To the Editor, Alexis Berne:

To address your comment,

> In addition, I would like to come back to a concern raised by an "early" reviewer: wind effect. In your response, you refer to Singh et al, AMT, 2021 to state that wind has no effect. My understanding of the tests presented in Singh et al 2021 (see Section 4.2) is that the influence of wind speed on the estimation of the mass of the drop(let)s was shown to be negligible. But the point of the reviewer (if I properly understood) was on the catching efficiency, which is a completely different and valid issue. I would like you to at least discuss this issue in your manuscript.

we have added the following to lines 109-118 of the manuscript to address catch efficiency:

Hydrometeor catch inefficiency is a large contributor to precipitation rate measurement error, especially in bucket-type precipitation gauges (Pollock et al., 2018). Rasmussen (2010) found that the Yankee hotplate had a catch efficiency of only 50% with wind speed of 5 m/s and 35% with wind speed of 8 m/s. The DEID underwent a series calibration wind tunnel tests to determine the effect of wind on mass measurements. During these experiments, mass measurements remained approximately constant, revealing that catch inefficiency is not a contributor to the precipitation rate measurement (Singh et al., 2021).

The high catch efficiency from the DEID was demonstrated during a storm that took place at Alta, UT on April 16, 2020 between 0000 and 1600UTC (Figure 10 of Singh et al. (2021)). The co-located weighing gauge was located inside of a wind fence, while the DEID was not. Despite wind speeds during the storm ranging from 4-13 m/s sustained with 8-19 m/s gusts, DEID precipitation measurements were within 6% of the co-located weighing gauge. For this reason, precipitation rate as a function of catch efficiency is not explored in this work.

Please see below for our responses to the new reviews.

Sincerely,

Karlie N. Rees
Timothy J. Garrett

Report # 1:
Referee #3: Darrel Baumgardner
No Suggestions

Report # 2
Anonymous Referee #4

Reviewer for manuscript AMT-2020-393
Title: Idealized simulation study of the relationship of disdrometer sampling statistics to the precision of precipitation rate measurement
Authors: Rees and Garrett

This study used the Monte Carlo method to verify the sampling width area that would allow to measure precipitation rates precisely, in particular low precipitation rates. The manuscript contributes to the development of sensors to measure precipitation. I noted many small issues that should be considered before publication.

We thank the reviewer for their constructive comments.

Minor comments:
1. Section 2: Write the full name in the title of the section.

The Section 2 header now reads: Differential Emissivity Imaging Disdrometer principle

2. Line 102: Add a number to the equation. Should probably explain this simplified version of equation 1 was obtained.

Added an equation number and updated line 100 to read: When combining the constants into a single value K_d, Eq. (1) simplifies to

3. Lines 106-110: Make sure that the units are given to all variables and the abbreviation is used. For example, change 'units of meter square' to m2. Verify the full manuscript.

Corrected notation in lines 106-108 (and verified this throughout the manuscript):

where β = 3.6 x 10^6 mm s m^{-1} h^{-1}, f_s is the camera resolution (frame s^{-1}), A_{evap} is the total area of water on the sampling area (m^2), I_{mean} is the pixel intensity related to the temperature difference between the plate and water through T_p-$T_w(t)$≈(255-I_{mean})/256xT_p, ϱ_w is the density of water (1000 kg m^{-3}), and A_{hot} is the hotplate area (m^2).

4. Figure 1: the figure caption should be improved. Instead of using a red circle you could label the different parts using arrows and add the scale on the image.

Figure 1 has been updated, replacing the ellipse with text boxes and arrows. A scale was not added since other objects on the tower, including the thermal camera, are skewed at an angle and the scale would not be consistent for those objects. The caption now reads: Photograph of the DEID during the Red Butte field experiment in Salt Lake City, Utah with the thermal camera pointed at the hotplate surface.

5. Line 129: Change 'inverse millimeter' to mm-1.

Line 137 now reads: with units of mm^{-1}.

6. Line 132: Specify where it will be discussed.

Moved the paragraph to Results, so deleted "as will be discussed."

7. Lines 131-136: This paragraph would probably fit better in the results section.

Moved this paragraph to the Results Section 4.1 (lines 177-182).

8. Line 138: Change 'a' for 'the' because there is only one Marshall Palmer distribution.

Changed "a Marshall Palmer distribution" to "the Marshall Palmer distribution" in line 140 and throughout the manuscript.

9. Line 141: Why not using the scientific notation here? Please change to 3.6 x 10-3.

Line 143 now reads: where α = 3.6 x 10^-3.

10. Figure 4 is referred before Figure is discussed. The author could either change the order of figures or the order in which they are referred in the text.

Removed premature references to Fig. 4 from this section.

11. Line 147: What is 'A' again? Consider add a Table with the definition of all the variable used in the manuscript.

Added list of constants and variables in Appendix A: Nomenclature

12. Line 149: It should be fall speed in 2 words. Change throughout the manuscript.

Changed “fallspeed” to “fall speed” in line 151 and throughout the manuscript.

13. Line 155: Add ‘size’ after drop distribution.

Modified lines 156-157 to read: So that small particles with D < 1 mm are not over-represented (Ulbrich and Atlas, 1984), the drop size distribution is modified by the shape parameter μ and generated according to Eq. (6).

14. Line 165: The terminology used earlier area width. You should use the same terminology throughout the manuscript.

Replaced “width” with “area width” throughout the manuscript.

15. Lines 190-191: Rephrase this sentence, which is hard to follow. “The derived minimum required … plate used.”.

Rewrote lines 197-199 to read: For moderate rain where R = 1 mm h^{-1}, the derived minimum required sampling area width to meet WMO requirements is 13 cm. That is, the size of plate used was insufficient for the measurement of rain this intense.

16. Line 197: Specify which case it is.

Line 204 now reads: To assess whether the presence of non-Poissonian clustering is the case,

17. Line 222: Write full name instead of using the acronym.

Line 230 now reads: Despite their sizable collection areas, like the Differential Emissivity Imaging Disdrometer, they may nonetheless fail to meet WMO standards if operated at a nominal 1 minute sampling interval.

Report # 3
Anonymous Referee #5

This short paper examines sampling of raindrop distributions with a new instrument, the DEID. The authors use Monte Carlo sampling to identify the sampling area/time needed to meet WMO standards for precipitation at various rain rates. They then apply this information to the new DEID instrument.
Overall, the paper is concise and easy to interpret. While I have no qualms with the analysis, some of the conclusions (e.g. implications for other instruments) would have been better explored within this paper. For example, having an intercomparison of the DEID with the Parsivel. The other major sticking issue is the robustness of the results (non-Poissonian distributions) that I see an earlier reviewer commented on. In the end, this is an interesting paper but the robustness/usefulness to others may be lacking. In these cases, I usually prefer publishing vs. not as this could have utility to some. As such, I only have a few minor comments below:

We thank the reviewer for their constructive comments.

1. (Line 10): Would it be better to say 'remotely-sensed precipitation measurements' vs larger scale precipitation measurement systems? Maybe it's just my brain, but it kept interpreting the current wording as larger scale precipitation systems. Add references for TRMM, given you have refs for the other categories?

Changed in line 11: "larger scale precipitation measurement systems" to "remotely-sensed precipitation measurement systems".

2. (Line 15): omit 'even very', I think the sentence has the same meaning without these words.

Omitted 'even very' from line 15.

3. (Line 23): omit 'size' as this is implied by area.

Omitted 'size' from line 22.

4. (Line 85) Since color is arbitrary, shouldn't white/black be referred to by brightness temperature?

Lines 83-84 now read: Since aluminum is a thermal reflector (thermal emissivity $\epsilon \approx 0.03$), whereas water is not ($\epsilon \approx 0.96$), particles have high brightness temperature and appear as white regions on a low brightness temperature, black background.

5. (Figure 1): I appreciate the hand-drawn ellipse, but a vector ellipse is perhaps more professional.

Figure 1 has been updated, replacing the ellipse with text boxes and arrows following another reviewer's comment.