Review of *Aircraft Evaluation of MODIS Cloud Drop Number Concentration Retrievals* – Passer et al. (2024)

This paper evaluates MODIS-retrieved concentrations of cloud drops to those measured in situ based on three field campaigns that leveraged the CIRPAS Twin Otter aircraft. The results reveal that in some cases, the MODIS retrievals are within the range of uncertainty in the aircraft measurements, which coincides with all parameters used in the MODIS retrieval also agreeing well with the in situ measurements. However, in other cases, MODIS deviates considerably from the observed concentrations, and the authors do not find any cases where the MODIS-retrieved droplet number concentration is correct due to compensating errors in the retrieval parameters. The authors present different reasons for these errors based on the variables used in the retrieval algorithm.

In general, this paper is well written and easy to follow. I believe it will make a solid addition to the literature and provides a foundation for understanding uncertainty and errors in MODIS-retrieved droplet concentrations, which are commonly used in the field.

Other than some minor comments/suggestions to help clarify some sentences, my only major comment is whether the authors have considered an analysis of the different cases in terms of other variables to determine the conditions under which MODIS retrievals are more or less accurate? More specifically, I am thinking about variables not used in the retrieval but could indicate conditions in which the MODIS retrievals would be more/less accurate.

If the authors have any questions, please do not hesitate to reach out!

Zachary J. Lebo

Major Comment

1) As denoted above my only somewhat major comment is regarding an expansion of the analysis to include other variables that may help determine why MODIS is biased in its droplet number concentration retrieval in some instances and not others. I think a first go at this could just be re-doing Figs. 1 and 2 to be color coded not by day but by another variable or the difference between the MODIS and in situ values. The latter might just be a cleaner way to demonstrate some of the later analysis. Beyond the variables used in the retrieval, are there other in situ observations that you could use to "color" the points in these figures and help discern conditions that MODIS over- or underestimates the droplet number concentration? Thermodynamics? Other characteristics of the drop size distribution (skewness, bimodality)? Pitot tube measurements of eddy dissipation? Just some random thoughts. These may all very well show no relation to the MODIS biases, but I think it is worth the effort to show this.

Minor Comments

1) Lines 80-81: How does this compare to the in situ measurements? At least based on Fig. 1 using the standard error calculations, in many cases, the error bars for the PDI are larger than those of the MODIS retrievals. Granted these are different things, but just want to be sure that it is recognized in the paper that MODIS and the in situ observations come with their own uncertainty.

2) Lines 91-94: Why just these three campaigns? Is it a limit of the PDI being used?

3) Line 97: Suggest adding 1-3 sentences briefly describing this matching.

4) Lines 107-108: data "are".

5) Lines 108-109: This is rather vague. What do you mean by "most representative"? In terms of what?

6) Line 111: I am not understanding the "are selected during flight by the flight scientist" part. Can this be omitted?

7) Line 114: Should this be a relative distance or does it not matter for these thin clouds? For deeper clouds, 60-90 m from cloud top, in my opinion, would still be cloud top.

8) Lines 154-155: How do you quantify "very good agreement"?

9) Fig. 1: In the figure, N is used for the concentration but N_d is used in the text.

10) Line 214: No idea why I put this comment on this line, but one thing that I noticed is that from Case 1, to Case 2, and then Case 3, the droplet concentration increased. Is that consistent? Statistically, do the cases with the lowest concentrations agree best with MODIS? Why?

11) Line 214: "the" MODIS number concentration.

12) Line 214: "…almost twice the PDI…"

13) Lines 256-257: Do you mean the MODIS-retrieved cloud base is within 50 m of the in situ observations? I interpreted this as the MODIS retrieval footprint location at first.

14) Lines 258-259: Is there a better (other) way to test MODIS-retrieved cloud base than using aircraft?