Response to anonymous Reviewer 2 comments on "The Fifth International Workshop on Ice Nucleation phase 2 (FIN-02): Laboratory intercomparison of ice nucleation measurements"

We thank the reviewer for both the positive comments as well as detailed additional comments and corrections.

General Comment: As a general comment, I do think the Summary and Conclusion section could have expanded the "do's and don't's" a bit. The authorship represents a large number of those active in the field and I do not think it would be giving away any secrets if they discussed a bit what failed, or was discovered not to have worked during the campaign. Also, they do make a few suggestions for the future, but I am left wondering if the community came no closer to formulating certain experiments that could be done side-by-side anytime two or more instruments are co-sampling. In other words, does any suggested minimum protocol emerge to assess the agreement between instruments? Perhaps a complete picture and set of recommendations emerging from FIN-02 will be detailed in another publication?

Authors' response to General Comment: While the goal of the workshop was not necessarily to fashion protocol for all future such instrumental comparisons, nor to be judgmental, we agree with the reviewer that we could expand our recommendations, and point to things that could/should be done in a comparison involving any particular number of participants. At the same time, it is clear to those involved that the composite results of all three phases of the workshop will be needed to provide a complete picture and set of recommendations. Additional papers in that regard are forthcoming. <u>We have completely reorganized and added to the Summary and Conclusions of this paper on the basis of the requests of both reviewers.</u>

Changes in manuscript re: General Comment:
The Conclusions have been reorganized, first by summarizing and augmenting the initial discussion within the structure of the objectives listed in the Introduction of the paper, and secondly by adding a list of topics recommended for further research. As this section amounts to nearly 6 pages, we append it specially to the end of this response after first completing responses to itemized editorial comments.

<u>Itemized Editorial Comments (page/line):</u>

Comment 1. *Page/line* 1/38 item b only has a departmental affiliation it is missing an institutional affiliation.
Comment 1 author response/manuscript change: Thanks, corrected.

Comment 2. Page/line 6/16-18 What comes after the comma at: "...Fig. 1, and why..." does not make sense as written. The why results are given at certain RH is not noted? I think the clause needs to be rewritten.
Comment 2 author response/manuscript change: We have rewritten this section for clarity: *"Therefore, a single RH_w level for this condition to occur is not noted in Fig. 1. Instead, results are stated as being associated with*

specific RH_w values (or % supersaturation values, which equal RH_w-100) that are simply a value that was lower than the droplet breakthrough condition in some cases. In other cases, the maximum RH_w achievable prior to droplet breakthrough is reported."

Comment 3. Page/line 7/28 I recommend you change "in this manuscript" to 'presented here'.
Comment 3 author response/manuscript change: Changed as requested.

Comment 4: Page/line 7/30 This first sentence of the section is long and awkward. I recommend it is changed. It can be split into 2 sentences.
Comment 4 author response/manuscript change: Done

Comment 5: Page/line 8/4-5 thermodynamic paths not path • 8/10 would limit particle loading
Comment 5 author response/manuscript change: Changed as requested.

Comment 6: Page/line 8/18 activation temperatures instead of "temperatures of activation". Also, add 'and referenced' after "...are listed". I was looking for the instrument references as I was reading and did not realize they were in the table until getting there. Finally, I suggest striking "Details on all of" rather begin the next sentence with "The specific ..."
Comment 6 author response/manuscript change: Changed as requested. Reference to Table 1 was also added on Page 5.

Comment 7*: Page/line 9/1 I recommend "besides" is changed to 'in addition to'*
Comment 7 author response/manuscript change: Changed as suggested.

Comment 8: Page/line 9/3-5 The sentence beginning "In this regard..." is awkward and should be rephrased. Is it the recommendation of the 2007 workshop, or previous workshops and it was followed in 2007?
Comment 8 author response/manuscript change: Rewritten as, *"In this regard, we follow the example of the 2007 workshop, and a key recommendation from ice nucleation workshops prior to that time, that an expansion cloud chamber be utilized to provide a simulation of cloud activation (DeMott et al., 2011)."* This is discussed in the 2011 paper and references to prior workshops are provided.

Comment 9: Page/line 9/5 recommend change to 'Schematic thermodynamic paths of the AIDA chamber experiments are shown by the ....'
Comment 9 author response/manuscript change: Changed as suggested.

Comment 10: Page/line 9/20 suggest '....cloud regime (i.e., 0 to -36 C). Thus they provide....'
Comment 10 author response/manuscript change: Changed as suggested.

Comment 11: Page/line 10/12 suggest wording is changed to 'However, in some experiments larger particles were present ...'
Comment 11 author response/manuscript change: Changed as suggested.

Comment 12: Page/line 10/13 should "some cases" be 'those cases'
Comment 12 author response/manuscript change: Corrected.

Comment 13: Page/line 12/2 I suggest that when ns,geo(T) is defined the units [m−2] are included.
Comment 13 author response/manuscript change: Done.

Comment 14: Page/line 13/6 suggest wording is changed to 'A striking feature of these results is the general correspondence between all methods ...'
Comment 14 author response/manuscript change: Changed as suggested.

Comment 15: Page/line 13 /14 suggest 'The greatest discrepancies' replace "Greatest discrepancies..."
Comment 15 author response/manuscript change: Changed to "The largest…"

Comment 16: Page/line 13/15 "Supplemental" should be 'Supplement'
Comment 16 author response/manuscript change: Done.

Comment 17: Page/line 13/19 suggest wording is changed to '...understanding of what RHw value might...."
Comment 17 author response/manuscript change: Changed as requested.

Comment 18: Page/line 13/23 The final sentence of the paragraph ending, "... Fig. 4 is encouraging" is oddly placed in a results section. I think it is extraneous.
Comment 18 author response/manuscript change: Removed.

Comment 19: Page/line 14/15 replace "at the same time" with 'simultaneously'
Comment 19 author response/manuscript change: Changed.

Comment 20: *Page/line 14/27 replace "Comparison" with 'A comparison'*
Comment 20 author response/manuscript change: Done.

Comment 21: Page/line 15/17-20 This is a very long and confusing sentence, I suggest rewording.
Comment 20 author response/manuscript change: This section is rewritten as, *"All immersion freezing methods capture the strong rise in activation due to the presence of the most active biological ice nucleators, those within the*

realm of the Groups I and II as defined by Yankofsky et al. (1981). This is expressed as a pronounced shoulder in all freezing spectra at temperatures warmer than -8°C in Fig. 7. We may note here that all bulk freezing methods shared the same impinger sample in this case, including the IS. This warm shoulder of ice nucleation activity has also been demonstrated by Wex et al. (2015), Budke and Koop (2015), and Polen et al. (2016)."

Comment 22: *Page/line 15/29 Should it not be CMU-CS?*
Comment 20 author response/manuscript change: Yes, corrected.

Comment 23: Page/line 15/33 awkward wording. The source of variations question?

Comment 23 author response/manuscript change: Rewritten as, *"In summary, the strong variability in activity seen at the warmest activation temperature regime for Snomax® particles brings into question the ability to utilize the warmest temperature (> -10°C) freezing behavior of Snomax® reliably for calibration purposes. This has been noted previously by Polen et al. (2016), and attributed to batch variability and the loss of activity during storage."*

Comment 24: Page/line 22/1 "provide the decision" is awkwardly worded.
Comment 24 author response/manuscript change: Replaced with "…provide guidance…"

Comment 25: Figure 3 caption – The caption fails to define what the differently colored points indicate. Furthermore, I suggest the 2 light blue shadings be somehow differentiated. If my understanding is correct then I think the 2nd sentence would read, "An initial impinger and filter sampling period is highlighted in light blue 1 and is followed by an APC refill and subsequent sampling period (light blue 2). In any case I think the caption should be carefully reread and reworded for clarity.
Comment 25 author response/manuscript change: We had hoped for the colored scales to direct eyes to the appropriate axes, but for clarity we have rewritten it all as, *"Data from the first half of a daily experimental series, after an initial fill of Tunisian soil dust (Experiment 11 and 12 of the FIN-02 APC series on March 18, 2015) into the APC at a time (time 0) taken to be the experimental start time. Impinger and filter sample periods after two separate chamber fills are highlighted in light blue shading. To obtain a reference aerosol concentration (cm^{-3}) via the CPC (total particles) (blue points and left scale) or optical particle counter at sizes larger than 500 nm (n_500 (brown points and right scale), as well as surface area ($\mu m^2\ cm^{-3}$) (black points and left scale) for the offline sampling period, the time-weighted average of the two sampling periods was determined. This period-integrated concentration value could then be used to ratio versus the concentrations of particles present at later sampling times during the online sampling of aerosols from the APC (green shaded region) in order to back-correct the online INP number concentrations to those interpreted from the offline samples."* The text section describing the procedure is already quite detailed, and does mention the fact that there were sometimes two sample chamber fills, and sampling periods for which the integrated particle number values and surface areas are determined.

Comment 26*: Figure 4 caption – Suggestions: (1) strike "on some points" (2) replace "buried within" with 'subsumed by' (3) add '...errors) or alternatively the binned...'*

Comment 26 author response/manuscript change: Changed as suggested.

Comment 27: *Figure 7 caption – bring "in this case" to beginning of sentence*

Comment 27 author response/manuscript change:

Done.

Comment 28: Figure 8 may be better presented vertically for such a 2 column journal? Perhaps the authors intend to stretch this over the entire page? Currently the text seems somewhat small. (also Figures 9-11).

Comment 28 author response/manuscript change: Due to the length of the caption, we will suggest to place these figures across the entire page, unless the editors suggest otherwise. And although the text is somewhat small, there were many different instruments to indicate, and it should be possible for most to expand the figures in PDF format. But again, we will go with the decision of the copy editors in this case.

Comment 29: General figure comments: Can the chosen color schemes for the instruments remain consistent between those figures that represent APC and AIDA data? Also, I think making many of the figures box plots with at least the major tick marks represented on the minor axis would be more reader friendly.

Comment 29 author response/manuscript change: It was indeed the intent to maintain color schemes for different data across figures. We will recheck that this is done. Once we began to introduce AIDA data at Figure 8 and beyond, and when we desired to show both soil dusts together in Figure 10, it complicated matters, so we simply made all of the online instruments black (or green and black in the case of Fig. 10). This also assisted with shading the APC versus AIDA sampling points in the later figures. We revise now to use black symbols for flow chambers all the way through the figure series, and we distinguish IS and FRIDGE-IMM series as blue in the APC figures now. The exception to this overall scheme will continue to occur in Figure 10, where green is used to distinguish the two dusts amongst the direct sampling instruments. As for the scaling on box plots, it would be too difficult to add the extra scale in the AIDA figures and simultaneously keep the long legends that are perhaps for important for easily distinguishing instruments. For that reason, we do not add the secondary scales on any of the figures.

New Conclusions section:

4 Summary and Conclusions

Through careful coordination and collaboration in a laboratory setting, most of the objectives of the second phase of the Fifth Ice Nucleation Workshop were strongly advanced if not fully achieved, and the existence of the data set should continue to serve explorations of measurement consistencies and issues for applying different techniques in isolation or in tandem for making atmospheric ice nucleation measurements. Extensive comparisons involving a large number of teams and using multiple INP types were made within just a three-week workshop. Some operational issues occurred for investigators at times (obvious errors, measurement biases, inability to achieve comparative conditions for proximal immersion freezing) and where these were recognized, data were either not entered into comparisons or in a few cases were revised. Some issues were investigated, such as the appearance of small ice in the CSU CFDC data for INPs with steep activation functions. Others remain the subject of active investigation.

We may summarize the workshop results generally around the stated objectives as follows:

1) *Compare ice nucleation measurement systems for conditions considered to be equivalent as much as possible, across a wide dynamic temperature range, including temperatures warmer than -15°C.*

To simplify this first analysis of FIN-02 data, a focus was placed in this paper on immersion freezing nucleation and activation within continuous flow chambers in the water supersaturated regime, across a wide temperature range including temperatures warmer than -15°C through the use of bacterial INPs in selected experiments. The proximal behavior model for comparing immersion freezing by direct processing instruments versus bulk immersion freezing methods worked reasonably well, excepting cases noted later in this summary. Very good correspondence was obtained between many measurements for soil dusts and bacterial INPs, both ~~across~~ amongst instruments that directly-processed single particles and those that post-processed bulk aerosol collections for assessing immersion freezing INP concentrations (Figures 4 – 7). Agreement of INP number concentrations and geometric active site density within less than about 1 order of magnitude was achieved under most circumstances analyzed herein for these three materials. This was strictly demonstrated for both direct and post-processed samples over a more limited the temperature range, approximately -20 to -30°C for the soil dusts and -10 to -30°C for the bacterial INPs. For these atmospherically-relevant particle types, no strong biases between the two basic types of measurement systems were evident in this range of overlap.

The fact that agreements were quite good overall in this study may have been strongly assisted by the combination of co-sampling the same aerosol particle sources in the same laboratory, sharing similar collected aerosol samples, and limiting the largest particle sizes assessed in workshop experiments to those that could readily be measured by all techniques. The nature of active sites for the various INPs examined may also have influenced comparability of direct particle sampling versus post-processed bulk collection methods. Consequently, it appears that soil dust particles are much more equally assessed for INP content than some minerals and mineral mixtures, and may better serve as potential calibration INPs. This was supported by the worst agreement between methods, up to three orders of magnitude, for illite NX and the FS02 samples that have a very steep activation spectra versus temperature, which exacerbates disagreements that otherwise represent only a few degrees of temperature change. In the case of illite NX, discrepancies seen in Hiranuma et al. (2015) were reproduced at temperatures warmer than -25°C. The steep activation behavior of the FS02 also led to the finding that when sampling such INP types, cooling to achieve evaporation in the exit section of a CFDC can express "late" activation of ice crystals that remain at small sizes and should not be attributed to the set point temperature of the instrument growth region. This may be an issue primarily for laboratory measurements of such INPs, since most natural INP T-spectral slopes are lower than for many of the samples tested, often only approximately 2 orders of magnitude per 10°C, rather than 5 orders or more per 10°C (DeMott et al., 2017; Price et al., 2018).

Assessment of agreement between direct processing of single particles and post-processing measurement systems was mostly only possible below -20°C since flow chamber devices have a limit of detection which restricts measurements at warmer temperatures. The exception is in cases where the higher concentrations of bacterial INPs were assessed. Since biological/biogenic INPs are the most likely contributors to freezing at modest supercooling (e.g., Murray et al., 2012; Hoose and Möhler, 2012), it would seem valid that combining bulk aerosol sampling measurements to capture INPs at very modest supercooling with direct measurements extending to colder temperatures within the same atmospheric study will lead to a reasonably valid representation of immersion freezing INPs (e.g., DeMott et al., 2017; Welti et al., 2018).

2) Gain insights into how detection of ice nucleation is influenced by the specific configuration of similar measurement systems.

Among measurements on samples collected for post-processing, there was no particular or consistent bias between different approaches to bulk suspension measurements. Furthermore, there appears to be little discrepancy between measurements made with particles collected directly into liquid versus collection onto filters followed by resuspension into liquid. There also appear to be no discernable impacts of freezing samples versus processing them immediately, on the basis of the μl-NIPI versus other methods apart from impacts on the warmest temperature freezing of bacterial particles (e.g., results from Snomax® experiments). Factors affecting reproducibility, such as accuracy of temperature attributed to sample freezing and instability of the warmest bacterial INPs, are the most important factors affecting the agreement between methods, which often spans an order of magnitude overall. Most measurement groups have likely performed careful assessments of their temperature measurements attributed to droplet volumes, but there is evidence that errors may occur due to the inability to perfectly assess temperature at the point of freezing (Beall et al., 2017).

For diffusion chamber measurements of collected particles, the need for awareness of volume effects on processed INPs remains as a requirement. Results in a few cases showed these measurements to fall to the low side in assessing immersion freezing nucleation. It may be necessary to collect varied volumes to assure that particle loading in different cases is not influencing accurate assessment of INP number concentrations.

Differences between INP measurements in the water-supersaturated regime by continuous flow chambers were seen, and these differences likely relate to the need of these systems to achieve higher than expected RH_w in order to fully activate aerosols to facilitate their subsequent immersion freezing on the full particle population within the diffusion chambers (DeMott et al., 2015; Garimella et al., 2017; Burkert-Kohn et al., 2017). These instruments may universally have an issue in focusing aerosol particles reliably into the center of the imposed RH_w field, among other factors that depend on particle types, including their hygroscopicity and ability to activate ice nucleation already in the sub-water saturated regime (not discussed in this paper). Solving the issue(s) involved could provide the guidance on correcting these data for the RH_w-sensitivity factor present in the water supersaturated regime for all of these devices. Different systems have varied ability to achieve higher RH_w, depending on the different water breakthrough RH_w as imposed by device design (see Section 3 and Section S.1.2). For example, it was noted that the PINC instrument more commonly measured INP concentrations at the lower range of the flow chamber devices, which may be attributable to its shorter residence time. These systems will continue to be used in this manner to measure atmospheric INP activation, but will struggle to equivalent capture activation to the same degree until issues are solved. Such solutions could involve redesign of how samples are introduced to the chambers. This is clearly deserving of special study, which was beyond the scope of this workshop. Study of the use of different evaporation region temperatures also merits attention as it may impact detection of ice formation at higher RH_w. Limitations on assessing the impacts of larger aerosols as INPs in continuous flow instruments will remain, unless special inlets are developed.

Of note in this study is the agreement between most direct sampling and post-processing measurements at the colder temperatures in comparison to the large discrepancies found in a recent study comparing measurements of ambient particles (DeMott et al., 2017). We believe that this is attributable to assuring comparability of measurement methods in FIN-02 by restricting particle sizes so that all methods captured most of the largest particles in the distribution. This likewise implies that discrepancies between direct and post-processing methods can be expected to occur in ambient sampling when larger particles are present, although the source of those discrepancies as true impacts (i.e., of larger particles acting as individual INPs versus-breakup of INPs after time in bulk suspensions) must remain a topic of future research. Both bulk sample immersion freezing and proximal immersion freezing in the flow diffusion chambers sometimes underestimate freezing in comparison to the PIMCA-PINC single particle immersion freezing method. For CFDC type instruments, this is partly understood as the need to achieve much higher RH_w, sometimes practically unachievable, to effectively simulate and capture immersion freezing (previous paragraph), requiring corrections that were not applied in this study. Whether such corrections are the only reason for discrepancies with PIMCA-PINC require further investigations. Reasons why the bulk immersion freezing methods do not always agree with PIMCA-PINC may relate in some unresolved manners to factors at play during extended bulk immersion, such as breakup, sedimentation, and alteration of active sites. It would be helpful if the PIMCA-PINC method could be extended to lower active fractions and INP concentrations, but this appears to be a fundamental limitation of the phase discrimination technique.

3) Utilize different INP types to investigate if differences between instruments vary with these different types.

The use of varied INP types was clearly vital in achieving the first two objectives summarized above. For example, the use of a highly active biological INP type clearly helped to demonstrate that there is not fundamental limit on INP detection by any method if limits of detection are met. It is not known if this conclusion is peculiar to the biological INPs, although these may be the most common and important type to detect in the warmer supercooled temperature regime. While the utility of Snomax® as a calibration INP was again demonstrated here, issues in achieving well-defined active fractions at temperatures above -9°C via post-processing of bulk collections for immersion freezing found in previous studies were repeated herein. Comparisons with direct processing methods was not obtained in this temperature regime, making this an important topic for future studies.

The use of both natural soils and mineral samples as INPs allowed for seeing that the soil INPs were more consistently measured within and across measurement methods compared to the mineral component K-feldspar and a material representing key mineral compounds of desert dust aerosols (illite NX). The steeper nucleation rate functions of the minerals were key to identifying the potential bias in production of ice nucleation in the evaporation sections of the CSU and INKA CFDC's, likely due to the additional cooling occurring there. Other devices that warm the airflow while reducing the relative humidity toward ice saturation to evaporate activated cloud droplets did not see small ice crystal production. Detection of the small ice crystals produced in this manner can be largely biased against through adjustment of the channel size used for ice detection in the optical particle counter, although mitigation through redesign may provide a more satisfactory long term solution. Further investigation of this issue is merited.

Through the use of multiple INP types, results from this workshop could also be compared versus previously published parameterizations. These comparisons were very encouraging for demonstrating reproducibility of laboratory study results in general, further supporting the picture of general consistency of present INP measurements within identified uncertainties.

The FIN-02 archive will remain for additional scientific investigations, such as at least limited comparisons in the ice nucleation regime below water saturation (see below), analysis of experiments regarding homogeneous freezing and the role of particle pre-activation for ice formation. While the FIN-02 workshop objectives were generally achieved, a number of topical needs remain and some recommendations are suggested.

- Although the coordinated sampling protocols during FIN-02 worked very well, and the possibility of establishing certain calibration standards was suggested, it is not practical for the majority of members of the international INP measurement community to gather with high frequency for such activities. It may be possible that similar correspondence of measurements can be obtained through the distribution of some standards and the use of defined aerosol generation protocol. A basic attempt at such an exercise that restricts sample types to a natural dust and bacterial INPs is worth exploring, as a wide distribution exercise has only thus far occurred for illite NX. The general correspondence of present workshop data with n_s parameterizations derived in previous laboratory studies provides a positive outlook.
- Special investigation of detection of ice formation in the regime below water saturation remains as a need that will be only partially addressable with FIN-02 data due to somewhat limited range of temperatures assessed by most direct processing instruments. While the number of instruments involved in such an assessment is more limited, it is no less important for evaluation in regard to the use of ice nucleation instruments in the colder regions of the troposphere. For example, are similar results obtained or is there a wider discrepancy between shorter residence time diffusion chamber, substrate-based processing devices, and controlled expansion cloud chambers in this regime?
- Ice nucleation measurements are also needed for fundamental understanding of ice nucleation and of the nature of INPs, which an array of measurement devices can address better than a single technique. Questions remain on differences between condensation and immersion freezing (Vali et al., 2015; Burkert-Kohn et al., 2017), the nature of ice nucleation in the regime below water saturation, connecting practical measurements with molecular scale understanding and many other topics.
- Other focused studies involving instruments within direct and post-processing communities are recommended for addressing needs specific to these communities. For direct sampling, examples are a careful comparison of the operational characteristics of continuous flow instruments as a function of RH_w, and a rigorous comparison of use of optical size for detecting ice in CFDC-style instruments versus use of depolarization and machine learning methods. For post-processing methods, the role of sample storage

aggregation and breakup as a function of particle loading and size in bulk immersion freezing studies deserves study.

- Establishing best practices for handling of bulk immersion freezing samples, and for limiting and correcting for the background freezing counts introduced in the water used for collection (for impingers) or for rinsing (of filters) is a topic that was not covered directly in FIN-02. Improvement and standardization of protocol would only help to improve the good results obtained across these methods in this study. This is a topic of a separate paper published in this special issue (Polen et al., 2018).
- The role of INP size and more careful quantification of biases involved in assessing this factor deserves more focused attention. The use of monodisperse aerosols in a workshop like FIN-02 would present logistical challenges, but would add an important dimension for study and greatly assist interpretation of results.
- The low INP concentration regime still presents a strong challenge for the measurement community, one that becomes critically important in atmospheric studies. Low INP concentrations are ubiquitous at modest supercooling, but can also occur lower temperatures in the atmosphere. For existing direct sampling devices like flow chambers, no current comparisons have focused on their abilities to control and correct for background frost artifacts. While ambient measurement campaigns such as FIN-03 allow some focus on this topic, a laboratory campaign could do the same. There is also no current check on the accuracy of post-processing methods for immersion freezing at modest supercooling where this is the only method practically available at present, one that necessarily involves the loss of time and space resolution when sampling on aircraft. Can new methods be developed for directly assessing INP concentrations in larger sample volumes? Even modest improvement to direct methods to provide more overlap of measurement methods in the regime > -20°C would help to further evaluate the validity of meshing direct and post-processing methods to characterize INPs over the full mixed-phase temperature regime. Aerosol pre-concentration has been applied to extend the dynamic range of direct INP measurements in atmospheric studies (e.g., Tobo et al., 2013; Boose et al., 2016), but aerodynamic concentration methods bias against particle sizes much below 1 μm. Hence, it is worth investigating the possible use of other concentration methods applicable to the full aerosol size distribution, such as pre-condensation. Novel ideas are needed.
- Further comparisons for which the sampling groups are "blind" to the nature and concentrations of INPs being sampled could be useful toward giving confidence to the wider community that the INP measurement community is capable of recognizing issues and properly interpreting data. This will assist confidence and utility of larger global data sets. Such a comparison from FIN-02 will be reported on in a separate publication in preparation.
- Similar exercises as FIN-02 are also needed in sampling under ambient atmospheric conditions. This is the subject of the FIN-03 campaign that will be reported on separately.

Workshops such as FIN-02 will continue to play a large role in assessing measurement biases and ultimately improving the comparability of INP measurements made by a large community of researchers sampling on a global scale. The shared experience of these workshops is irreplaceable in providing special insights into the status of and issues involved in obtaining INP data in different scenarios that may be dominated by certain aerosol types. FIN-02 demonstrates that the INP measurement community remains on a progressive track towards assessing convergence between different methods used for INP quantification.