

Atmos. Meas. Tech. Discuss., referee comment RC2
<https://doi.org/10.5194/amt-2021-266-RC2>, 2021
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Comment on amt-2021-266

Anonymous Referee #2

Referee comment on "Simulation-aided characterization of a versatile water-based condensation particle counter for atmospheric airborne research" by Fan Mei et al., Atmos. Meas. Tech. Discuss., <https://doi.org/10.5194/amt-2021-266-RC2>, 2021

General comments

This paper reports some good work to characterize a commercial water-based CPC, designed for operation near sea level, at reduced pressures, and furthermore that such operation is possible with only minor modification of the instrument. This capability is important for capturing the vertical profile of aerosol in airborne research, and water is a far safer alternative to the traditional butanol working fluid. The measurements are backed up with a modelling study which also helps explain the CPC response, and limitations therein, to pressure changes. I provisionally recommend this manuscript for publication pending changes described below.

The manuscript should have been more carefully proofread prior to submission. Although a number of syntax and typo issues are noted below, all authors are strongly encouraged to have another go at careful proofreading as part of their response to reviews.

Specific comments

Why choose 500 mb as the lower pressure limit? Research aircraft reach sub-100 mb and balloons even lower pressures. The graphs may provide the answer, but some statement about why you didn't investigate lower pressure ought to be included, possibly in the introduction. Especially if lower pressure was attempted unsuccessfully, include a few words about what was tried and the outcome.

Abstract: should give the pressure range investigated instead of 'low pressure conditions'

Line 29: The statement about detecting sub-100 nm particles isn't strictly correct, since optical scatter detection is possible down to ~50-60 nm (UHSAS, DMT).

Please make your use of 'vWCPC', 'wCPC', etc. consistent throughout.

Lines 120-121

Equalizing diffusion losses by matching flows also requires matched tube lengths. Please indicate whether this was the case in your setup. Also this apparently contradicts the previous section which said two different flows were used.

Lines 137-138: To make it clear you are describing other work here, suggest starting the 2nd sentence this way: "They first computed the temperature and humidity profiles were using..." The next sentence describing the Hering et al. configuration doesn't seem to add anything to this paper and could be omitted.

Lines 162-163: What's the sample rate? How many samples during each 5-min. run, approximately? Otherwise we can't make sense of any standard deviations.

Line 183: The title of section 3.2 doesn't reflect the combination of model and observation within it.

Line 198: '...one 8 nm size particle grew to a smaller size...' Unclear what is meant here - please rewrite. Also change 'no matter' to 'whether'

Lines 234-235: It's not at all clear how the observations of 100 nm particles in Fig. 6 inform the behavior of particles at smaller sizes down to 15 nm.

Sect. 3.3:

Lines 241-242: Does this mean it does not count pulses that are below some trigger threshold?

Insert 'of maximum' after '90%'

Lines 245-246: Suggest rewriting this sentence: 'Meanwhile, for 100 nm particles at 500 hPa, the threshold concentration for a 10% reduction in counting efficiency was about...'

Lines 249-251: This is an important point that is not easy to see, and isn't shown in Fig. 7. Suggest pointing to the supplement figure: 'Additionally, Fig. S5(b) shows there is no significant...'

Also: change '...simulation estimated 10% reduction of s and Dp happened...' to 'simulated 10% reduction of s and Dp...'

Sect. 3.5 & Conclusions:

Should include a statement about the cut-off being less sharp than for the TSI standard settings, as the price for operation over a much wider pressure range. This can be important in the presence of a large ultra-fine particle mode.

Technical corrections, by line or label:

53 comma after 'system'

61 strike 'her'

67 comma after 'initiator'

68 change ')' after 2017 to a semicolon

85 change 'guided' to 'guide'

101 change 'positive pressure difference' to 'positive difference'

104-106

Suggest recasting this sentence to 'Thirdly, we added pressure transducers (Baratron 722B, MKS Instruments, Inc., Andover, MA, USA) to the vWCPC inlet and exhaust lines.'

Fig. 1 Please label at least one of the filters in the figure, or identify in the caption.

150 change '...which shows that the flow rate varied...' to 'which shows that when the flow rate increased...'

158 change 'maintained 2~4' to 'maintained in the range 2-4'

Fig. 3 Please state in the caption that the configuration is TSI's standard.

188 Change both instances of 'was' to 'is'

196 Strike the comma after 'both'

Fig. 4 It would be helpful to separate the bunched contour labels.
Caption: change 'temperature is 59' to 'temperature at 59'

Fig. 5 caption: change 'temperature is 59' to 'temperature at 59'

227 change 'imitator' to 'initiator'

236 change 'than the' to 'than when the'

240 insert 'efficiency' after 'counting'

Fig. 7 caption: change ' temperatures were set' to ' temperatures set'

268 change 'efficacies' to 'efficiencies'

285, 287 change 'was' to 'is'

Fig. 9: Drop the '25' tick label, both panels

307 change 'the above phenomena' to 'this behavior'

308, 309 'at' is preferable to 'under' because 'under 1000 hPa' might be read as _less than_ 1000 hPa, e.g.

Author contributions: Gregory Lewis and Maynard Havlicek are omitted.

Supplement

After Eqn. 1 (for D_{th}): the expression for D_{th} at other than STP is missing.

After Eqn. 2 (for D_{va}): '(0.21 by Steve)' what is this?

Please give a source for the Antoine equation empirical constants.

Please define all quantities in the diffusion time expressions. Many are not. The primes in Eqn. 6 (for Γ) appear to be on the wrong characters, and their meaning is not identified.

After Eqn. 3 (for Le): '...as detailed in the supplement.' This IS the supplement. Do you mean '...as detailed above'?

Fig. S2

Main title and y-axis labels need attention. May just be PDF rendering problems, but in my copy the RH unit reads '(l)', and the title repeats 'Relative humidity (l)' three times. Caption: change 'calculated at the' to 'calculated along the'.

After Eqn. 4 (for s): 'and assuming $dT/dz=G$ ' should just be ' $G=dT/dz$ '

Following paragraph: change 'hence lower the droplet size' to 'hence a lower droplet size'

After Eqn. 7 (for $C\text{-dot}$): change 'assume' to 'write'

After Eqn. 9 (for D_p/D_{p0}): change 'set to equal' to 'set equal'

Following sentence: remove ', which' after 0.01

Next sentence: should be Fig. S3, not 3.

Fig. S3

X- and Y-axis labels, and the legend, need attention. Subscripts and superscripts are displaced from other characters. Again, this could just be a PDF rendering problem. Please narrow the legend box to avoid clipping the traces if possible.

Are all the 'exit' subscripts necessary? Maybe strike them and instead include 'at the initiator exit' somewhere in the caption?

Caption: change 'setting temperatures' to 'temperature settings'

2nd paragraph after Fig. S3, 1st line: change 'function as' to 'are functions of'; and again Fig. S3, not 3.

The accommodation coefficients are discussed here, but don't appear in any expressions. How were they used?

Fig. S4 caption

Change 'for the droplet size is 3 mm when the droplet exit the initiator' to 'for a droplet size of 3 μm exiting the initiator' (making sure to correct mm to μm). Please add a sentence describing the insets.

Figs. S5, S6

Axis labels and legend text are far too small. Legend superscripts are dramatically separated from their base characters.

Fig. S5(b)

There are no magenta points on the plot, but they are in the legend (24C, $N=2e4$, 20 nm case).

Fig. S5 caption, last sentence: strike 'were' and the following 'with', and correct 'temprerature'.

Fig. S6 caption: change 'temperature is 59' to 'temperature at 59'.

Table S1

Asterisk-bullet mismatch for the note; use the same symbol.

References: Seinfeld and Pandis (2016), Lathem and Nenes (2011), Nenes and Seinfeld (2003) are not given anywhere, main or supplement.