

===== REVIEWER #2 =====

This is an important contribution to understanding how various optical imagers observe properties of snowfall. Overall, the manuscript is understandable. While I have no qualms with the included analysis, there does appear to be some low hanging fruit that would greatly improve the impact of the paper. These and other comments are highlighted below.

Specific comments:

Horizontal motion should/needs to be addressed. Sampling/flow issues aside (and this is extremely important but beyond the scope of the article), the open design of PIP will lead to more translational motion vs. the MASC. Based on the field campaign data, there should be surface wind data you could use that would help guide upper-values for analyses like Figure 3. Further, I would like to see how this relates to the PIP vs. 2DVD analysis (e.g. Figure 9).

I've added a 10 m/s particle motion to the analysis and discussion of motion blurring (as well as to Fig 3, now Fig 4). Changes to the text are scattered throughout section 5.1.

The normal caveats apply to studies based on one case during a campaign. Is there the opportunity to conduct this analysis on other cases? How many were available during ICE-POP 2018? More reasoning is needed. While this case provided lots of variety, it is important to demonstrate how varied results are for other types of cases as perhaps you could demonstrate for certain types of cases, the discrepancies between instruments is either amplified or diminished.

I would argue that, for this kind of study, each particle is a separate case, but just to be on the safe side, I processed data from a couple other cases (specifically, 9 January 2018 and 22 January 2018). Looking at the PIP vs MASC vs tensor dimension plots (similar to Fig 4, which is now Fig 5), the differences from the figure in the manuscript are minimal. As such, I've opted to stick with only using the 7-8 March 2018 event to make the narrative simpler. I also added a note mentioning this to the data section:

"Data collected during a snow event on 9 January 2018 and 22 January 2018 were also examined, but are not included here as their inclusion did not produce any notable changes in the results." Lines 103 – 105

The manuscript could be more concise by merging the Data and Instruments sections. For example, the first paragraph in section 3.1 is essentially duplicative with the material under data. I would remove this, then make the sections on the instruments as sections 2.x.

I don't see the duplication between the introductory paragraph of the instruments section (I assume this is what you were referring to) and the contents of the data section. I toyed around with merging the sections, but the result kept feeling awkward and forced so I reverted back to having them as separate sections. In the process of responding to the reviewer comments,

however, I've added the following additional text to the end of the data section that I think helps separate the two instances of "This study..." that might be making the text sound repetitive:

"Although the general presence of these habits were primarily identified through visual inspection of the PIP data, further support of their presence can be found by examining the time series of the particle size distribution, particle fall speed, and air temperature, as depicted in Fig. 1. Periods when aggregates are present can be identified by the larger equivalent diameters and slower fall speeds and periods with lump graupel can be identified by the smaller equivalent diameters and faster fall speeds; the lump graupel can be discerned from liquid precipitation based on the below freezing temperatures, which extend over a deep layer according to a nearby thermodynamic sounding (not shown). Data collected during a snow event on 9 January 2018 and 22 January 2018 were also examined, but are not included here as their inclusion did not produce any notable changes in the results." Lines 98 – 105

Technical comments:

Line 200: is vs. will be performed?

Switched to 'is' Line 227

Paragraph (255-268): This paragraph could be cleaned up. Examples include multiple 'For simplicity' phrase and you could omit 'it should be noted'. I would lead off with the 2nd sentence to remind the reader, than discuss the number of factors that aren't addressed rather than revisiting the 'number of factors' phrase.

I've gone in and cleaned up the text a bit based on these suggestions. Lines 283 – 295

Line 275: Agreed, but you should probably provide a citation for this statement. The larger concern is potential horizontal motion

I added a new paragraph to explain the new statistical approach to the motion blurring calculations that I performed for the revision (Lines 296 – 307). As part of that, I included a sentence explaining our selection of particle motion speeds, including references to Locatelli and Hobbs (1974), Garrett et al. (2012), and Vazquez-Martin et al. (2021):

"The particle motion speeds are chosen as follows (e.g., Locatelli and Hobbs, 1974; Garrett et al., 2012; Vázquez-Martín et al., 2021): 1 m s⁻¹ represents a relatively fast falling snow particle, 4 m s⁻¹ represents an excessively fast fall speed for snow particles, and 10 m s⁻¹ represents relatively fast horizontal motion (albeit below the U.S. National Weather Service wind threshold for blizzard conditions, -15 m s⁻¹). Lines 300 – 303

Line 304: Extra 'both' in this sentence.

Fixed. Line 347

Line 321: How about: Motion blur of the top (bottom)- edge pixels occurs when the particle leaves (enters) those pixels during the image exposure period.

This sentence became much simpler after correcting the error Reviewer 3 found where we were double counting the motion blur effects. The new sentence reads:

“The motion blur of these top-edge pixels occurs when the particle leaves those pixels during the image exposure period.” Line 369 – 370

Figure 3: The sentence starting with ‘Calculations... and Specifically...’ is repetitive with the body of the text and does not describe the visual properties of the figure. I would omit for brevity or restate in text instead of the caption.

I've removed this part of the Fig. 4 caption (I also remade the figure to be statistically generated rather than the rough estimate I had been making as well as added a 10 m/s line to talk about horizontal blurring).

Figure 4: best fit lines? I would omit the last sentence in the figure caption as this is already included in the text right after Line 355.

Removed final line of the Fig. 5 caption and added “The diagonal grey lines indicate where the x value is equal to the y value.”

Figure 7: Once again, some of the caption is discussed in text (sentences starting with ‘This’ and the first ‘The’).

Removed the sentence starting with ‘The’ from the Fig 8 caption. I feel like “This example uses a circle with a radius of 0.5 mm to compute the base perimeter and area” is worth retaining as a brief reminder to the reader.

Line 447: ‘Because the 2DVD’

Fixed. Line 509