bin 4, would still appear to fall within the uncertainty range.

L310-312 – the data still agree within the aircraft error bars, despite the offset.

L316 – I believe the Liu et al. (2018) effective diameter covers the size range 1 to 20 microns diameter.

L320-322 – and also the different size ranges used to calculate deff, in some cases.

Section 3.4, L324-358:

- Given the fairly large differences between aircraft and UCASS in fig 6a, it would be useful to mention in the previous section that what appear to be small differences in dN/dlogD can translate to very large differences in volume distribution.

- Can the authors comment on where the difference in the ∼5-10 micron size range in fig 6a comes from? Would it be the 3-4km layer in fig 5b?

L334-336 – this is a surprising statement – is the UCASS/aircraft comparison from figure 4b not available for a column integrated comparison, given that a vertical comparison is already given in fig 4b?

L 336 – it would be useful to see fig 5 as dV/dlogD as well (see also comment in figure section) to see if the bimodal nature persists vertically, or is featured only in one layer. This may also help explain differences between the remote sensing retrievals and the in-situ observations.

L340-353 – what about contributions from different aerosol types towards the bi-modal distribution?

L372 – While worth retaining the Estelles (2018) reference, the authors may like to cite Kudo et al., (Optimal use of PREDE POM sky radiometer for aerosol, water vapor and ozone retrievals, Atmos. Meas. Tech. Discuss. [preprint], https://doi.org/10.5194/amt-2020-486, in review, 2020.) which publishes some of the same data.

Conclusion

L448-449 – “Furthermore, it was found that the number concentration of large particles decreased with altitude.” – This was not evident in the article and results presented. See comments referring to results section of the paper.

Can the authors make any comments or conclusions about differences in results and data comparisons previously published from LOAC, given the differences in instruments described in the introduction? Based on the new results here, are there clear advantages to either LOAC or UCASS that can be shown?

Data availability – please check this statement is in accord with ACP data policy – I do not believe ‘available from the authors’ is now acceptable.

Figures Fig 1 – caption – presumably the grey bars and UCASS dots are for AOD? The caption however reads like these represent AE – please reword.

Fig 4 – caption – what does the shading around the aircraft data represent? Fig a – why does the distance (black) line disappear abruptly above 5.2km when data is still present for aircraft and UCASS? If CAPS data is only shown up to 14 microns, this comes from the CAS and not the CIP, and this should be corrected in the caption.

Fig 5 – the panels should be enlarged so that the plots are easier to interpret.

Fig 5 – it would be useful to include this figure also as dV/dlogD, so that the discrepancies/similarities between fig 5 and fig 6 can be easily traced.

Fig 7 – enlarge panels to improve readability

Fig 8 – enlarge panels to improve readability, and also enlarge legend font size. In caption, define what a/b/c/d refer to.

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