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Atmospheric Measurement Techniques
Discussions

Interactive comment on "Measuring Droplet Fall Speed with a High-Speed Camera: Indoor Accuracy and Potential Outdoor Applications" *by* C.-K. Yu et al.

Anonymous Referee #1

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General comments:

The accurate knowledge of the terminal velocity of raindrops has high hydrological and meteorological relevance since it is a key microphysical parameter in, e. g., precipitation radar algorithms and precipitation models. It has been a long history of measuring techniques in this field since the beginning of the last century, but there is still a need for precise, accurate, and low cost measuring methods for determining drop fall speeds. The paper of Yu et al. describes an experimental setup utilizing a high speed video camera for terminal velocity measurements. However the setup itself seems to be very simple, there are a lot of difficulties and questions which have to be solved and worked out. The subject of the paper, i.e. the utilization of a relatively new technology for

atmospheric measurements, suits to the scope of AMT and is of high interest to the atmospheric physics community.

In general, the paper is clearly written, well organized and scientifically sounds and can be recommended for publication in Atmospheric Measurement Techniques. Nevertheless, I have some remarks and questions which can be taken into account for a revision before publication:

Specific comments:

line 135-137: The fall distance used in the present setup should also be compared to the results from the very recent paper of Chowdhury et al. (Atmospheric Research, Volume 168, 1 February 2016, Pages 158-168).

line 144: How large is the "narrow focal zone"? If the depth of field is very narrow then the applicability of the HSC will be limited; if it is too large, drop size information will be lost.

line 165: The bright spot inside the drop image cannot be a specular reflection of the light source since it is located on the other side of the object. It is rather a lensing effect.

line 175: From Figure 3 the authors determine an optimal brightness (grey level) value of 26. I would rather say it is 26+/- 2. What error should it cause in the drop size if you use 24 or 28 instead of 26? Further, why didn't you apply the method of Jones and Saylor (2009), where they calculate a histogram for the grey levels and calculate the optimal brightness value?

line 194: The deviation from the spherical shape is realistic. The question is rather how large the axis ratio is, and whether the axis ratio value realistic or not. It should anyway be given a comparison of the axis ratios of the drops to the literature values which could give another approximation of the quality of your size determination.

line 206: I could not follow the estimation for the range of size error. Furthermore, the drop images shown in Fig.2a/b are very fuzzy, therefore the size error of +/- 2 pixels seems to be unrealistic. A common method for HSC systems is to calibrate the size error of the camera with calibrated spheres, see, e.g., Chowdhury et al. (Atmospheric Research, Volume 168, 1 February 2016, Pages 158-168), please consider to apply it in your study.

line 215: In Figure 5 you indicate the drop size and velocity. It would be desired to know how large d and the corresponding time were.

line 225: Can you provide here in the text an example for a velocity measurement and its error estimation? For example for the drop shown in Fig. 5. It would be easier for the reader to follow your consideration.

line 244-263: Why didn't you use the parameterization of Beard (1976) in which you can set all the relevant physical parameters specifically for your measurement conditions? This parameterization had been proven to work well also for drops with reduced surface tension, for instance (see Müller et al., Atmos Res, 2013).

Fig. 6 and Fig. 10: Please add the error bars to the figures.

Fig. 6. Caption: please refer here to the Equation number for calculating Vt.

line 301: The size error considerations are only valid for rigid drops. But we know that large raindrops are oscillating also in asymmetric modes (see Szakáll et al., 2010, for instance), therefore the integration method may result in false sizes. What error would arise when considering the asymmetrical nature of raindrop shapes after collision, for instance (see Szakáll et al., 2014)? It should also be taken into account or at least mentioned as a source of error.

Fig. 7: Axis labels cannot be read. Furthermore, please indicate in the figure caption what in Fig. 7a and Fig. 7b are plotted.

line 307: The statement holds only if the theoretical values are correct. It would be interesting to see whether the same deviation can be seen when using the parameter-

ization of Beard (1976).

line 348: I guess the focal plane itself was not longer (larger) but its distance to the camera has been increased. Was the depth of field in the outdoor experiments the same as in the indoor ones?

line 371: Here, again, the Beard (1976) parameterization can be applied with the corresponding outdoor parameters.

line 397: How realistic is to collect larger dataset of a rain event? The internal memory of the camera is limited, therefore the saved data should be transferred to a computer. This results in a relatively long idle time, isn't it?

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