## Review of "The Fifth International Workshop on Ice Nucleation Phase 3 (FIN-03): Field Intercomparison of Ice Nucleation Measurements," by P. J. DeMott et al. 2024

It was a pleasure to read "The Fifth International Workshop on Ice Nucleation Phase 3 (FIN-03): Field Intercomparison of Ice Nucleation Measurements," by P. J. DeMott et al. 2024. The manuscript presents data and summarizes results from the third of a series of instrument measurement comparisons that were aimed at achieving better collective community understanding when it comes to measuring ice nucleating particles (INPs). The focus of the third effort was utilizing a subset of instruments used in the first two phases, to focus on making field measurements of ambient air. While many of the same instruments were used in FIN-02[1], that study's focus was on laboratory-based measurements. The field-based FIN-03 measurements add complexity due to the heterogeneous nature of ambient aerosol and the low naturally occurring concentrations of INPs. The FIN campaigns are well known and brought much of the community together, but given the summarized measurements were conducted in 2015 it has been a bit of a wait to see the outcomes of the 3rd phase published. The results summarized in the submission remain well worth reporting and valuable to the community at large. However, in its current form the manuscript lacks polish and consistency, which diminish its readability. Moreover, given the large gap between when the measurements were made and their submission in this form, the submitted work seems to, in places, lack connections to work published in the intervening years. This is not a blanket statement, as some more contemporary results (references) are used, but there is a lack of consistency that again points to a need for a systematic review of the manuscript.

I suggest that the author's take into consideration the contextualized comments I include below and resubmit an updated manuscript.

### Itemized Scientific and Editorial Comments:

*Suggestions are given by line number taken from the downloaded pre-print PDF document:*

• (Abstract, 48) strike "a subset of"

• (Abstract, 50) suggest a rephrasing to: Composition of the total aerosol was characterized using ...

• (Abstract, 55) suggest a rephrasing to: Mineral dust containing particles were ...

• (Abstract, 56) should probably be diameters

• (Abstract, 58) Here and throughout the text (lines 93, 186, 187 etc.) the symbol $\sim$ is used where $\approx$ would be a better choice. Although not always strictly followed, generally the former, 'similar to', means the same order of magnitude. Most often the author's intention it seems is the later, which is 'approximately'.

• (Abstract, 67) Should this say: ....order of magnitude or more, more efficient

• (Abstract, 76) strike "at most times"

• (79) suggest a rephrasing to: Aerosol particles that ...

• (140-143) A reference (and probably in other places) to Brasseur et al.[2], seems like it should be included. Much like the campaign summarized by the Lacher et al.[3] paper, the Brasseur et al.[2] Measurement Report describes intercomparison and measurements by instruments for counting INPs, including a subset of the instruments used in FIN-03.

• (171) suggest to replace "aerosol" with particle.

• (228) A Thomson et al. (2000) paper is referred to but is not found in the listed references.

• (323-324) suggest a rephrasing to: ...all ice nucleation instruments utilized in FIN-03 is provided in Table 1. Detailed operating principles, locations of samplers ....

• (362) "Frost corrections are defined through..." The wording is strange here. Suggest replacing through with, using or utilizing, or somehow rephrasing.

• (§2.2) A general comment on the presentation of instruments and instrumental setups in §2.2, both §2.2.1 and §2.2.2. I would suggest the author's do a careful re-reading of the instrument sections

and that they re-write the sections such that equivalent information is presented for each instrument. During reading the lack of consistency became most apparent in §2.2.2, but this forced me to return to the earlier text and notice a general lack of consistency. When presenting different instruments different details are presented, and it is not evident why or what, if any, importance these differences indicate. For example, for the NC State - CS the temperatures of sample storage are included, but not in the case of the CSU-IS. My intent is not that the author's should include all the information for all the instruments. Rather the author's should decide on what are the important and relevant parameters and make sure to present them uniformly. The reader should have the same information for all apparatuses. Alternatively, they must tell the reader why some things are important for some instruments but not for others.

The current presentation is both a-systematic and simultaneously uninformative as to why/how the information that is presented is chosen.

• (370) "(by 3 time)" by a factor of 3?

• (378 and again at 407) The o.d., which I take to mean 'outer diameter' is an irrelevant dimension here, as it gives no information concerning inner diameter.

• (411-412) The "low-pass filter" sentence seemingly comes from nowhere? Why are these counts removed? I do not follow the logic at the beginning of this paragraph.

• (447) suggest: ...has been previously...

• (462) suggest: ...except that Teflon tape replaced stopcock grease sealing the impinger...

• (491) suggest: ...2 m distant.

• (501-502) suggest: ...suspension estimated using Eq. 1. (Vali has been cited when presenting the equation.)

• (549-550) suggest: ....specific analytical procedures differ.

• (560) suggest: ...is derived using Eqs. 1 and 2.

• (563-566) This is a confusing description of the EAC's working architecture and may not even be necessary given the instrument papers available. I would suggest re-writing if it is to be included. For example, what does "12 kV against a grounded..." mean? I think that it must be that the 12 gold wires have an applied 12 kV electric potential.

• (576) suggest: At SPL samples were taken with the EAC for ...

• (Figure 2, plus caption) The font in panels (a) and (b) is extremely small and hard to read, make uniform with (c) which is much better. (c) is entirely missing from the caption, although I take it that it is described beginning with, "Timeline...."

• (666) extra (

• (759-760) suggest: ...during a period of warming

• (766) I find it strange that figure S3 is referred to before figure 7 appears in the text, as S3 seems to be a distillation of Figure 7. It seems the authors should carefully consider their choices as it regards these results and figures. Moreover, both aforementioned figures strictly speaking present the 1:1 comparison incorrectly. In Figure S3 a blue FRIDGE-CS bar should show 100% agreement in the FRIDGE-CS column, and so on for all instruments compared with themselves. Currently they are missing, and the caption does not mention that the 1:1 comparison is ignored because it is 100%. The same is true of the diagonal of the figure matrix in Figure 7. In fact, S3 is a bit of a strange presentation, and perhaps some sort of matrix like presentation with a heat map (for example) would be better, but "agreement within 1 order of magnitude" is a bit awkward in general. Figure 7 is more informative but quite busy, and this might be the better figure for the supplement. Albeit I would include 1:1 or 100% agreement along the diagonal for rigor.

In general, I would suggest this information could be better presented and communicated and would suggest the author's re-imagine these figures.

• (Figure 6) Are all temperatures necessary? For the main text perhaps a distilled figure focusing on a few temperatures, or results for temperature averages could be a better alternative and more effective at communicating the point. Also, some lines connect points across missing data points at the warmest temperatures, where I assume no activation was observed. I would suggest that these points are better left unconnected, for clarity of the figure, but also because it is likely the value is actually 0 INP or below the resolution. For the CSU-CFDC panel (e) such data points are not connected, which is a much better approach than in some of the upper panels.

In the figure caption, use the accronyms as they were introduced in the text. Strike “from Goethe University Frankfurt”. This kind of information appears in the text and does not need to be reproduced in a caption.

• (page 40) A general question when using the comparison that 1 order of magnitude is a good agreement. It would be worthwhile to present a simple calculation to quantify how many particles (i.e., activated droplets or volumes in immersion freezing) result in an order of magnitude change. At some temperatures and concentrations, the counting statistics may be rather poor, it would be interesting to address this given the already dilute nature of the ambient sampling.

• (Table 2) I see the CF constant discussed in the text, but no discussion of the other constants in the Table. Are these taken from previously published literature? Or used as fitting parameters here in some minimization scheme? Please illuminate.

• (989) “trends better” what is meant here? correlates?

• (1200) again the Brasseur et al.[2], seems like it should be included.

• (1240-1241) Rephrase, “factor of a few increases” Something here is awkward and unclear. Deposition freezing increases with increasing RH?

• (1246) Again awkward phrasing, “...achieved statistical significance from the CSU-CFDC data.”

• (References) In addition to the previously mentioned Thomson text, the Burrows, 2022 paper that is referred to is not found in the Reference list.

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[1] DeMott, P. J., Möhler, O., Cziczo, D. J., Hiranuma, N., Petters, M. D., Petters, S. S., Belosi, F., Bingemer, H. G., Brooks, S. D., Budke, C., Burkert-Kohn, M., Collier, K. N., Danielczok, A., Eppers, O., Felgitsch, L., Garimella, S., Grothe, H., Herenz, P., Hill, T. C. J., Höhler, K., Kanji, Z. A., Kiselev, A., Koop, T., Kristensen, T. B., Krüger, K., Kulkarni, G., Levin, E. J. T., Murray, B. J., Nicosia, A., O'Sullivan, D., Peckhaus, A., Polen, M. J., Price, H. C., Reicher, N., Rothenberg, D. A., Rudich, Y., Santachiara, G., Schiebel, T., Schrod, J., Seifried, T. M., Stratmann, F., Sullivan, R. C., Suski, K. J., Szakáll, M., Taylor, H. P., Ullrich, R., Vergara-Temprado, J., Wagner, R., Whale, T. F., Weber, D., Welti, A., Wilson, T. W., Wolf, M. J., and Zenker, J. (2018). The Fifth International Workshop on Ice Nucleation phase 2 (FIN-02): laboratory intercomparison of ice nucleation measurements. *Atmospheric Measurement Techniques*, 11(11):6231–6257.

[2] Brasseur, Z., Castarède, D., Thomson, E. S., Adams, M. P., Drossaart van Dusseldorp, S., Heikkilä, P., Korhonen, K., Lampilahti, J., Paramonov, M., Schneider, J., Vogel, F., Wu, Y., Abbatt, J. P. D., Atanasova, N. S., Bamford, D. H., Bertozzi, B., Boyer, M., Brus, D., Daily, M. I., Fösig, R., Gute, E., Harrison, A. D., Hietala, P., Höhler, K., Kanji, Z. A., Keskinen, J., Lacher, L., Lampimäki, M., Levula, J., Manninen, A., Nadolny, J., Peltola, M., Porter, G. C. E., Poutanen, P., Proske, U., Schorr, T., Silas Umo, N., Stenszky, J., Virtanen, A., Moisseev, D., Kulmala, M., Murray, B. J., Petäjä, T., Möhler, O., and Duplissy, J. (2022). Measurement report: Introduction to the HyICE-2018 campaign for measurements of ice-nucleating particles and instrument inter-comparison in the Hyytiälä boreal forest. *Atmospheric Chemistry and Physics*, 22(8):5117–5145.

[3] Lacher, L., Adams, M. P., Barry, K., Bertozzi, B., Bingemer, H., Boffo, C., Bras, Y., Büttner, N., Castarede, D., Cziczo, D. J., DeMott, P. J., Fösig, R., Goodell, M., Höhler, K., Hill, T. C. J., Jentzsch, C., Ladino, L. A., Levin, E. J. T., Mertes, S., Möhler, O., Moore, K. A., Murray, B. J., Nadolny, J., Pfeuffer, T., Picard, D., Ramírez-Romero, C., Ribeiro, M., Richter, S., Schrod, J., Sellegri, K., Stratmann, F., Swanson, B. E., Thomson, E. S., Wex, H., Wolf, M. J., and Freney, E. (2024). The Puy de Dôme ICe Nucleation Intercomparison Campaign (PICNIC): comparison between online and offline methods in ambient air. *Atmospheric Chemistry and Physics*, 24(4):2651–2678.