

## ***Interactive comment on “MBL drizzle properties and their impact on cloud property retrievals” by P. Wu et al.***

### **Anonymous Referee #3**

Received and published: 27 July 2015

Review for Manuscript ID: AMT-2015-64

Title: MBL Drizzle Properties and Their Impact on Cloud Property Retrievals

Authors: P. Wu, X. Dong, and B. Xi

General comments:

Improving our knowledge of the properties of marine clouds is vital, so understanding the robustness, applicability and uncertainty in retrieval methods is therefore very important. The presence of drizzle usually complicates the retrieval of many liquid cloud properties. This manuscript discusses the impact of drizzle on a specific cloud retrieval over a mid-latitude Atlantic location that experiences plenty of marine stratocumulus

C2272

conditions.

Specific Comments:

Title: The title suggests that the paper is evaluating the impact of drizzle on a range of retrievals, but in fact the paper is evaluating only one specific retrieval. MBL might not be an obvious abbreviation and should therefore be expanded.

Page 4308, lines 11-12 and Page 4309 lines 4-5: These sentences are not accurate - drizzle can have a huge impact on certain cloud property retrieval methods, rendering them completely invalid. There are a number of papers in the literature that discuss the impact of drizzle on certain cloud retrievals.

Introduction: Fox and Illingworth (1997) used aircraft data to note that drizzle is in fact ubiquitous in all marine stratocumulus clouds thicker than about 200 m.

Kollias et al. (2011) and others suggest that the radar reflectivity threshold should be -30 dBZ or even lower. As noted later in the manuscript, none of the thresholds stated here are actually suitable for diagnosing the presence or absence of drizzle in stratocumulus.

Page 4308, line 23: Replace 'marine time' with 'maritime'.

Page 4309, line 9: Replace 'drizzle' with 'drizzle drops'.

Page 4309, lines 5-24: Surely the arbitrary separation between virga and rain requires a more careful explanation, including the reason why you are interested in separating the two? What is the difference between identical drizzle fluxes falling from two cloud layers; one at a height where the drizzle evaporates before reaching the surface, and one which is low enough for the drizzle to reach the surface (assuming that the drizzle evaporation rate is the same for both cases)? The precipitation should be classed as drizzle in both cases, not rain (line 8) just because it reaches the surface, unless you state that rain is a continuum of precipitation including drizzle. You are not retrieving virga and rain microphysical properties (line 51) but drizzle properties.

C2273

Page 4310, line 13: This should read 'attenuated backscatter coefficient'.

Page 4310: The method of O'Connor et al. (2005) provides the median equivolumetric diameter  $D_0$ , not the particle effective radius. This is stated correctly in equation (1).

Page 4310, line 18: This sentence should state '...can be assumed to be adequately represented by a normalised gamma distribution'.

Page 4311, lines 3-4: State how you arrived at these uncertainties. What uncertainties do you assume for each instrument parameter? Are all the instruments calibrated? And how are they calibrated? I suspect that the attenuated backscatter coefficient from the ceilometer in the ARM archive has not been calibrated.

Page 4311, lines 5-16: Which instrument do you obtain the solar transmission ratio from? And what are the uncertainties in the various retrieved properties? Which LWP retrieval method do you use, is it statistical or physical, and have you considered the impact of a wet radome on the LWP retrieval?

Page 4311, line 13 (equation 2b): Note that any scaling of the retrieved effective radius with height with respect to the reflectivity profile is not valid in the presence of drizzle. Essentially, the reflectivity profile in marine stratocumulus is typically dominated by the return from drizzle drops, not the cloud droplets.

Page 4313, line 1: This is unlikely to be rain in the classical sense, given the droplet sizes stated earlier.

Page 4313, lines 1-3: Depending on how you define cloud base, what you may be seeing here is the region where the retrieval method is not applicable, i.e, the retrieval method requires that both the radar and lidar measurements come from drizzle only - in this region it is likely that the radar measurements are still dominated by drizzle, but the lidar measurements are dominated by cloud droplets, not drizzle droplets. If this is the case, then the retrieval is erroneous, it is not a 'transition layer' (in fact it is a good indication that you are applying the method in-cloud where it is not appropriate). Is this

C2274

responsible for the strange peaks in Figure 2 at about 40  $\mu\text{m}$  in the effective radius for both drizzle classes - doesn't look physical. This would also modify the statements in Page 4313 lines 17-25 and later.

Page 4313, lines 8-11: A reflectivity of 0 dBZ is still not really high enough to be classed as rain in the classical sense of weather radar.

Page 4315, line 10: To be more precise, you are investigating the impact of drizzle on a specific cloud property retrieval method. (Repeated elsewhere: Page 4316, line 7, line 16, line 214, etc.)

Page 4315, line 15: Again, this statement depends on the retrieval method. Or, do you mean the impact of combining drizzle and cloud droplets in a cloud+drizzle size distribution makes no impact on the effective radius calculated from the combined distribution? This doesn't seem reasonable.

Page 4315, line 19: But this site is mid-latitude maritime rather than continental.

Page 4315, line 21: This statement is contradicted by the sentence that follows. It seems more reasonable to say that the specific retrieval method being tested here is biased by the the presence of drizzle, but that this bias is generally very small.

Page 4315, lines 24-27: I'm not sure what you mean by this assertion? Do you mean the impact is small for the retrieval, or on the actual microphysical properties? Do you mean the relative impact is small? An optical depth of say 0.5 for the drizzle portion may be small in comparison to a cloud optical depth of 20 or so, but might be regarded as significant in its own right in certain situations.

Page 4316, line 20: Relative difference would be more informative here, and can then be directly related to the retrieval uncertainty.

Figure 1: It would be useful to include the ceilometer attenuated backscatter coefficient as an additional panel for these two cases.

C2275

Figure 2: Are the PDFs and CDFs for drizzle particle effective radius and number concentration derived from all drizzle properties, layer-mean properties, or properties just below cloud base?

---

Interactive comment on Atmos. Meas. Tech. Discuss., 8, 4307, 2015.

C2276