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Atmospheric Measurement Techniques Discussions

Interactive comment on "Quantifying Hail Size Distributions from the Sky: Application of Drone Aerial Photogrammetry" *by* J. S. Soderholm et al.

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Interactive comment on "Quantifying Hail Size Distributions from the Sky: Application of Drone Aerial Photogrammetry" by J. S. Soderholm et al.

Anonymous Referee #2 Received and published: 19 September 2019

The authors present a new technique for measuring hail size distribution using aerial photography and a machine learning approach to detecting and measuring individual hailstones. This is a novel method using new technologies and would provide better sampling with more automation. There are, however, a number of requirements for this technique and I would like to see more discussion on these limitations and in what kind of scenarios this method would be practical.

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Discussion paper

The authors wish to thank the reviewer for taking the time to read this paper and the valuable comments regarding improvements to the discussion of requirements and limitations.

Further concerns:

Pg 2 Ln 22-25: Can you quantify these requirements better? It looks like, in this case,the hailstones must be larger than 20mm. What kind of spacing must there be between them on the ground? How much is the technique affected by the presence of smaller hailstones as well?

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This is an important point, thank for for highlighting it. The hail size requirements are a dependent on the effective ground resolution of the orthomoasic, and thus are best discussed after the sensor is introduced (section 2). Two additional sentences have been added to section 4 (p. 6 lines 17-20) that provide recommended minimum hail size and ground coverage for successful HailPixel surveys. In summary this is a minimum value of 20 mm for the major axis length and a maximum of 50 % ground coverage. Further testing would be required to determine the effect of smaller hailstones on the measurement accuracy.

Pg 3 Ln 6: Is there a restriction on the 10m wind speed in order to fly the drone at such a low speed? Does accuracy fall off with a large or variable wind?

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Thank you for raising this point. The wind speed at the time of capture was a gentle breeze (3.5 – 5.5 m/s) and this has been added to page 3, lines 6-7. The authors recommend that hailpixel surveys are conducted with near surface below 8 m/s to reduce the likelihood of motion blurring. This recommendation has been added to the text in page 6, lines 22-23. The authors believe the accuracy of the hail size retrieval would be effected without a doubt in stronger winds.

Pg 4 Ln 8: How were the 12 training tiles chosen? Does the number of tiles necessary for training depend on the concentration of hail, or on the type of background?

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Twelve tiles were chosen to ensure the total number of stones was approximately 1000. A smaller sample size may have also been appropriate but the sensitivity of the model performance to training size was not explored. Further, pre-training weights from the COCO dataset were used to initialise the model, limiting the need for very large training datasets. The specific tiles used for model training were manually selected to represent the different background types, as this is also an important part of training an RCNN model. The manuscript has been amended to clarify that the 12 tiles used used to achieve a sufficient sample size and were selected manually to sample the different background types (page 4, lines 11-12).

Pg 4 Ln 26: Do the tiles have similar distributions or concentrations?

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The hail concentration of individual tiles varied between 15 and 91 stones per m2, with a mean of 47 stones per m2. Inspection of the spatial distribution indicated that vegetation density and slope plays an important role in the concentration of hail when it finally comes to rest. Higher concentrations appear in regions of denser grass, likely due to the grassy areas acting to dampen bouncing and rolling of stones, increasing collection. The lowest concentrations appear on unvegetated areas where hail can readily bounce and roll. An analysis of individual tile concentration has not been included in the text because it doesn't reflect the true distribution of hailstones for these reasons.

Pg 5 Ln 5: What kind of range does the 'lightness value' have? If the lightness value of a hailstone must be >50 more than that of the edge, how much does this restrict the type of background against which hail can be measured? How sensitive is the lightness value or its variability to the overhead light (sky conditions, sun angle)?

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The lightness value is a 8 bit index that has a range of 256 values (added to the text in the foot note on page 4). The authors agree that the minimum difference in lightness between the hailstone centre and hailstone edge is definite limitation for the technique. However, even for light-coloured soils, the lightness difference still remained well above 50 units. A comments has been added to the text (page 5, lines 9-10) regarding the performance of this lightness difference threshold for different background types. Regarding the sensitivity of lightness values to the sky conditions, the November 2018 survey was conducted during cloudy conditions. The automatic exposure and white balance control on the UAV camera was able to compensate for the low lighting conditions. Comparable lightness values for hail and background types would be expected for full-sun conditions with the correct exposure and white balance adjustments.

Pg 5 Ln 10: How many hailstones were counted on the pad? How does the total concentration compare? Were there no hailstones <20 mm measured on the hail pad or were they just not considered for this comparison?

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Thank you for raising these important points. A total of 17 impacts with major and minor axis measurements were sampled from the hail pad, with a concentration of 141 stones per m2. This information has been added to the text on page 5 lines 15-16 and lines 23-25 respectively. The mean concentration observed by the HailPixel survey was 47 stones per m2, significantly less than the hail pad. This is possibly due to the fact the two samples were not co-located, and the hail pad experienced a longer duration of hail fall. Further, bouncing hail stones may have introduced secondary impacts on the hail pad that were indistinguishable. This justification has been added on page 5 lines 23-25. No stones less than 24 mm major axis length were sampled by the hail pad.

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Please also note the supplement to this comment:
https://www.atmos-meas-tech-discuss.net/amt-2019-281/amt-2019-281-AC1-supplement.pdf

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