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Atmospheric Measurement Techniques Discussions

# *Interactive comment on* "SPIN modification for low temperature experiments" *by* André Welti et al.

**Anonymous Referee #1**

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**General comments:**

This manuscript describes the modification of the commercial instrument SPIN (SPectrometer for Ice Nuclei), which is a device for measuring ice nucleation activity of laboratory-prepared as well as natural ice-nucleating particles. In particular, by modification of the compressor system for cooling the measurement chamber of the instrument, the authors extended the temperature range of the SPIN device. The functionality in the entire (now extended) range of humidity and temperature is studied using model laboratory aerosols of ammonium sulfate and silver iodide. Overall, this is a valuable approach, although at the low temperature there seems to be an offset from the theoretical homogeneous ice nucleation curve. The authors speculate that this may be due to the fact that the aerosol particles do not reach equilibrium before freezing, see comment (6) below. I find this somewhat unsatisfactory and suggest that the authors spend more thought on this (and maybe, if possible, supply some additional sensitiv-



ity measurements). Moreover, because the paper's goal is allowing other scientists to make the same modifications to their SPIN instrument, I suggest a more detailed description/listing of the individual steps in order to become unambiguous.

Formally, the paper text, length, and figures are appropriate. However, I have a request regarding wording: apparently, the authors mix up vapor pressure and partial pressure and I request a correct and consistent usage of these terms, see comments (1) and (3) below.

In summary, the manuscript provides a useful approach and technical modification of an existing instruments, which I consider to be publishable in Atmospheric Measurement Techniques after the comments below have been considered in a revised version.

**Scientific comments:**

(1) Page 2, Line 17; and caption to Fig.1: "Under steady state conditions a linear temperature and vapour pressure gradient establishes between the plates." I think the term vapor pressure is not used correctly and consistently. Vapor pressure is a property of a liquid or solid, and partial pressure is a property of a gas (mixture). The term vapor pressure is used here with its meaning of partial pressure. The IUPAC definition is: "For a mixture of gases the contribution by each constituent is called the partial pressure." In the caption of Fig.1 the term saturation pressure is used, which actually is the (saturation) vapor pressure.

(2) P.4, Figure 2: I would prefer that the figure directly indicated the modifications in the setup, either by colors or by shading etc. As it is now, the modifications are not evident to me. Given that these modifications are the essential novel part of this study, I also strongly recommend a more-detailed point-by-point listing of all modifications, so that any other SPIN user can follow and repeat it with their setup immediately. The latter may be provided in an appendix or supplement.

(3) P.4, L.6/7: “decreasing absolute vapour pressure”. What is an ABSOLUTE vapor pressure? I guess you mean total partial pressure, do you? See comment (1) above.

(4) P.5, Figure 3b and abstract and P.8, L.11: According to Fig.3b, the total experimental range to measure ice nucleation (indicated by the hatched area) is extended by 14 K at maximum when compared to the original SPIN range, but certainly less than the 20 K given in the abstract as well as in the conclusion (P.8, L.11). Please correct accordingly.

(5) P.6, L.10: “and 1% AF curve derived using the parametrization of Koop et al. (2000)” How was the Koop-line calculated for 1% activation? The line will depend upon the time interval for which the aerosol particles are exposed to the T and RH conditions. What time interval was used for the calculations?

(6) P.6, L.15: “aqueous aerosol do not reach equilibrium before freezing in SPIN” This is indeed a possibility, and maybe at the lowest temperatures diffusional limitations within the liquid droplets may also become relevant. However, this non-equilibrium state before freezing hampers the accuracy and applicability of SPIN, in particular in the extended low temperature regime. I would hope for more investigations as this is the main additional range of the SPIN instrument introduced in this work.

**Minor and technical comments:**

(7) P.1, L.15: “At intermediate temperatures (236K < T < 273K) heterogeneous ice nucleation above water saturation...” I believe this should be AT OR BELOW water saturation, rather than ABOVE it. Or do you mean to “... above ICE saturation”?

(8) P.1, L.24: Here and at many other places in the text “Often, the dependency of ice nucleation on T, RH by a specific mechanism” I do not like the notation T, RH within a sentence. I guess you mean “... on T and RH by a ...”? Please reword and use consistently throughout text.

(9) P.2, L.29-30: I assume these are the boiling points at standard or ambient pressure,



correct? Please refine wording.

(10) P.3, Figure caption 1: Reference Murphy and Kopp (2005) is misspelled.

(11) P.4, L.7: “4 $\mu$m in $\sim$10 s residence time” Replace “in” by “within”.

(12) P.6, L.3: “are reports of (NH4)2SO4 forming ice heterogeneously at cirrus temperatures” This is only correct for non-deliquesced (i.e. effloresced) particles. I suggest to add the deliquescence line of (NH4)2SO4 to Fig 4b.

(13) P.8, L.11: “We describe a mechanically easy modification” Maybe “simple” is better than “easy”?

(14) P.8, L.18: Replace “AgI” by “AgI particles”

(15) P.8, L.23: There is no link provided to the repository.

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