Comment on amt-2022-59
Anonymous Referee #2

Referee comment on "Intercomparison of airborne and surface-based measurements during the CLARIFY, ORACLES and LASIC field experiments" by Paul Alan Barrett et al., Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2022-59-RC2, 2022

Review of "Intercomparison of airborne and surface-based measurements during CLARIFY, ORACLES and LASIC field experiments"

The manuscript provides a comprehensive overview of collocated measurements of two aircraft platforms and a facility on the ground. The detailed description of the experiments is of great quality, although its presentation can be improved. Moreover, although mentioned, the differing approaches regarding the drying (or not drying) of the sampled aerosol is a critical flaw in the study comparing aerosol parameters under different states. A deeper discussion, including the expected growth of the aerosol particles and probable losses due to evaporation, should be included in the results part addressing the prevalent RH for shown PSDs.

The manuscript is well written and structured. However, the extensive use of abbreviations makes it partly hard to read and comprehend. Furthermore, inconsistency in the text appears in abbreviations and units. Too many to address individually. Authors must carefully recheck and harmonize all abbreviations and units. A list of acronyms is recommended.

After a needed major revision, the manuscript is recommended for publishing. Major and minor comments are listed below.

Major comments:

In general, comparing measurements with different setups, actively dried or not, is not
recommended. To ensure comparable conditions, one should care for RH below 40 %. Especially the RH is of crucial importance for filter-based absorption photometers. The observed gradient in the RH (Fig 4c) transposes into the airplane's piping and will bias the absorption measurements due to the principle of differential measurement of the light attenuation behind the filter spots even if the cabin is heated to 30 °C (which also has implications for the volatile components of the aerosol particles). I.e., a sample at ~80 % RH at ~12 °C outside equals inside at ~26 % at 30 °C. As shown in the profile, there was a change to ~1 % RH at ~20 °C outside, which equals 0.6 % at 30 °C inside. This relatively fast change of more than 25 % can significantly impact the filter-based absorption at NASA P3's PSAP or the TAP used on FAAM. However, the Nafion™ dryer at FAAM aircraft should dampen this effect significantly. The discussion must address this feature of the experimental setup.

Table 3 is way too large. One should consider presenting the content more comprehensibly, like with figures. E.g., the table content can be separated into the coefficients of the linear fitting and average values.

Figure 5 displays correlations of two variables consisting of uncertainty each. Hence a linear fit is not applicable, and an orthogonal fit accounting for both uncertainties should be applied. Moreover, it is unsuitable for fitting a linear behavior based on two observations. I would suspect that the statistical significance of those fits is small. Enhance the number of data points by decreasing the averaging window or address this in a deeper discussion.

Since a major point of the motivation is biomass burning aerosol, the discussion, and presentation of the aerosol particle light absorption coefficient is, in my opinion, not sufficiently addressed. Please also provide profiles of aerosol particle light scattering and absorption and a discussion of those.

**Minor comments:**

Abstract:

Line 40: please add ° in the coordinates

Introduction:

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Instruments:

Line 115: Although referenced, no details on the SMPS of the AMS rack are presented in section 2.4.2

Line 121: exemplarily for other referencing parts in the manuscript. For all references, a period should adjoin the subsection. Instead of 2.52, it should read 2.5.2.

Line 118: Provide details of the CPC by referring to section 2.6, i.e., their volume flow rate.

Line 120 and 124: What means good? Within which range?

Line 126: Please provide the particle losses due to the tubing as a function of particle diameter used to correct those losses, e.g., in the supplementary material.

Line 132: Please provide the period of the periodical change.

Line 160: split ms^{-1}; otherwise, it is inverse milliseconds.

Line 186: Period after Beer's Law.

Line 209 and repeatedly appearing along with the text: Please avoid judgmental adjectives such as "good."

Line 217: Remove one period.
Line 259: (first appearance): Ensure the optical coefficients are properly subscripted.

Line 300 and 359: Use a uniform notation; Nafion™ or Nafion(TM)

Line 354 and 359: Explain where the dilution of the aerosol arises and the underlying reasons. Comment in which why this was accounted for. Leakage of the Nafion™ membrane will bias the outside measurement with airplane cabin aerosol.

Line 378: (first appearance): AAE (absorption angstrom exponent) is not $\sigma_{ap}$. Please change.

Line 393: Comment or discuss where the factor of 1.8 originates from; Line 719: Comment on the underlying reasons for the empirical scaling factor used for the PSD.

Line 400: According to the reference list, "Howell et al. (2020)" was published in 2021.

Line 428: Comment on the expected uncertainty omitting the refractive index correction of particles larger than 800 nm.

Results

Line 641: rephrase sensitivity to "the slope". Consistency: BAe-146 or BAe146. Choose.

Line 661: Discuss the differences in the measured CN between the two airplanes based on the cut-off of the CPCs.

Line 792: One could update Figure 9, including the separation between NIR and VIS, and add the corresponding integrated values.


Line 1071: Provide a valuable reference for BBA density.

References:

Add doi if available to each reference.

**General comments:**

Regarding tables: Table description on top of the tables.

The manuscript is very long. I recommend a revision in places that can be shortened. For instance, the instrument description part contains repetitive passages (e.g., gaseous components) and can be shortened, e.g., in the form of tables. A tabular overview of the instruments and corresponding parameters would be more understandable. After, differences between the airplanes and ARM-site regarding drying and instrument location (if necessary) can be explained.

Updating the colors of the fitting functions and adding the wavelength when optical coefficients are considered can improve figure 5.

Figure 5, 6: Please provide the aerosol particles' volume and surface size distribution and their integrated and cumulative (along the diameter) sum values, e.g., in the supplementary material. Those would help comprehend the contribution of the different aerosol populations to the optical properties since those are a function of the cross-section of the aerosol particles.

Comment on the different observed size ranges of the different AMS systems, i.e., the difference between ACSM and AMS when comparing the chemical composition. I am not an expert in that field, but could it be that this explains the observed difference?
Line 1595: The specific instrument should be mentioned in the legend for each variable in all the figures. Change typo: its AAE (absorption angstrom exponent, not extinction angstrom exponent)

Figure 10a): Comment and discuss the discrepancy of one order of magnitude in the observed PSD of the 2DS and CDP.