

Interactive comment on “Development and characterization of an ice-selecting pumped counterflow virtual impactor (IS-PCVI) to study ice crystal residuals” by Naruki Hiranuma et al.

Anonymous Referee #1

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Review of “Development and characterization of an ice-selecting pumped counterflow virtual impactor . . .” by Hiranuma et al.

The manuscript describes the development of an improved pumped counter flow virtual impactor. The major improvement over a previous version is a cut-off diameter of 10 to 30 micrometers compared to a cut-off diameter of 5 micrometers in the previous version. The increased cut-off diameter allows one to separate ice crystals from liquid droplets, which should be helpful for identifying ice nucleating particles in mixed phase clouds.

The topic of the paper is appropriate for Atmospheric Measurement Techniques (AMT), and the manuscript describes sufficient characterization and advancements to warrant

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publication in AMT. I recommend the paper for publication after the following comments are addressed adequately.

Major comments:

1) Section 4.3, Transmission efficiency. It was not clear how Figure 7 was generated. I went back and read the TE analysis and the methodology in Gallavardin et al. 2008. From the description in Gallavardin et al. 2008 it was clear how the NOAA PCVI transmission curve was generated, but I was still confused on how the open symbols were generated for the IS-PCVI in Figure 7. In addition the brief description in section 4.3 on how the transmission efficiency was determined seems to be different from what is in Gallavardin et al. 2008. The description of how the transmission efficiency was determined needs to be expanded and improved in the current manuscript for clarity.

2) Also related to the above, in Section 4.3 D_c was 15.3 micrometers but the estimated 50% cut-size for the particular flow conditions was 9 micrometers based on Figure 7. Shouldn't these numbers be the same? I.e. shouldn't D_c equal the 50% cut-size?

3) Page 17, line 16. "...with only a small amount of soot (<5%) making it through the IS-PCVI". This assumes that the minisplat has the same sensitivity to soot as bacteria. My understanding is that single particle mass spectrometers may not detect small particles, such as soot, with 100% efficiency. The authors should discuss the detection efficiency of the minisplat to soot and bacteria as a function of size and discuss the implications for their findings.

Minor comments:

4) Page 5, line 6. "more specifically the 5 ohm heating wire is varied inside the heat conductive nozzle tip around the converging section over the 35 mm length, keeping the ...". Is the heating wire varied or is the current through the heating wire varied?

5) Page 8, line 20. "ddH₂O". Typo?

6) In a few equations, symbols are not fully defined. For example, what is $V(\infty)$

and V (vapor) in equation 8. The meaning of the symbols can be figured out from the context, but it would be clearer to define all symbols.

7) Page 14, lines 25 to 30. “The outline heating was turned off to prevent evaporation of droplets.” Can there still be some evaporation due to the addition of the dry counter flow?

8) Page 14, line 9-11. “During this expansion, both OPC 2 (>15 microns) and CPC2 counted > 0.1 cm³ of ice residuals...”. Should this sentence be modified since OPC 2 does not count residuals, rather it counts ice crystals.

9) Figure 8 and 9. The trace for CFD-modeled is not a straight line?

10) Page 15, line 8. “the linear relation does not hold if the ratio is outside these bounds”. Change this to “the linear relation may not hold if the ratio is outside these bounds” unless you have data to prove otherwise.

11) Page 16, line 3. “the sum of the CPC 2 and CPC 3 counts < the CPC 1 counts”. From the figure it looks like the sum of the CPC 2 and CPC 3 counts are > the CPC 1 counts”. For example at a CPC 1 count of 150, the CPC 2 + CPC 3 > 150. What am I missing?

12) Page 16, line 10-11. “the minor deposition mode nucleation was also detected by the AIDA OPCs (fig 12 a.iii) around 10.56.” I don’t see this in the figure. Can annotation be added to point out what the authors are referring to?

13) Figures. In figure 11 and figure 14 has the CPC2 been corrected for the enhancement factor of the CVI (this should be made clear in the figure caption or somewhere). Also in figure 14, has the numbers for the minisplat been corrected for this enhancement factor of the CVI?

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