Review of acp-2016-1180 by Garimella et al.

The paper describes an important study of the flow conditions inside a CFDC chamber for INP measurements. The study generally confirms the findings presented by DeMott et al., 2015, that a considerable correction factor *cf* needs to be applied in order to correct the CFDC chamber INP measurements. The measurements underestimate INP concentrations apparently because a fraction of the aerosol flow spreads away from the center where the supersaturation is highest. While DeMott et al. suggested a constant factor cf = 3 to be used for their CFDC chamber, the present study for the SPIN instrument finds cf to be variable, ranging between 3 and 10, with a mean value of 4. A Random Forest Regression (RFR) reveals that prediction of the highly variable *cf* can be improved when considering 65 housekeeping variables of the SPIN instrument that seem to be most important in influencing the spreading. Nevertheless, a clear correlation with specific instrumental conditions has not been identified. Therefore, individual INP measurements remain highly uncertain.
The simulated Fig 9b does resemble Fig 2 from DeMott et al, 2015, suggesting that the spreading effect is indeed responsible for the experimentally observed activation curves.

While the subject of this study is highly important for the growing community of researchers using CFDCs for INP measurements, a number of improvements are necessary before the paper can be accepted for ACP.

General comments

1) The introduction of the correction factor cf for the SPIN CFDC measurements is important for the experimental determination of INP concentrations. It should be mentioned already in the abstract that a mean correction factor of ~4 is determined for this SPIN instrument, and that the correction factor is highly variable between 3 and 10. The large uncertainty of individual INP measurements due to the large uncertainty of cf should be mentioned in the abstract and discussed in detail in section 3.

2) The measurements concern immersion freezing experiments but the spreading is likely to be present for deposition freezing experiments as well. Please discuss the influence on INP measurements in the deposition freezing mode. Should the same correction factors be applied?

3) While the paper is clearly written in most parts, some parts are imprecise and not well-written. This concerns especially the first half of section 3 (pages 8 and 9, Table 1 and Figs 2-5, see specific comments below). The descriptions are not detailed and accurate enough and for several paragraphs it is difficult to extract the main message the authors want to convey. For example, the description and interpretation of Fig. 4 is only 2.5 lines (p 8, l 3-5), and the exact purpose of this Figure does not become clear to the reader. Is it supposed to show that f_{lam} changes more or less erratically between 0.1 and 0.8 for conditions that are kept as constant as possible? What does it tell about the reproducibility and uncertainty of the INP measurements?

4) Can effects of thermophoresis be excluded? Do the aerosol particles potentially leave the theoretical aerosol lamina due to thermophoresis?

5) A particle that moves slightly outside the central lamina but still in the yellow region of Fig 3 should still be activated and growing efficiently. Is the assumption correct that all particles that leave the central lamina once (and are therefore counted in the "late" tail of the pulse) are not activated and cannot be measured as INP (therefore necessitating the large correction factors)?

6) The most likely reasons for the observed spreading effect and for the discrepancy between the ideal instrument and the real measurements should be discussed. Are uncontrolled eddy turbulences the main/only reason for the spreading?

Specific comments

1.) The manuscript switches frequently between the ZINC and the SPIN instrument and sometimes it is unclear which specific instrument is meant (e.g. Fig 2: pulses are shown for ZINC, Fig 3: SPIN results, Fig 4 which instrument? SPIN? (please include instrument name in Figure caption), Fig 5 SPIN, etc.).

2.) p 5, l 20-21: Why did you use 1-second pulses for SPIN and 10 sec pulses for ZINC?
Did you measure the CPC_{in} pulse every time and are the blue and red trace in Fig 2 measured for the identical pulse? The blue pulse in panel A seems to be shorter than 10 seconds. How long is the transfer time through the SPIN and ZINC chambers?
The example of Fig 2 does not seem to be a typical one: with f_{lam} = 77.7 and 76.2 % it is much higher than all the values displayed in Figs 4 and 5. According to Fig 5, the most frequent f_{lam} is in the range of 10-15%; and the average f_{lam} is argued to be ~25% (see comment to Fig 5 below). Please display (also) the measured CN_{out} for such a more typical case. Does it make sense to present the percentages for f_{lam} with a decimal place?

3.) p. 6, line 13-19 and Figure 3: the description is not sufficient. In the Figure caption it is stated that the particle distribution is "measured across the chamber". Is this true? In the text of p 6 it says that "combining the arrival pulse with the shape of the velocity profile the corresponding distribution of particles across the width of the chamber can be determined". How is this distribution determined in detail? This seems to be a complicated matter to me that would require CFD modelling, etc.? Do you derive a different distribution for each measurement pulse?
The term "measured across the chamber" would indicate that CN measurements are made at the end of the chamber at different distances from the cold wall. Please use such a term only if such measurements were actually performed.

4.) Figure 4:
The y-axis should range from 0 to 1. There are only 25 data points shown, the text talks about 30 data points. Are all data points displayed?
It is stated that the tests shown in Fig 2 were done at +20°C (p8, l 3 and p6, l 14). Does this mean that there was no cooling applied and the chamber walls were at room temperature for these measurements? Are these conditions transferable to realistic flow conditions? It would indeed be interesting to see in how far the pulses change between a warm chamber at constant temperature and a chamber operating with the two different cold wall temperatures.

5.) Figure 5:
There seems to be an error in the Figure: The y-scale of the panel on the right does not correspond with the histogram on the left. The text claims that the mean of the distribution of f_{lam} is at 0.25, in the graph on the left the mean seems to be around 0.15.

6.) p 8, l 10: Here it is reported that values for f_{lam} range from 3 to 73 %. Why are values of 76 and 77 % reported in Fig 2? (difference between ZINC and SPIN?)

7.) Figure 7:
The colors are hard to discern. Four colors are shown in the legend, but several other colors are shown in the graph. This is potentially because overlapping colors result in “new” colors? A different representation would be helpful, e.g. show the four probability distributions not as histograms but as line plots.

8.) p 9-p 10: The ice growth model is insufficiently described. What are the assumptions? How are things calculated? I agree with the other reviewer that this needs considerably more discussion.

9.) p 10, l 13: f_{lam} and cf are not equivalent, but rather “inversely equivalent”.

Technical comments

p 7, l 15: “import” → “important”

p 7, l 21: “middle-top of the SPIN” → “middle and top section of the SPIN”

p 11, l 12: “activation curves of droplets… “

p 11, l 13: “black and blue” → “red and blue”.

p 11, l 18: “4. Conclusions” (section numbering)

p12, l 17: “variability to be conducted”

p 27, l 3: “Unlike Figure 6” should read “Unlike Figure 8”

p 27, l 15 : “black and blue” → “red and blue”