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Comment on acp-2021-179

Anonymous Referee #1

Referee comment on "Mass and density of individual frozen hydrometeors" by Karlie N. Rees et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2021-179-RC1, 2021

I support publication. The authors describe measurements of mass and density of thousands of frozen hydrometeors, during two months in 2020, using a newly developed instrument. A paper describing that instrument, the Differential Emissivity Imaging Disdrometer (DEID), is currently in review in AMTD (Singh et al.). While it isn't necessary to read both papers to understand this one, I did find a brief review of that paper helpful as I read through this one.

If the paper were essentially published as-is, it would be fine. I have a few comments that the authors can consider, but have no changes that I feel must be made for the manuscript to be publishable in ACP.Lines 120-121: ``...raindrops do not preserve their area after impaction on the plate.''

line 89: "...frozen particles nonetheless tend to maintain their shape such that A_{max} is representative..."

line 211-212: "The plate was roughened with 600 grit sandpaper to allow for droplet spreading and more rapid evaporation."

These three statements introduce some ambiguity for me. I can see why droplet spreading and more rapid evaporation make the analysis of the heat transfer aspects of the problem easier, but why don't the droplets resulting from melting snowflakes or graupel spread? Why do they preserve their area (roughly)? Is it because they land on the plate rather gently? I know from my own observation of watching single snowflakes or aggregates land on surfaces that they don't tend to land forcefully. Usually the aggregates don't even break off pieces of the needles if they are clumps of dendrites. This makes sense to me because the terminal speed of these types of hydrometeors is usually pretty small.

Many raindrops, on the other hand, are large enough to have an appreciable terminal speed; the kinetic energy of their impact could flatten them. Does this mean that if drops are small enough (fog might be the limiting example) that their area would be preserved upon impact and the DEID could be used to estimate a density?

There should be a relationship between the area that a drop makes upon contact and its size. Marshall and Palmer used a version of that phenomena when they correlated the size that drops made on dyed filter paper. (Before that, Bentley had used small canisters of flour to measure the sizes of raindrops.) It seems that something akin to that principle could be used here.

I recognize that this is beyond the scope of the present paper and that what I'm suggesting here is complicated by the fact that both liquid and frozen hydrometeors are impacting upon the plate. That said, perhaps the authors could comment on this, even if only in the Reply to the Reviews, since those are archived as well as the paper.