Atmos. Meas. Tech. Discuss.,
doi:10.5194/amt-2019-44-AC1, 2019

Atmospheric Measurement Techniques Discussions

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Interactive comment on "Aerosol size distributions during the Atmospheric Tomography (ATom) mission: methods, uncertainties, and data products" *by* Charles A. Brock et al.

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Received and published: 8 May 2019

We thank both referees for their thorough and helpful reviews of this manuscript. We respond to each comment below in brackets.

Reviewer #1

This manuscript describes in detail the aerosol particle measurements carried out during the ATom missions onboard the NASA DC8. It describes the measurement systems and the generated data products which will be freely available to the scientific community. This data set is of high relevance for atmospheric research and will certainly be

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widely used. The manuscript is very well-written and should be published in AMT after the following minor points have been considered:

[Thank you for the positive comments on the manuscript.]

page 5, line 35: Please give the equation used for the efficiency factor. I assume it is Equ. 9 in Belyaev and Levin?

[Yes, this is correct. Equations 1-4 now describe in detail how the inlet aspiration efficiency was calculated.]

page 6 line 12: replace by "...and the LAS instrument were calculated after Brockmann (2001) on a second-by-second..."

[Done.]

page 7, line 30ff / Fig 6: What was the averaging time for the size distributions? It's hard to see from the graphs a1, b1, c1. These are not the reported 1-second data products but rather 30 second averages.

[We have redrawn this figure (see below). The averaging time has been changed 60 s and is now explicitly described in the figure caption. We have modified Fig. 6 to use the final submitted data (which eliminated some portions of data due to cloud contamination) and to zoom in on 10-minute segments of the flight. The size distribution plots (middle and right columns) have been modified to show the inverted and interpolated size distribution as a shaded histogram, which makes things clearer (especially for color-impaired readers).]

page 8, line 20: please refer to section 4.3.1 when mentioning that the time resolution is variable.

[Done.]

Section 4.3.1: looking at Fig 6, b2 and c2, the first channels of NMASS (< 15 nm) may also suffer from poor counting statistics. Why is the averaging not applied to the first

NMASS channels as well?

[Each channel of the NMASS measures the cumulative number of particles larger than a threshold diameter, so the statistics for each channel are usually excellent. The red solid lines in Fig. 6b2 and 6c2 show the differences between the channels, which may not be statistically significant when there are few particles in this size range. However, it would be challenging to combine channel-specific averaging time intervals with the algorithm that inverts all the NMASS data together (Eq. 5), and there would be physically improbable results (such as sharp edges to the size distribution) at the boundaries between averaged and non-averaged channels.]

page 9 line 18: Any literature references for typical Aitken mode size range definitions?

[We have added a reference to Whitby, 1978, who provides a thorough description of aerosol modal structure.]

page 9 line 32: The AMS measures only the accumulation mode. The density of the nucleation mode may be different (higher, if assuming that H_2SO_4 plays an important role for nucleation).

[It is correct that we don't know the composition of the nucleation mode. The AMS does capture the composition of particles in the 25-60 nm range of the Aitken mode. However, their composition is averaged with that of the accumulation mode, which often dominates. Thus, estimating the density requires making assumptions about the composition of the smaller particles, but both poorly neutralized sulfate and organics likely play a role. Applying the average composition of the non-refractory component of the Aitken+accumulation modes to these smaller particles is the most impartial assumption we can make.]

page 11 line 32: remove line break.

[Corrected.]

page 12 line 14: this is channel NMASS-1 CPC5 in Figure 2, right?

[Correct, and now we note this in the text.]

page 12, line 35-36: That would mean that the inlet transmission is unity up to 3 _m and drops immediately to zero. On page 5 it was said that at 12 km the transmission at 3 _m is still 50%. Would it be possible to average the >7 km distribution over a longer time? What does "> 7 km" mean exactly? Can you give the altitude range that is averaged here?

[We expect a more gradual decline in the inlet transmission than an abrupt drop, but don't have the measurements to support it. Unfortunately, there is no underlying theoretical or experimental basis for particle losses in a turbulent, conical diffuser on which to base a more sophisticated expectation. The CAS probe on the CAPS has poor sizing resolution in this Mie resonance range (and the LAS is not great, either). The LAS is also very limited by its low sample flow rate (<1 cmˆ3 per s), which leads to poor statistics. Altogether, this makes it difficult to provide a more quantitative basis for evaluating inlet performance, other than to say it appears to have reasonable transmission up to 3 μm at high altitude, and to the maximum size considered, 4.8 μm, at low altitude. We see that sampling efficiency falls (apparently rapidly) at larger sizes. We prefer to leave the discussion as it stands now–generally consistent with the findings of McNaughton et al. (2007). The altitude range of the averaging for panel b (7 to 12.9 km; now noted in the figure caption) included all available data for this flight in that altitude range and at RH<35%, so there is no further help for the statistics.]

[Figure caption for modified Fig. 6 (below):

Figure 6. (a1, b1, c1) Left column shows three example time plots of STP concentrations measured by each channel of the two NMASS instruments and by the non-thermodenuded UHSAS on 13 February 2017 on a flight over the South Atlantic Ocean between Punta Arenas, Chile (43.2° S, 70.9° W), and Ascension Island, UK (7.9° S, 14.3° W). Each plot shows 10 minutes of flight time and uses the same scales, and the cases were chosen to show how size distributions dominated by different modes

are measured. "Striping" of the UHSAS concentrations in (b1) and (c1) is caused by poor 1-s counting statistics at low concentrations. (a2, b2, c2) Center column shows linear particle number size distributions averaged over the 1-minute interval shown by the grey shading in (a1), (b1), and (c1), respectively. These size distributions show raw NMASS size distributions (dashed red curve) obtained by simple differencing of adjacent CPC channels using the 50% efficiency values of each CPC response curve (Fig. 2). Negative differences between the channels are shown as gaps in the curve. The solid blue curve shows the raw UHSAS size distribution, which is reported in 99 channels. The shaded histogram shows the combined final data, composed of the inverted NMASS data and the time-averaged and size-interpolated UHSAS and LAS data as reported in the ATom archive using 20 constant logarithmic size bins per decade of diameter. (a3, b3, b3) Right column shows the same size distributions plotted using a logarithmic y-axis to illustrate the accumulation mode better.]

Interactive comment on Atmos. Meas. Tech. Discuss., doi:10.5194/amt-2019-44, 2019.

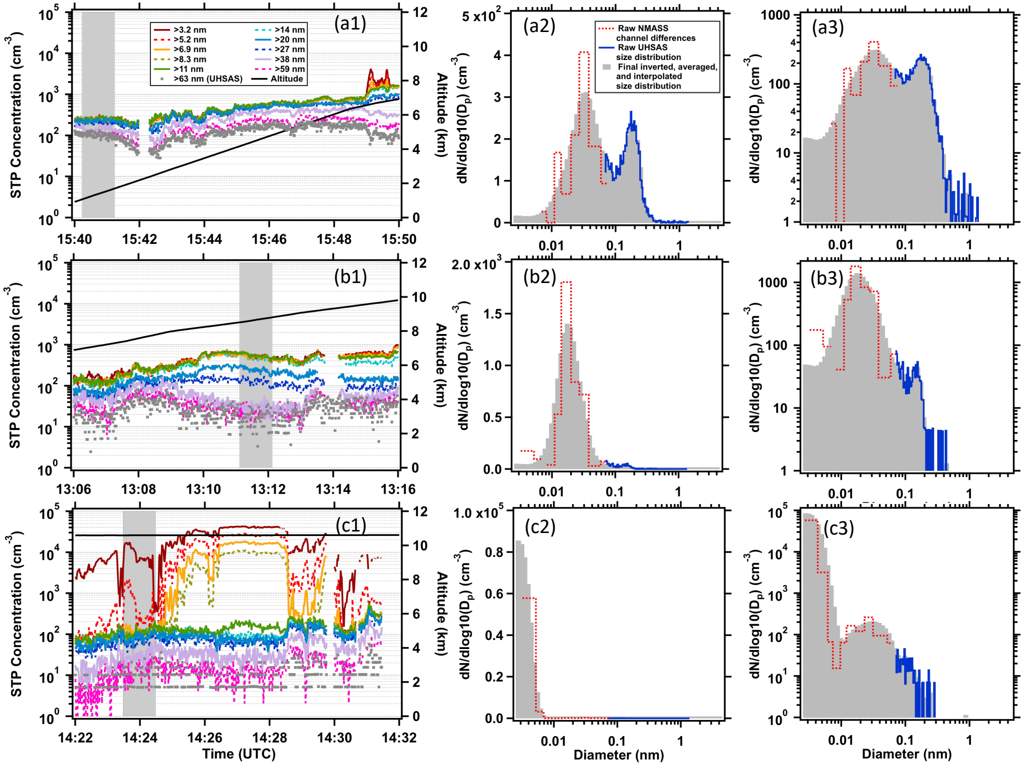

Fig. 1.

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