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Interactive Comment

Interactive comment on "Investigating potential biases in observed and modeled metrics of aerosol-cloud-precipitation interactions" *by* H. T. Duong et al.

Anonymous Referee #2

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This paper explores three common empirical metrics for the sensitivity of cloud drop effective radius and rain rate to variations in aerosols that are presumed to be entrained into the clouds. The introduction notes that climate models operate on broader spatial scales than do the observations and cloud models, and that even in the analysis of observations and cloud models the quantitative results of computing these metrics depend on characteristics of the data used and some of the choices made in the computations. Therefore, by quantifying the sensitivity of aerosol-cloud metrics to these data characteristics and choices, this paper serves as a sort of clearinghouse for alerting the community to potential errors when comparing cloud/rain sensitivity to aerosols determined with different measurement techniques or when comparing observations to models. Sources of such errors considered in the paper include ignoring the evolution of cloud sensitivity through its lifecycle, differences in spatial resolution of the data and/or model, choices about averaging aircraft observations, variability in the vertical distribution of aerosols relative to cloud, and effects of wet deposition of aerosols.

The paper is a useful contribution in that it provides a quantitative treatment of a variety of important potential analysis errors in one convenient reference. The impact of the paper might be greater if the discussion of the results related more directly to specific applications. For example, the discussion of spatial resolution does not specifically state which spatial scales are relevant for cloud models, airborne observations, satellite observations, or global atmospheric models, or how the spatial averaging values chosen in the study relate to these scales. I would encourage the authors to try to make these connections clearer in the discussion so that the relevance of the work to the efforts of the broader community is clearly conveyed.

I found some important elements of the discussion confusing. These are enumerated below.

1) Figure 2 is very difficult to sort out, perhaps because the curves for different lifecycle stages overlay one another. One must stare at this plot for a while before figuring out which factors relate to different curve shapes. This could be made more clear if the curves for the different lifecycle stages were shown on different axes than the curves for different spatial resolution. Also, the third sentence in section 3.2 does not explain why the coarser spatial averaging "has the effect of compressing the chi-LWP and S0-LWP curves to lower LWP values". Presumably this arises from the skewed distribution of LWP within clouds. This should be clarified.

2) Likewise, I am confused about the physics underlying the discussion in section 3.3 about the analysis of aircraft observations (p.29907, lines 7-28). Here it states "the -dln(re)/dln(Nd) values tend to approach 0.33 when using the Nd and re combinations that exhibit the widest range of values. Similar reasoning explains why values of chi

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and S0. . .” However, it is the reasoning that is missing from that first sentence. Is there a physical reason why one would choose to use the maximum value of Nd or re rather than some vertical or horizontal average? Which choice makes the most sense for characterizing the interaction of aerosols with clouds, since that is the goal? In the next paragraph it is implied that these choices have quantitatively the same effect as changing the spatial averaging distance of the aircraft data. But this is only true because of how Nd, re, and LWP are distributed within a cloud. These discussions accurately describe what is shown in the tables and plots, but they do not adequately describe why. Therefore, we get a quantitative description of how different choices for processing the data give different results, but no insight into which approach makes the most sense for characterizing the interactions of aerosols and clouds.

Other minor issues:

3) Is there a reference that discusses the utility of the aerosol index (product of optical thickness and Angstrom exponent) as a CCN proxy (p.29904 line 1)?

4) Section 3.4 should include a reference to Costantino and Breon (Geophys. Res. Lett., 37, L11801, doi:10.1029/2009GL041828, 2010) and a comparison with their results, which address the same problem of the vertical distribution of aerosols.

Interactive comment on Atmos. Chem. Phys. Discuss., 10, 29897, 2010.

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