

## ***Interactive comment on “Water droplet calibration of a cloud droplet probe and in-flight performance in liquid, ice and mixed-phase clouds during ARCPAC” by S. Lance et al.***

**Anonymous Referee #2**

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This paper presents strong evidence indicating that an attempt by Droplet Measurement Technologies, Inc. to solve the problem of shattering, common to other forward scatter probes, with its new Cloud Droplet Probe (CDP) has led to a serious exaggeration of the co-incidence problem, which is present in all these probes. This conclusion is postulated on basis of a comparison of integrated particle volume measured by the CDP to a King probe measurement, and confirmed by computer simulations.

The simulation results are convincing. They show how the superposition of scattered light from particles in the laser outside the sizing volume at same time particles are go-

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ing through the sampling volume can result in both undercounting and over sizing. The results of the measurement comparison (Fig. 5) are closely matched by the simulations (Fig. 9a).

What needs to be explained though in words is why the coincidence error in LWC is linear and zero crossing such that at very low concentrations where no coincidence is to be expected the CDP integral is 30-40% low (Fig. 5). One would expect the curve to level off at some concentration if coincidence were the cause of this error. In this context one wonders also what weight to place on the mixed cloud results. The instrument is calibrated using liquid water drops, and this calibration is presumably used to size the ice crystals as well as the drops. The integral thus includes potential ice volume, while the King probe does not. Despite these issues, the paper clearly raises a warning flag users of similar probes need to pay attention to.

Another important question addressed in the paper is how valid is the traditional method of calibrating forward scatter probes by use of glass spheres of known size and extrapolate to water drops on basis of modeled (Mie code) instrument's response. It is good to see that overall the old method seems to hold, because it is so much easier to perform, which is important on a field deployment. However, the water drop calibration does suggest some discrepancy with calculated response for particles in the Mie-resonance region (1-10 micron diameter) which, although of little importance except in the rapid growth region near cloud base, shows the importance of using calibrations rather than calculated response curves to determine channel boundaries and pulse height/drop size correspondence.

Lastly, the paper provides a good summary of the fundamental problems that are known to affect measurements by forward scatter probes in general. It might be pointed out however, that there are other important problems which, although not fundamental to the technique, often cause as large or larger errors in size distribution measurements. Misalignment or mis-assembly of optical elements and attenuation of laser intensity on dirty lenses commonly shift the instruments' calibration and alter the pulse-

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height/drop-size correspondence. A big question is also how to convert a pulse height due to an ice crystal to 'size'. Is there really any justification for presenting a diameter, or volume, for a pulse generated by a particle of unknown phase and shape (such as is measured in mixed phase clouds)?

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