Anonymous Referee #2
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[A0] For clarity and visual distinction, the referee comments or questions are listed here in black and are preceded by bracketed, italicized numbers (e.g. *[1]*). Authors' responses are offset in blue below each referee statement with matching numbers (e.g. *[A1]*). Page and line numbers refer to online AMTD version.

The manuscript reports on investigations of the non - uniformity of size - dependent aerosol deposit in a rotating MOUDI. Non – uniformity was studied at three different optical resolutions of a microscope. In the second part, the paper discusses ice nucleation experiments done on selected areas of some of the MOUDI stages using a droplet freezing technique (DFT). It introduces a method to correct ice nucleating particle concentrations for the aerosol non - uniformity found in the first part. The MOUDI – DFT results are compared to measurements done simultaneously with a continuous flow diffusion chamber. The comparison shows reasonable agreement of the two different techniques at the chosen conditions. The manuscript presents a detailed investigation and an improvement of the recently introduced MOUDI-DFT technique for measuring ice nucleating particle concentrations as a function of size. It is well written, the study is put into context and relevant earlier work is referred to. The manuscript is of interest to the readers of Atmospheric Measurement Techniques. I recommend it for publication after the few following comments have been addressed.

We thank the referee for his/her helpful comments!

[1] General remarks: Similar to the 1st referee's comment, it is not clear to me from the manuscript if Fig. 4-6 are averages over all analyzed glass cover slips and if so, what the variation between the slips is.

[A1] Data presented in Figs. 4-6 are indeed averages over all analyzed hydrophobic glass cover slips with the error bars representing the 95 % confidence interval, which is related to the sample-to-sample variation. In the revised manuscript, instead of the 95% confidence intervals we report the standard deviation, which illustrates the sample-to-sample variability. In addition, the text has been modified to clarify that we are reporting the average from the different cover slips and the standard deviation. Specifically, the sentences of 2235/10-16 have been revised to the following:

"The normalized particle concentration, which is the quotient of the particle concentration of a given step divided by the maximum particle concentration, was calculated as a function of distance from the center of the MOUDI aerosol deposit for each hydrophobic glass cover slip at spatial resolutions of 1 and 0.25 mm. Visual inspection of aerosol deposits showed that there was spatial variability of the particle concentrations at a spatial resolution as low as 0.10 mm for MOUDI stages 6-8, so these stages were also analyzed at this spatial resolution. A total of three

hydrophobic glass cover slips were analyzed for stages 2 and 8 and four hydrophobic glass cover slips for stages 3-7."

The statement at the beginning of Sect. 3.1 (2238/3-6) has also been revised for improved clarity:

"Shown in Figs. 4, 5, and 6 are the normalized concentrations of aerosol particles as a function of distance from the center of the MOUDI aerosol deposit at spatial resolutions of 1, 0.25, and 0.10 mm, respectively, when averaged over all analyzed samples. The uncertainty in Figs. 4-6 is the standard deviation of these samples."

[2] In addition, have you looked into the effect on the normalized particle concentration of the 0.5 mm uncertainty in centering the microscope viewing area and the hydrophobic glass cover slip to the deposit center? Your results show that there are non-uniformities at the 0.1mm scale, hence they might as well exist in the y-direction (perpendicular to the line through the center).

[A2] Here we think the referee is pointing out that we have only taken into account a 0.5 mm uncertainty in the x-direction, but there also may be an effect in the y-direction. In response, in the regions where we are analyzing the DFT, we are far enough from the center of the aerosol deposit that an uncertainty of 0.5 mm in the y-direction does not significantly influence the measured particle concentrations in the x-direction or the derived correction factors. The 0.5 mm uncertainty in the y-direction only changes the correction factors by approximately 1 % at most. This is because particles are concentrated in rings, and the radii of the rings are relatively large where we are analyzing the DFT (radius of the rings varies from 2.4 to 10.1 mm).

[3] The comparison to the CFDC measurements are a good first step to validate the MOUDI-DFT method. However, only two data points with some uncertainty in both instrument's measurements is not enough to proof the accuracy of the new method. Thus, as promised by the authors, further comparison studies are necessary in the future.

[A3] We agree with the referee.

[4] Are the results expected to be affected by different aerosol types?

[A4] At this point we do not know if the intercomparison results depend on the aerosol type. Different levels of agreement have been observed in past intercomparison studies depending on the aerosol type studied. For example, more disagreement between instrumentation was found when investigating the immersion freezing properties of illite NX (Hiranuma et al., 2015) than when using Snomax (Wex et al., 2015). Hence additional intercomparison studies are needed with different aerosol types. To address the referee's comments this discussion has been added to the revised manuscript.

[5] Specific Remarks Page 2227, Line 7: Please clarify at this point already if size is (aerodynamic, geometric, mobility) diameter or radius?

[A5] This line has been revised with additional details:

"For example, instruments based on the continuous flow diffusion chamber (CFDC) design of Rogers et al. (2001) limit the size of particles analyzed to those with an aerodynamic diameter ≤ 0.75 µm in some cases (DeMott et al., 2003) and ≤ 2.4 µm in others (Garcia et al., 2012)."

[6] Page 2237, Line 3: What are the standard deviations of temperature and SSw of the CFDC during each of the two experiments?

[A6] This sentence has been revised to include the requested information:

"In sample CSU-1 the average CFDC temperature and SS_w with 1 SD uncertainty were −21.7 ± 0.3 °C and 5.5 ± 0.6 %, respectively, while in CSU-2 the CFDC conditions were −26.6 ± 0.2 °C and 5.8 ± 0.6 % SS_w."

The uncertainties in the CFDC temperature and SS_w have also been added to Table 1.

[7] Page 2237, Line 4: If it cannot be ruled out that dust was a major component of the samples, the factor 3 should be treated as an uncertainty in the CFDC data.

[A7] The recent work of DeMott et al. (2015) showed that the CFDC may underestimate the INP concentration in some samples of natural mineral dust by a factor of 3, but more work is needed to determine if ambient aerosols in general are similarly underestimated. Therefore, we feel that it would be premature to apply this correction to the samples of this intercomparison for the data presented in Fig. 9. However, to address the referee's comment the paragraph of 2237/9-17 has been revised to the following:

"DeMott et al. (2015) found that CFDC measurements of natural mineral dust where particles were exposed to an SS_w of approximately 5 %, as was used in this study, resulted in an under-prediction of INP concentrations by a factor of 3 when compared to the use of a higher SS_w (approximately 9 %). It was therefore suggested that a correction factor of 3 be applied to INP concentrations of mineral dust samples determined by the CFDC using an SS_w of 5 %. More work is needed to determine if INP concentrations are similarly underestimated in general ambient aerosol samples such as those of this study, but the potential impact of this factor of 3 on the intercomparison results is discussed in Sect. 3.5."

A new sentence has also been added to Sect. 3.5 beginning at 2243/5:

"If we apply a correction factor of 3 to the CFDC data due to this technique underestimating the INP concentration (DeMott et al., 2015), a possibility noted in

Sect. 2.6 although not established for our sampling conditions, the average INP concentration found by the CFDC would be greater than that of the MOUDI-DFT by a factor of 11.5 in sample CSU-1 and 2.6 in sample CSU-2."

[8] Page 2237, Line 22: Are representative particle size distribution measurements available for this location which could be used to validate or constrain this factor?

[A8] Total aerosol particle size distributions are available, but during measurements at both CSU and other locations (e.g. Mason et al., 2015) we found that INP and total particle size distributions do not match. As our data does not suggest that using the total particle size distribution to constrain this factor would improve its accuracy, we therefore prefer to keep the current method.

[9] Page 2241, Line 24: Does fnu,0.25-0.10mm vary with the number of sections used in the described calculations? Have you looked into that and could comment on it?

[A9] The non-uniformity correction factor $f_{nu,0.25\text{-}0.10mm}$ does change with the number of sections used. If too few sections are used such that aerosol deposit non-uniformity is not sufficiently captured, the value of $f_{nu,0.25\text{-}0.10mm}$ will be too small. We used four sections for stages 2–5 as non-uniformity in these stages was not found at spatial scales below 0.25 mm, and we used ten sections for stages 6–8 as non-uniformity in these stages was found down to spatial scales of 0.10 mm. Using more steps would not change the value of $f_{nu,0.25\text{-}0.10mm}$. The following sentences have been added to 2241/25 for clarity:

"The number of sections used to divide the microscope viewing area was selected for each MOUDI stage such that the section width was smaller than or equal to the spatial scale of non-uniformity. If fewer (i.e. wider) sections are used, non-uniformity is not sufficiently captured and $f_{nu,0.25\text{-}0.10mm}$ is under-estimated. However, using more (i.e. narrower) sections does not change $f_{nu,0.25\text{-}0.10mm}$."

[10] Technical corrections Page 2226, Line 7: change 'can be' to 'is.'

[A10] Correction made.

[11] Page 2231, Line 19: Replace 'video images (. . .) were' by 'video recording (. . .) was' or 'image recording (. . .) was', depending on what has been done.

[A11] This sentence has been changed to the following:

"In the DFT, a hydrophobic glass cover slip that contained particles collected with the MOUDI was placed on the base of the flow cell, the rest of the components of the flow cell were then assembled, and a video recording of the particles was initiated (Fig. 2a)."

[12] Page 2232, Line 7-8: insert a minus sign before '1°C'.

[A12] Correction made.

[13] Page 2237, Line 11: replace ‘under prediction’ by ‘underprediction.’

[A13] Correction made to “under-prediction.”

[14] Page 2238, Line 22: change ‘three SDs’ to ‘three standard deviations (SDs)’s.

[A14] The use of “SD” was chosen by the editor of the manuscript.

[15] Page 2261, Line 6: delete ‘in’ before ’found.’

[A15] Correction made.

References:

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