

Review of: The Welzmann Supercooled Droplets Observation 2 (WISDOM) on a Microarray and application for ambient 3, Reicher et al.

This work attempts to build on the extensive past literature on droplet freezing assays, by leveraging microfluidic technologies. Several calibration experiments are performed on the stage in an attempt to quantify the accuracy and precision of measurements of ice nucleation rates and ice active site densities. It is noteworthy that assessing the absolute values of these quantities is a particularly challenging endeavour, owing to the lack of 'primary standards' whose nucleation behaviours are known to a high degree of certainty. Indeed, past intercomparison studies have yielded considerable spreads in rates and ice active site densities for homogeneous nucleation and the heterogeneous nucleators, and deviations between instruments has not been satisfactorily addressed.

While the current work could definitely be of interest to the community of researchers interested in atmospheric ice nucleation processes, there are serious gaps in the paper which I feel need to be addressed prior to consideration for publication. The majority of these gaps revolve around the qualitative nature of the comparisons performed, and lack of error analysis on the rates and ice active site densities determined.

Major issues

- In figures 5, 7, 8 & 9, there are no vertical error bars presented to represent the uncertainty in the measurements. What is for example, the uncertainty stemming from the stochastic nature of nucleation in the homogeneous freezing experiments? What is the effects of the uncertainty stemming from the random sampling of ice nuclei into droplets on the heterogeneous ice active site densities in figures 7, 8, 9. Without statistically sound error bars and confidence intervals on the certainty of the data, comparisons are rendered almost meaningless.
- The authors note in the abstract (L16), that the method produces excellent 'statistics'. To what quantity are the authors referring to here? Nucleation rates? Ice active densities? If so, what is the effects of sampling hundreds of droplets over say 50? By what kind of factors are uncertainties reduced? If this is purported to be a major advantage of the technique, surely the improvement in these 'statistics' by this method should be quantified?
- in this direction, some of the benefits of this technique over past techniques should be elaborated upon and clarified; the discussion of past issues, without acknowledging how they have been successfully dealt with in the past is rather peculiar. For instance, many cold stage instruments do not suffer from issues surrounding the Bergeron-Findeison process, and do not need oil to be placed on the droplets. At line 53, it is said that generation of 1 uL volumes is not trivial. To my understanding, this can be done with a pipette, which would seem rather trivial to me.
- In section 2.3, on the automated detection of phase transitions, it is noted that the algorithm can 'successfully distinguish between a phase transition event and noise' (L 150). Whilst this statement may well be correct, I see no mention of to what accuracy the algorithm can successfully distinguish between phase transitions. Is this 100% accuracy? How many experiments were performed manually to determine this?
- In the quoted value of ± 0.25 K for the Linkam cryostage temperature sensor, which is subsequently quoted in the captions for figures such as 5 and 7, how was this value

determined? Knowing this would certainly be useful for the reader. By what procedure was this value obtained?

- In figure 7, the data for NX illite appear to be at the extreme lower end of the spread, based on the error bars used for the Hiranuma data. Surely this should be discussed in the text?
- In lines 268-269, it is said that ns is in best agreement with the Leeds-NIPI for NX-illite. Yet close inspection (the subtle shades of grey used here in the graph make this a bit difficult to see), shows that there is in fact no overlap in the temperature range between the measurements presented here, and those of the Leeds NIPI uL.
- In addition, in comparison to the binary instrument in figure 7, the data are up to an order of magnitude or greater off, which is not immediately obvious as the authors have chosen to only label the scale for every factor of 100 increase. It is noted that this is within the uncertainty of the instruments, but what is the uncertainty of the quoted values for the WISDOM (see my first point above...). Does the uncertainty really cover 2 orders of magnitude? With what degree of statistical certainty are you sure that these two measurements are in agreement?
- Lines 136-137: If the chips are being clogged by larger particles, then you may be severely altering the size-dependent particle composition of the samples as they pass through. How is this dealt with and accounted for?

Other issues

- Line 28: INP should be INPs
- Line 34: Why is this only 'possibly' in future climates?