

## ***Interactive comment on “A new subgrid-scale representation of hydrometeor fields using a multivariate PDF” by Brian M. Griffin and Vincent E. Larson***

**Brian M. Griffin and Vincent E. Larson**

bmg2@uwm.edu

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In this response to the reviewer's comments, the reviewer's comments are italicized, and our responses are in roman font.

### **Anonymous Referee #1**

*This paper describes a new PDF representation of the subgrid variability of hydrometeors implemented in the CLUBB scheme. The new method incorporates a delta function in the PDF at 0 that represents precipitation free regions of the grid. Much of the paper outlines the mathematical formulation of the new PDF. Testing of the new PDF is performed against three LES simulations. Incorporation of the delta function is shown to*

C1

*improve the microphysical process rates by reducing evaporation and increasing accretion thereby allowing larger amounts of precipitation to reach the ground. The paper is very well written and contains appropriate methods and references. I only have minor comments shown below.*

Thank you for your review.

*Line 132: I can't quite follow why the relationship is approximate. I would have thought that  $\text{mean}(N_{cn}) = \text{mean}(N_c)/\text{cloud\_fraction}$ , which would be exactly the in-cloud mean. Could you clarify?*

This is now discussed with equations in a new appendix. The revised manuscript now says "The value of  $\overline{N_{cn}}$  is approximately the in-cloud mean of  $N_c$ , and in special cases, is exactly the in-cloud mean of  $N_c$ . Please see Appendix B for a more detailed explanation."

*Figures 2,4,5,6: Values of  $\ln(r_r)$  less than about -11.5 are very small. Often even the DDL does not match these values well. However I would guess that they probably do not contribute appreciably to the total mass or the process rates. Is that correct? Is it worth commenting on the fact that even DDL does not represent the extremely small values well.*

Yes, even the DDL does not match the left-hand tail of the PDF, but those hydrometeor values are small. The revised manuscript now includes the statement "However, even the DDL PDF fails to capture the far left-hand tail of the LES PDF. In the RICO, DYCOMS-II RF02, and LBA cases, between about 5% and 20% of the LES PDF is found to the left of the DDL PDF (see Figures 2b, 4b, 5b, and 6b). However, these values of hydrometeor mixing ratios are small. They are roughly a factor of 20 or more smaller than the median value. By combining these factors, we see that the percentage contribution of hydrometeor mixing ratios that are omitted on the left-hand tail is only about 1%."

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*Line 536: looks like an erroneous ‘.’ After precip.*

*Line 537: Again looks like an erroneous ‘.’ After precip.*

In the revised manuscript, “in-precip.” has been replaced everywhere by “in-precipitation”.