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Atmospheric Measurement Techniques Discussions

Interactive comment on "Automation and Heat Transfer Characterization of Immersion Mode Spectroscopy for Analysis of Ice Nucleating Particles" *by* Charlotte M. Beall et al.

Anonymous Referee #1

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General comments: The work presented here is a valuable contribution to our understanding of droplet freezing measurements in ice nucleation research in general and a thorough description of a new Automated Ice Spectrometer (AIS) in particular. This instrument is an improved and automated version of the Colorado State University's Ice Spectrometer as it was described in the paper by Hiranuma et al. (2015). The manuscript presents the new instrument and its improvements against the old setup in detail. The novelty and significance of the work lie in the modelling of the thermal properties of the system. The results show that with the current setup the temperature of an aqueous immersion freezing sample in the AIS is homogeneous and that the freezing temperature can be measured accurately, provided the temperature probe is

placed properly. In a recent intercomparison of methods on NX Illite suspensions by Hiranuma et al., 2015 the immersion freezing temperatures were scattered by at least 5°C. The modelling results presented here may help to better understand which part of such observed discrepancies may come from inhomogeneities in sample temperature and from bias of temperature measurement. However, there are many other potential reasons for scattering between the different methods, such as sampling issues (filters vs. impingers) and differences in particle extraction from substrates. In the end the authors demonstrate that their improved AIS performs well by analyzing suspensions of the NX Illite test dust samples used by Hiranuma et al. (2015). At the warm end of ns vs. T spectra their data compare well to those of 5 other methods. Overall the manuscript is crafted well, and I recommend to publish it in ACP, after some of the points raised below have been addressed by the authors.

Specific scientific points:

P. 2, l. 2: I wonder what is meant by "the homogeneous freezing RH of aqueous solution droplet" ? Isn't the RH irrelevant, if you consider homogeneous freezing of liquid water ?

P. 5, L. 29: I do not understand why the intensity of light reflected back to the camera decreases when droplets freeze, as frozen drops become opaque and lighter than clear liquid drops, scattering more light towards the camera and leaving less for absorption at the dark background of the well block ? Please clarify.

P. 9, : A statement is required on how the equations (4) and (5) were derived, or where they are taken from.

Technical corrections:

Explain the acronym AIS upon first use: at present AIS occurs many times (e. g. in the abstract, and elsewhere) before it is first defined on page 5, L.1.

P. 2, L.13, insert "to" (identify drivers . . .)

P. 2, L. 24 and many other places: check the references in brackets: often names of authors are put in brackets, although the names are part of the sentence. An Example: “In (Hiranuma et al. , 2015), 17 online and offline . . . “

P. 3, L3: remove droplet assay

P.3, L. 3: Upon introducing the ice spectrometer the text refers to a paper by Hill et al. (2016) that is not in the reference list. Or do you mean Hill (2014)? Please clarify. P.3, L. 10: How can 50μl of water be filled into a 1.2μl well ? Please check the numbers.

P.3, L.19: introduce the acronym FRIDGE after “Frankfurt Ice Nuclei Deposition Freezing Experiment.”

P. 4, L. 23: Remove “Automated” in header of chapter 2.2

P. 5, L. 12: I presume that it’s not room air but heat that leaks into the nitrogen flow ? If so, then write something like “”. . . room air heat leaks into . . .”.

P.5, L. 32: "are" instead of "is" in: “time, freezing temperature, and location of the well are recorded . . .”

P. 8, L2: In Fig. 5 nothing is highlighted in yellow, as stated in line 2 and on P. 9, L. 16 . Please check.

Figure 5: In my copy the labels of all 4 axes as well as the legend and text in the insert have some strange characters (?). Please check.

References: Hiranuma et al.: A comprehensive laboratory study on the immersion freezing 45 behavior of illite NX particles: a comparison of seventeen ice nucleation measurement techniques, Atmos. Chem. Phys. Discuss., 14, accepted, doi:10.5194/acpd-14-22045-2014, 2015.

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