Referee Comments for Manuscript AMT-2015-142 "Operation of the Airmodus A11 nano Condensation Nucleus Counter at different inlet pressures, different operation temperatures and design of a new inlet system," J. Kangasluoma et al.

General Comments

The authors have obviously done an enormous amount of calibration work on the Airmodus A11 and have succeeded in their objective of elucidating the technical issues involved with operating it at different inlet pressures or operation temperatures. The inclusion of a revised, more efficient inlet system is also welcome. The trends noted from these calibrations leading to the final operational advice are certainly of some value to unwary users of this instrument. It is unfortunate that, as the authors rightly point out at the end of the Introduction, none of these calibrations may be considered as quantitatively applicable to the A11 system in general. This severely limits the overall value of this work.

In general, the experimental setups and the results of the measurements are adequately described, though dimensions for the revised inlet system should be given. However, the authors seem to suffer from a great deal of confusion with regard to volume flow versus mass flow, or more correctly, standardized volume flow. In a number of places, flows termed as mass flows in the text are actually volume flows. These will all be enumerated in the following section. In addition, to lessen the degree of confusion for the reader, mass flow (standardized volume flow) should be given a notation different from that of volume flow, Q. This will improve the clarity of, for instance, Eq. 3 enormously.

Specific Comments – major and minor

page 8484, line 24: "… laboratory calibrations are representative of field ~~conditions~~ performance."

p 8487, ln 9: Though "strangling" a flow presents quite an amusing picture, a more appropriate word here would be simply "restricting".

p 8487, lns 10-11: 50 kPa corresponds roughly to 5600m altitude in a standard atmosphere.

p 8487, ln 15: It should be made clear here which flows the mass flow controllers control. I believe it is the saturator and excess flows. This would also be a good place to give the values for those flows as well as additional information about normal operation. For instance, when the saturator flow is scanned, is the excess flow simultaneously scanned so as to keep the inlet flow constant? Though this may be described more fully in Vanhanen et al., it is not much to include these few extra details of operation here.

p 8487, lns 15-16: "The volume flows were calculated as Q/p, where Q is mass flow and p is pressure.

p 8487, lns 16-18: Please give the actual volume flow for the CPC here. 1 L min^{-1}?

p 8487, ln 13: "… the inlet <u>volume</u> flow …" makes this clearer.

p 8487, Eqs (2)-(3): In these two equations, Q_{CPC}, Q_{inlet} and $Q_{inlet\_low\_pressure}$ are volume flows while Q_{excess} and $Q_{saturator}$ are mass or standardized volume flows. This would be so much clearer if a different symbol were used for the standardized volume flows. It could be as simple as Q'. Also, Eq. (3) is generally good for all pressures, not just low ones.

p 8488, ln 1: "… ~~strangling~~ <u>restricting</u> the flow …"

p 8488, lns 21-22: The use of "hydrogen sulfate" to describe these particles is at best ambiguous, if not actually wrong. I believe these are particles composed primarily of sulfuric acid molecules, H_2SO_4, with perhaps one hydrogen sulfate ion, HSO_4^-, to account for the charge. Thus, "sulfuric acid" should suffice here.

p 8489, lns 8-13: The use of the phrase "maximum detectable size range" is very misleading. Though it is the range that is to be maximized, it is more readily interpreted as the size being maximized, which makes no sense in this context. "Detectable sizes" are everything greater than the cutpoint size. Instead of "detectable size", which apparently is meant to refer to the "minimum detectable size", it would be better to refer to the "cutpoint size", which is commonly understood in reference to CPC efficiencies. The phrase "tested the range of cutpoint sizes" would then seem to more precisely describe what was done.

p 8490, lns11-12: The scaling in Fig. 5 needs a little more explanation. What other effects are being scaled out? And as long as you are repeating all of the legend information in the main text, please include "The blue circles are the uncorrected data."

p 8490, ln 21-22: Earlier it was noted that the CPC flow is controlled by a critical orifice, thereby fixing the volume flow at a constant value. So clearly it cannot be decreasing here with decreasing pressure. Furthermore, there is no obvious connection between the flow rate and the "aerosol volume concentration in the optics." So just what is it that is being corrected for here? Certainly when the pressure drops by a factor of 2 through the sample flow restricting valve, the aerosol volume concentration, barring losses, also drops by a factor of 2. But since the electrometer measures the same reduced concentration, this effect is already accounted for.

p 8492, ln 13: To explain the observed phenomenon, it is hardly necessary to postulate some mysterious mechanism for homogeneous nucleation in the absence of any significant supersaturation. There is a far more plausible explanation for why adding aerosol does not increase the measured concentration over that of background at a saturator flow of 0.3 L min^{-1}. The concentrations involved are getting quite high, about 10^5 cm^{-3}, no doubt leading to a notable degree of vapor depletion as well as latent heat release. Either of these or both, in concert, are limiting the maximum concentration of DEG droplets formed which can grow to a size detectable in the CPC. This asymptotic limit is independent of whether the droplets are formed via homogeneous or heterogeneous nucleation. The effects of this limit are also visible to some degree at a saturator flow of 1 L min^{-1} where it is evident that the curves are again converging to the same maximum value as the measured concentration increases.

p 8492, lns 19-20: Again, the use of "maximum detectable size" is very confusing here. An alternative wording might be "We found it possible to vary the cutpoint size from 1 nm to 6 nm."

p 8493, ln 2: Is 10 mm the tube ID? Please make that clear. For that matter, the general dimensions of the revised inlet system should be noted, including the tube IDs as well as the extraction tube OD along with any relevant lengths. This would more appropriately fit in section 2.3 on page 8489.

p 8493, ln 11: "… ions ~~larger~~ smaller than 4.5 nm." There should be a reference to Fig 12 here.

p 8493, ln 18: The mass flow controllers are keeping the mass flows fixed, so it is the volume flows that are changing at reduced pressures.

p 8493, ln 26: As the saturator temperature is important in determining the cutpoint size and activation efficiency, one cannot simply "reduce the saturator temperature." The concept is more clearly stated in the second Solution entry of Table 1: "Adjust saturator (temperature) for suitable activation efficiency."

p 8494, lns 4-5: "… transmission efficiency close to 100% … ." Please qualify this statement with a phrase such as "for particles greater than 1.xx nm."

Figure 4: Excess and saturator mass flows are fixed by the mass flow controllers, independent of pressure. What is being plotted here are the varying volume flows as a function of pressure. The only mass or standardized volume flows on the plot are those designated "at std conditions". But then if it is already designated as a mass or standardized volume flow, there is no need to add "at std conditions." Also, why are the measured points above the calculated line for the "inlet mass flow" but below the line for the "inlet mass flow at std conditions"? Both should be converted to standard conditions with the same formula.

Figure 9: The reference to "squares" in the caption needs updating. It should read "Curves with no symbol represent the background concentration and triangles the concentration …".

Figure 11: The legend refers to "box". Please explain that reference.

Figure 12: Is this a fit to measured data, in which case show the points, or from theory?