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Atmospheric Measurement Techniques Discussions

Interactive comment on "An experiment to measure raindrop collection efficiencies: influence of rear capture" *by* A. Quérel et al.

Anonymous Referee #2

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This is a very interesting contribution on the raindrop collection efficiency of submicron particles. Previous work in that domain was performed about 4 decades ago and there is a clear need to update and complete the knowledge. This work addresses both the experimental and theoretical aspects of the question. Data collected using a recently developed facility (BERGAME) are compared with theoretical models. Furthermore, the experimental setup developed is a vertical tower (10 meter height) is particularly suited for this type of experiment because it is as close as it can be to a drop free fall situation and therefore reproduces better the natural conditions. The formal aspect of the paper (text, figures) is very good and the paper is easy to read and very clear. As mentioned by the authors in the conclusion, more work is needed to generalize the measurements to other drop sizes. The manuscript is worth publication in AMTD.

However, I have a few comments that I develop hereafter and that should be clarified:

1 – Page 518, line 3: "the ratio Cc,dae/Cc,dap is considered equal to Eq. (1)". Eq (1) is the collection efficiency. Is this what you mean here? In addition a comma (,) is missing for the denominator.

2 – Page 520, figure 6: Although the results obtained for D0=2mm and D0=2.6mm are relatively close (as mentioned by the authors), I think it would be interesting to distinguish both diameters in Figure 6.

3 – Page 520, figure 6: What represent the error bars?

4 – Page 521, lines 1-2: "These results perfectly overlap ours (Fig. 6)" I am not sure that "perfectly" is adequate here. Although I agree that the measurements obtained by the authors are close to the "rare" experimental results available (Lai et al. 1978), I see that the latest are somewhat shifted toward lower aerosol diameters, which in this case would be closer to the Beard (1974) model discussed later (Fig. 8). Could those differences be explained by a different experimental setup (10-m free fall shaft in this work when compared to a short type acceleration system used by Lai et al.)?

5 – Page 522, figure 8: Regarding the comparison between experimental results with theoretical model (Fig. 8) for the D0=2mm. While a relatively good agreement is found for aerosol sizes of less than one micron (i.e. for aerosol particles located on the left branch of the V-shaped curve), the discrepancy becomes more important for aerosol size above 1 micron. I definitely agree with the authors that this observation would justify additional experiments with different drop sizes close to 1mm. Among the possible explanations, the authors pointed the Beard (1974) model simplification (that assumes spherical drops) and does not account for drop oscillation. In addition to model simplification, what could be the part of experimental uncertainties (drop size, drop velocity) on those differences?

6 – Page 523, lines 3-6: I quote: "Another important result obtained is that the collec-

tion efficiency seems to be independent of relative humidity for drops with a diameter of 2 mm (Fig. 9)." and "Figure 9 shows that there is no measurable effect on the collection efficiency resulting from varying relative humidity." I am not sure this independence is directly noticeable when looking at Figure 9. At the best, the statement is confusing. Indeed, for high values of the relative humidity (RH=85%), the points (red) are all located in the vicinity of the Greenfield gap (minimum of the collection efficiency). For the lowest values of RH (RH=25%), the points (blue) are concentrated at the right branch of the V-shaped curve, while intermediate values (RH=60%) are mostly found on the left branch of the V-shaped curve (green-yellow). By looking at the figure only, it is hard to see the independence of the collection efficiency with respect to RH. Furthermore, the experimental points are organized as predicted by the Davenport and Peters (1978) model reported in Figure 9. Despite the difference in magnitude (the Davenport and Peters model providing lower values of the collection efficiency than the experiments), the collection efficiency increases with decreasing RH. Additional explanation seems to be needed here.

7 – Page 530, table 1: I assume the uncertainties for the drop velocity and the axis ratio are directly measured. Is this the same for the uncertainty regarding the drop diameter? Was the drop diameter directly measured during the experiment or is it the diameter based on expected experimental uncertainties? I am asking this because the uncertainties reported for the drop fall velocities ($\pm$1.1 m/s for D=2mm and $\pm$0.9m/s for D=2.6mm) do not correspond to an uncertainty of only $\pm$0.1mm on the nominal diameter. I think the discussion regarding the experimental uncertainties (drop diameter, fall velocities, axis ratio) should be completed (possibly in the section describing the drop generator).

8 – Page 530, table 1: While the reported average drop velocities are relatively close to the theoretical value (Beard model 1976), there is an important variability in those values. I assume that drop velocity are measured far enough from the drop generator (at the aerosol chamber level) to achieve terminal fall speed. A few words of explanation

or annotation on the figure 2 (location of drop velocity and axis ratio measurements) would be welcome.

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