

Interactive comment on “Characteristics of immersion freezing nuclei at the south pole station in Antarctica” by K. Ardon-Dryer et al.

Anonymous Referee #2

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This paper presents measurements of immersion freezing nuclei at the South Pole Station in Antarctica. Samples were taken on filters and later analyzed in the lab with the static chamber TAU-FRIDGE. The paper is well written but lacks some in-depth treatment of error analysis and background counts on the blank filters. This has implications on the discussion on the data. I therefore suggest to re-evaluate the paper after major changes have been applied.

Detailed comments on the manuscript are:

p. 93, line 8: Today, most scientists agree that particles need a minimum size of 100 nm to be active as IN. Could you comment on that and discuss this where you refer to the old studies where IN are reported to be mostly around only 10 nm?

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p. 94, line 14: How do you define wind directions at the south pole? Is it appropriate to refer to them with cardinal points at the south pole? Wouldn't all winds come from north there anyway?

p. 95, line 9: To assess the quality of the data in this study it would be very helpful to know details about the dimensions and shape of the filter holder and the sampling inlet and how it was placed with respect to wind direction. When sampling aerosols in a non-isokinetic way (which is definitely the case when the wind is “in the back” one has to take under- and oversampling of certain sizes of aerosols into account. This also depends on the wind speed and the pump speed with which air is drawn through the filter. Please provide information about the details and discuss possible sampling artifacts. It is possible that the current setup leads to an undersampling of larger particles which are known to be the better IN than smaller particles!

p. 95, line 13 (and introduction): I am wondering why this study focuses on immersion freezing nuclei. In antarctica I would assume that the likelihood of finding liquid or mixed-phase clouds is rather low, which is a prerequisite for immersion freezing to take place. Under the given conditions I would assume that deposition and condensation freezing would be much more important. Can you please add (in the introduction) references about the importance and relevance of immersion freezing in antarctica and why you focus on this mechanism?

p. 95, line 24 and p.96 line10: The influence of the Vaseline layer and the background found on the blank filters should be discussed more in-depth. Especially the treatment of the blank filters is of relevance as the measurements show that they contain a significant amount of background IN. How were the blank filters treated? Were they shipped to and from antarctica as well, and undergone the same procedure as the sample filters (including mounting them into the filter holder just without sampling air through them) or were they directly measured from the original packaging.

p. 96, line 15-20: Even if the fraction of particles that froze at the same temperature

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as the blank have been removed from the analysis the current paper neglects the influence of the background counts on the discussed data. I strongly recommend to be more careful here (as already mentioned with my quick review) and include the measurements (M) of the background (BG) in the calculation of the frozen fraction (FF) at a given temperature. e.g. something similar like: $FF = (M - BG) / (M_{total} - BG_{total})$. I also do not understand how the authors assessed the influence of the background counts to be 2.4% with formula 2 (line 24). Can you please discuss in detail how this was done? I understand that since the FF increases very steeply with Temperature below a certain Temperature, that the influence of the background quickly decreases. Please also provide error bars for your data, especially in the plots where you discuss differences between different data sets. How significant are the differences taking the error bars into account? At least the statistical error due to poisson statistics could be reported here.

p. 98, line 18: Please specify the type of instrument: e.g. greater than $0.01 \mu\text{m}$ as measured with a condensation particle counter (TSI 3760).

p 101, line 25: The last sentence is kind of circular logic: Maybe it is better to write: Since the measurements vary strongly with the meteorological conditions, more measurements at different conditions are needed in order to be able to derive reliable parameterizations... or something along these lines.

Figure 3: As I already mentioned in my quick review, the variability of the curve for different blank samples would be helpful especially when the blank data is used to correct the sample data.

Figure 10 and text referencing it: The temperature scale is named temperature but the parameter in the fit function -as mentioned in the text- is supercooling. Please be consistent with the scales and terminology.

Interactive comment on Atmos. Chem. Phys. Discuss., 11, 91, 2011.