

## ***Interactive comment on “Laboratory and In-flight Evaluation of a Cloud Droplet Probe (CDP)” by Spencer Faber et al.***

### **Anonymous Referee #2**

Received and published: 26 February 2018

This is a thorough and concise manuscript which I recommend for publication after a couple of changes have been considered. Laboratory and airborne field characterizations of a commercial cloud droplet sizing spectrometer (CDP, Cloud Droplet Probe) are reported. As such it fits well into the scope of Atmos. Meas. Tech.

I have three general and a number of specific comments/suggestions:

#### General comments

Some discussion about the general applicability of the presented test results of a specific instrument of the CDP type to other instruments of the same type than tested here is required. To which extend the reported sizing deviations are systematic problems of the CDP, and to what extend they hold for the specific probe used here only?

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It should be made clearer which progress has been achieved over the results reported previously (in particular with respect to Lance et al., 2010, 2012). Is there more than the incorporation of computerized position stages, instead of manual positioners as used by Lance et al. (2010)?

It should be discussed that the two major parts of the paper (laboratory and field observations) actually don't have much to do with each other. In the lab the sizing was tested, in the field LWC data were evaluated. Also, droplet sizing spectrometers are not made to derive higher order moments of the size distribution, deriving LWC from this type of measurements is originally not intended by these droplet sizers. The immanent sizing uncertainties amplify (cube) in LWC. For LWC measurements different operating principles are much more appropriate, such as the well tested hotwire probes (e.g., the Nevzorov probe). Therefore, it is kind of unfair to compare the extremely error prone LWC data from the droplet sizing spectrometer to the much more straight-forward hotwire bulk probe LWC measurements. Why should you use a droplet spectrometer for LWC measurements if a bulk hotwire instrument is cheaper and much more accurate? I don't say that it makes no sense to compare both LWC measurements, in an ideal world both LWC measurements would agree. However, in the real world I am not surprised at all, that there is a huge discrepancy between the two approaches as illustrated in Figure 6 of the paper. I suggest to include a short discussion on this subject into the manuscript.

#### Specific suggestions

Title: The wording in the title is inaccurate in the sense that not the GDP probe itself, but its measurement uncertainties in terms of droplet sizing and LWC are evaluated. Maybe the title could be changed to something like "Laboratory and In-flight Evaluation of Uncertainties of Droplet Size and Liquid Water Content Measurements of a Commercial Cloud Droplet Probe". BTW: I always try to avoid acronyms in the title.

Abstract: Please quantify the seven droplets sizes generated in the lab; otherwise it

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is unclear what you mean with “For the smallest diameters” (lines 5-6 of abstract) and with “For all larger diameters” (line 7).

## 1. Introduction

I always try to avoid mentioning specific companies (PMS, DMT) in scientific papers, we should not advertise. That should be replaced by appropriate references to reviewed papers.

I am glad you appreciate the major contribution of Lorenz and call it the “Mie-Lorenz theory” instead of mentioning Mie only. However, to be consequent you should call it “Lorenz-Mie theory”, Lorenz was first! And please stay consistent, later in your text you forget Lorenz and use “Mie-theory” only.

I suggest to include the following additional reference when discussing the FAST-FSSP and instrumental broadening of size distribution: Schmidt, S., K. Lehmann, and M. Wendisch, 2004: Minimizing instrumental broadening of the drop size distribution with the M-Fast-FSSP. *J. Atmos. Ocean. Tech.*, 21, 1855–1867.

Page 3, first paragraph: You imply that Lorenz-Mie theory only holds for small droplets, which is not true. It is just not appropriate to apply Lorenz-Mie theory for larger particles; it is much more efficient to use geometric optics for larger particles. But in principle Lorenz-Mie theory is not restricted to small droplets, please would you make respective changes to the text.

## 2. CDP Operating Principle

A schematic drawing of the CDP would greatly help readers not familiar with this type of instrument to follow your explanation of the principal of operation of the CDP. Alternatively, you may drastically reduce the description of the operational principal and refer to respective literature.

I mostly avoid to refer to gray-literature manuals provided by companies in scientific texts. If unavoidable, just give the web site address.

The differences between FSSP and CDP should be emphasized, progress achieved by CDP in addition to the revised electronics should be highlighted.

Last line in paragraph 20 on page 4: Please quantify “high droplet concentration”.

### 3. University of Wyoming Droplet Generating System

You need to make clear why you partly repeat work done already by Lance et al. (2010).

A schematic illustration of the droplet generator setup might be helpful.

Droplet speed measurements are discussed, at this point the reader asks why this is important. Later it becomes obvious that this is needed to compare with droplet velocities occurring in real aircraft measurements. Just make sure the reader understands here that these measurements have some meaning for the later text.

Maybe you briefly discuss about droplet evaporation during generation and transport to the sampling volume of the CDP.

How about mechanical distortions of the droplet generation setup and its impact on droplet generation, is there a problem with small-scale wind turbulence?

### 4. Results of Droplet Generator Tests on the CDP

Second paragraph in 4.1: Quantify “Smaller droplets”, “shorter test periods”, and “less stable”.

Figure 1: Maybe you add a similar figure just including droplets passing through the center of depth of field. The axis labels are way too tiny. Coloring is not optimal in my point of view.

I don't see any reason why the pure counting efficiency is not exactly 100 %, please comment on that.

### 5. Comparison of ... (please use capital letters for the section title, as you did before)

As discussed above already, you are entering a new world here. Anyway, these data

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cannot be compared to your lab studies. Just discuss this, I don't want you to delete this section.

Sometimes you duplicate/repeat figure captions in the text.

The discussion of the differences in Figure 6 is kind of speculative. This is unavoidable, at least partly. A reader could ask why you mostly use data collected in complicated super-cooled conditions with quite some chance to encounter mixed-phase clouds. The matter is already complicated enough in pure liquid water clouds.

The discussion on the droplet speed influence is not satisfying. No way to at least roughly test something in this regard?

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