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Atmospheric Measurement Techniques Discussions

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Interactive comment on "An instrument for quantifying heterogeneous ice nucleation in multiwell plates using infrared emissions to detect freezing" *by* Alexander D. Harrison et al.

Anonymous Referee #1

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Review of "An instrument for quantifying heterogeneous ice nucleation in multiwell plates using infrared emissions to detect freezing" by Harrison et al.

General comments: I support publication of this manuscript in AMT. The research aligns well with the scope of AMT. The reviewer finds the application of release of latent heat for detecting a freezing event in immersion mode ice spectrometer unique. The authors successfully present the applicability of their technique (IR-NIPI) to characterize immersion freezing efficiencies of three different forms of the sample (incl. chips, powder and ambient particles collected on the filter and scrubbed with water) at T > -22 °C. In particular, its applicability to the atmospheric sample seems promising

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Discussion paper

- the reviewer finds Figs. 8 and 9 nice and elegant. With further improvements in the temperature uncertainty (±0.9 °C is reported in the manuscript) and applicability in different droplet volumes (so, wider T coverage), IR-NIPI may become very versatile in the INP research (specifically for biological high-T INPs). The review has only minor (but important) comments.

Minor specific and technical comments: P1 L11-13: The main focus of the presented work is on novel application of latent heat in immersion freezing spectrometry, and the reviewer finds the discussion of online vs. offline unnecessary (especially in the abstract). L12-13 is erroneous – some cloud simulation chambers can assess multiple Ts. The reviewer strongly suggests removing "While instruments . . . Hence,".

P2 L36-38: Reference suggestion - Hande, L. B., and Hoose, C.: Partitioning the primary ice formation modes in large eddy simulations of mixed-phase clouds, Atmos. Chem. Phys., 17, 14105–14118, 2017.

P2 L40: ∼1 L-1 at what temperature? Please clarify to the readers.

P2 L42-43: Plus developing realistic but computationally inexpensive parameterization is also a key to what is addressed here by the authors.

P2 L45: Quantitatively define "warmer temperatures" perhaps with specific reference(s). L51-53 implies -11 °C as warmer temperatures?

P3 L61-63: What about the Arctic? Some discussions may benefit the paper.

P3 L71: Reference suggestion - Stopelli, E. et al.: Freezing nucleation apparatus puts new slant on study of biological ice nucleators in precipitation, Atmos. Meas. Tech., 7, 129–134, 2014.

P3 L71: The reviewer thinks the discussion of previous studies applying latent heat release as an asset for ice nucleation research will benefit the paper. Please consider include and discuss; e.g., Marcolli, C. et al.: Efficiency of immersion mode ice nucleation on surrogates of mineral dust, Atmos. Chem. Phys., 7, 5081-5091, 2007.

P4 L99: ns(T)

P5 L140-141: Very important statement – recap this point (sharp rise in T = +2 °C) in the abstract and/or conclusion section.

P6 L142-145: The authors may want to rephrase this part and explain the points more intuitively.

P6 L158-161: Very good. The authors do truly careful experiments/assessments.

P7 L179-182: The authors may want to extend this part and explain the points more intuitively.

P7 L189-192: The reviewer is curious if using different droplet volume can improve this uncertainty. The reviewer does not intend to ask any additional measurements (especially since $\pm$0.9 °C uncertainty is well justified in L193-207), but doe the authors have any estimates of the maximum/minimum droplet volume that IR-NIPI can deal with?

P8 L214: Delete "see".

P11 L298-300: 16.7 L/min * 100 min = 1670 L. . . The authors might want to check their nINP (L-1) since they might have employed a wrong Vs (Eqn. 2).

P11 L304: Was a dilation used to prepare suspensions for the ambient sample analysis? If not, no worries. But, if yes, the dilution factor is missed in Eqn. 2.

Fig. 7A: There seems some outliers within this T-ns(T) scale (i.e., 0.01 wt% run 2). What is responsible for them? Perhaps, it is due to what is addressed in L280-293? Please clarify.

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