AMT-2021-185; Review

This manuscript deals with the analysis of cloud droplet size spectra measured by a commercial probe, the Cloud and Aerosol Spectrometer (CAS.) Topics include the error caused by the "ripples" in the Mie program that predicts the amount of forward-scattered light in the probe for each droplet and its location in the size bin related to that amount of scatter. Dealing with the error caused by the "ripples" is described. The distribution of size bins for field use is shown and compared to other size-bin options that appears to be the main topic of the paper. In particular, the authors note the possibility of using PbP (full particle by particle data) CAS files that record the scatter for each individual droplet. They show how this high resolution PbP data creates much greater detail than the field size bins. A final topic describes the effect of contaminated droplets on the output of the CAS.

This paper is a useful contribution for CAS users, especially if they wish to deal with the added complexity of using finer-scale size bins in describing droplet size spectra. While this is a well-written paper, some additional information is recommended to be included for making the contents more suitable for potential users.

Comments:

1. We know that droplet spectrometers, such as the CAS, have a very small sensitive volume where the forward scattered light of droplets is measured. This significantly limits their ability to measure droplet size spectra over short in-loud distances. The authors note the droplet spectra is "conveniently" measured in-cloud every "sampling instance" of1s, which at a typical research-aircraft velocity of 100 m/s is equivalent to 100m. The total sample volume seen by the CAS over this distance appears to give enough droplets ("thousands") for the CAS to sample, giving meaningful spectra for "normal clouds" as noted by the authors. Some spectrometer data has been published at 10 Hz, but here the ambient droplet concentration must be quite large for meaningful results. Given that ambient droplets can be described as being approximately distributed randomly in space means that the CAS must measure enough droplets to achieve acceptable statistical uncertainty in the resulting spectra. For that reason, obtaining CAS spectra over distances < 10m at the given aircraft velocity usually appears unrealistic.

The preceding comments apply directly to PdP data files that the authors describe as containing scattered light (and time arrival data) data for each of the first 292 droplets for each "sampling instance" of 1s. Clearly, such a low number of droplets for each 1s will not yield much useful information on desired high-resolution size spectra, therefore PdP from multiple 1-s "sampling instances" must be combined to achieve statistical significance. In the authors' given spectral plots this is apparently done because of the flight duration of the measurements covering "several minutes".

The authors state that their effort included a "…complicated and time-consuming analysis of the PbP files…". Thus, their PbP approach may be of limited practicality; although, it still may be useful if a limited number of high-resolution spectra are needed corresponding to lengthy sampling periods.

In addition to showing the spectra from the authors' measurements over several minutes, it would be useful for the reader if the authors also included spectral data for a 1-s interval and its associated companion PbP spectra, given that droplet spectra are often presented for this time interval. An estimate of how many intervals must be combined to obtain useful high-resolution PbP spectra would also be useful.

2. Droplet spectra from spectrometers are often given as continuous data without error bars. Since cloud droplets are approximately distributed randomly in space (~ Poisson distribution) it is possible to estimate from the droplets' count in each size bin the uncertainty of the count. This is rarely ever done. Please discuss how this statistical uncertainty affects the accuracy of your spectra measurements, especially those associated with PbP.

3. In Fig. 6 the authors show the effect of a 10% error in the scattered light measurement on the droplet spectra. This amount of error is less than the error spec provided by the CAS manufacturer as noted by the authors. Figure 7 shows a relative error of 20% for the flight-line sample volume, and shows the expected

result on cloud parameters when the scattered-light error increases to large values. Are the abscissa error values realistic? Given these substantial errors, does the detailed analysis of the Mie "ripples" in the paper lead to errors of the same magnitude, or can they be ignored in comparison? Please comment.

4. Section 6 uses Mie theory to estimate the effect of different refractive indexes on various droplet properties. For example, Fig. 11 illustrates the obvious strong effect on droplet properties for small values of the imaginary index. To put this result into perspective, can the authors indicate where typical ambient cloud droplets fit into the 3-D plots of Fig. 11?

Minor Comments:

L52 - what is meant by "…cast into the generic name…" Suggest removing this part and using '…instrument is the Cloud…'

Fig. 3 - The numerical values of the ordinate axis of the right-hand LWC plot are incorrect.