Atmos. Meas. Tech. Discuss., 7, C3281–C3284, 2014
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Atmospheric Measurement Techniques Discussions

Interactive comment on "BINARY: an optical freezing array for assessing temperature and time dependence of heterogeneous ice nucleation" *by* C. Budke and T. Koop

Anonymous Referee #2

Received and published: 20 October 2014

The paper presents a new tool to study heterogeneous ice nucleation in the immersion freezing mode. The Bielefeld Ice Nucleation ARaY BINARY is an optical freezing array that was thoroughly tested and applied/characterized using Snomax as ice nucleator as described in the manuscript. The ice nucleation process itself is assessed for its temperature and time dependence, thus distinguishing between a singular and a stochastic approach.

The BINARY represents a great extension of already existing laboratory, ice nucleation instrumentation with the capability to improve our understanding on heterogeneous ice nucleation as already shown in this paper using the test substance Snomax for

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characterization.

In general, the paper content is highly sufficient for a publication in AMT, and the obtained results concerning the instrument characterization and the IN properties of Snomax particles are well elaborated. From the scientific point of view, only minor comments are listed below.

Major comment: I sometimes found the paper hard to read and to follow due to the "jumps" between theory and results. Thus, I would suggest including a section "theoretical background" which separates the theory of ice nucleation and that of the analytical approach from the "results" section. Along these lines, a clearer distinction/separation between these two parts, i.e. IN theory and "math needed for data analysis" could be pursued. Also, IN-relevant data on Snomax would be highlighted more this way, although not being the main task of this study.

In addition, sentences are sometimes disconnected and structured in a way that impedes the reading flow. A check by a native speaker could be helpful in this way.

Minor comments:

P9138, l17ff: How does the observation of a strong T-dependency of lambda emphasizes "the capability of the BINARY device"? This is too vague for an abstract. Be more conclusive concerning this statement, also in the summary. In a similar way, the fact that the value "is larger" than literature values does not explain to the reader the uniqueness of the tool.

P9138, l26: Cziczo and Froyd, 2014, is not the most original paper for heterogeneous ice nucleation. Or do you refer to the introduction of the abbreviation for ice nucleators?

P9139, l9ff: "Representing immersion freezing . . ." in models? Still, the authors do not give a clear answer why immersion freezing it is difficult to represent in current models" (see second major comment).

P9140, l7ff: Rename the "above mentioned processes" to clarify to the reader.

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P9142, l12ff: Is the range of 0.5-5 muL exact? What is the typical variation in the 1 muL per droplet you produce?

P9142, l25ff: Did the mentioned techniques not use double-distilled water for their experiments? This sounds obvious – but is BINARY the first applying this?

P9144, l12ff: Can the condensation of water vapor in the compartments influence the measurement? Please make a statement/reference here and refer to the text afterwards.

P9144, l25: "Upon heating . . ." Please clarify this sentence

P9145, l2: "negative peak". Isn't that rather a minimum?

P9145, l16: The statement why using heating mode could be more comprehensive as I think it is important for the instrument characterization process.

P9145, l21: Results in "( )" make them appear unimportant

P9145, l25: Why is the spraying of the reference material ensuring the detection of the onset of the phase transition?

P9146, l2: "accordingly" refers to what?

P9146, l23ff: Please give reference for Snomax IN-activity

P9147, l14: Why using "[ ]" in the equation?

P9148, l1ff: The first paragraph deals with reference results from Turner et al., 1990, the second with own results, and the third switches back to Turner et al. Please consider a rearrangement since the reader expects an answer for the missing Class B immediately, which is given in the third paragraph.

P9149, l16: What do you mean with "rather minute time dependence"? "Rather is a vague word, and the explanation of "minute time dependence" should be more physical.

P9151, l25ff: Where do the alpha values of 23.9° and 35.3° come from?

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P9167, Figure4: I assume the Turner classes are indicated by the dashed lines? Please mention this.

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