Atmospheric Measurement Techniques Discussions

Atmos. Meas. Tech. Discuss., referee comment RC1
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Comment on amt-2021-44

Anonymous Referee #1

Referee comment on "A differential emissivity imaging technique for measuring hydrometeor mass and type" by Dhiraj K. Singh et al., Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2021-44-RC1, 2021

As far as I know, the authors are correct in stating that the novel approach for extracting mass and density information from individual snowflakes has never been tried before, at least not published in the open literature. The technique that is used is simple in its concept, although there are issues that need to be addressed before it is ready to be used by the broader scientific community.

I recommend publication after a number of major issues are addressed, not least the haphazard placement of the figures that many times are found in the text well before they are discussed. Whether this was an error by the copy editor or carelessness by the authors, it was a major source of frustration as I tried to review the manuscript and a source of uncessary distraction . Had the topic not been so compelling, I would have rejected this paper early on. I was not one of the first-cut reviewers, but I would have not allowed this to go into the discusson phase in the current form.

1) There are a number of shortcoming that need to be addressed before this paper can be published. The most significant being the lack of a comprehensive error analysis the documents the source of systematic and random erros and then propogates these into the derived quantities that are being highlighted, i.e., equvalent diameter, particle complexity, density, mass, visibility, SWE, etc. There are many potential sources of uncertainty that were mentioed but no quantitative estimates given. This is unacceptable for an instrumentation paper. One of the uncertainties that is given very short shrift concerns the probability that two more more snowflakes will be imaged together, not because they are aggregating when they fall but because one fell one top of the other. A very brief comment is made that under one condition, out of a 1000 images, ony 5 wewre touching. Figure 7 belies that statement since there are many fewer than 1000 particles and I count more than 10 that are touching. Given the long times needed to evaporate ice crystals (see my next ennumerated issue), 30-60 seconds, under even modest precipitation rates the probability must be moderately high that as one crystal melts/evaporates, another will fall on top of it. This situation is not addressed but a very simple calculation needs to be made, similar to what is done with other optical spectrometers, to estimate the coincidence probability for different size distributions and precipitation rates.

2) One of the most critical parameters in all of the equations to predict density and mass, is the time to completely evaporate a crystal; and yet only a single figure (Fig. 5) shows this parameter for a single water droplet. I would like to see some actual Size vs time for ice crystals in field experiments so as to illutrates the variability with size, mass and density. These times also help determine the frame rates and probability of coincidence, so a lot more needs to be discussed about their importance for deriving the parameters that are being advertised as available from this instrument.

3) The camera frame rates that are mentioned vary quite a bit, from 5-240. It appears that the higher frame rates were used just to validate certain aspects about detection and melting rates, but operationally much lower rates are used. Why? This raises a very important issue that is not addressed: "What is the processing time?". With 1.2 Mpixels to process from each frame, how long does it take to identify and accept/reject each particle in a frame, what are the filtering criiteria and has fast can all the derived parameters be output? Is this near-realtime or does this require substantial pot-processing time so that the applications can only be for research and not for operational applications?

4) How do you avoid measuring snow lifted from nearby surfaces, i.e. how do you know that you are measuring freefalling snowflakes?

5) Can you measure graupel or snow pellets that bounce?

6) Snowflakes form on aerosols and scavenge them, as well. These will remain as residue after the crystal melts. What is the impact on the measurements and how does this issue get addressed? How about issues of condensation on optical surface/components of the camera? Turbulent flow around the camera will likely deposit blowing snow on camera surface.

A final note: please review all the references to make sure that they are the original one and not just quoted like you did by using Rogers and Yao to reference parameterization of fall velocity. They published a reference textbook but the equations were developed by others. Please respect the original works and cite accordingly,