

## ***Interactive comment on “Cloud invigoration and suppression by aerosols over the tropical region based on satellite observations” by F. Niu and Z. Li***

### **Anonymous Referee #2**

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This manuscript uses a combination of datasets (CloudSat, CALIPSO, MODIS, ECMWF-AUX) to examine the effect of aerosol particles on cloud development and precipitation. They use statistical analysis to conclude that increasing aerosol pollution will reduce precipitation in warm clouds and increase precipitation in mixed-phase clouds. They specifically show that cloud top temperatures decrease with increasing aerosol index over oceans and with increasing AOD over land for mixed-phase clouds. They conclude these results are due to aerosol invigoration effects and microphysical effects, which is consistent with ideas previously proposed. The topic certainly should be of interest to ACP readers, and the results are consistent with ideas presented in previous work that they cite. The paper is concise and to the point, and it is written fairly well. My main issues relate to the lofty conclusions drawn without a sufficient amount of attention to the lack of identification of true causal relationships. The authors need

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to relax some of their statements. In particular, I believe the analysis to produce Figures 1, 2, and 4 should be revisited to more carefully present results to try to isolate an aerosol effect rather than allow cloud water to vary when comparing cloudtop T or precipitation to AI/AOD. I recommend publication after significant revisions.

**Specific Comments:** In certain parts of the paper some of the claims and conclusions should be relaxed. It is far-reaching to jump to quick conclusions as in page 5007 (line 3) that increasing ice water path is due to enhanced ice processes and aerosol invigoration effects. This claim appears four sentences into the results section without giving serious treatment to the importance of meteorology (this begins to be addressed around page 5008, line 3. This certainly should be modified, at least the order that these sentences are constructed. The authors should note that they cannot truly identify cause-and-effect relationships owing to the nature of their analysis, but can only suggest what the possible causes are for the interesting relationships they found. The way Figure 1 is presented is misleading as only the relationship between aerosol and cloud top temperature is shown without any consideration of other factors that could influence cloud top temperature such as meteorology. Figure 2 plots precipitation rate versus aerosol without any consideration of meteorological effects. Shouldn't rain depend on the amount of water in the clouds?, so why isn't this treated in the figure? Again, this plot is misleading like Figure 1 as a greater emphasis needs to be placed on separating aerosol and meteorological effects.

Why is AI plotted on a log scale and AOD on a linear scale? Please clarify.

Why is AOD used over land and AI over the ocean? This clarification is needed.

How was the AI and AOD binning performed for the x-axes of Figures 1,2,4? Clarify on page 5006, line 15-17.

Why is the LTSS range so different over land versus over the ocean?

More discussion is needed to share the sample sizes used in each of the curves of

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the plots. Presenting correlation coefficients with sample sizes would be much more meaningful. How many points are used in each AI and AOD category (clarify somewhere in the figures or in a table)? Do these sample sizes typically agree across the range of the x-axes values (if not, could this affect the results)? Also, what is the total sample size that the y-axis of Figure 3 is based on?

Figure 1 would be easier to interpret if the y-axes were changed. For example, currently it is hard to see the differences in cloud top T for liquid clouds in the top left panel.

How did the authors choose the temperature thresholds for the different categories of clouds (Page 5006, line 10-12)?

On page 5008, lines 12-24, the authors should state if they have any reason to believe how AI and/or AOD should be related to LTSS or CWV.

I would suggest that the authors re-do Figures 1,2,4 in such a way that they examine the relationship between AI/AOD versus cloud top T or rain at fixed conditions of LTSS/CWV. Otherwise, the plots as I noted above are misleading and can lead to false conclusions.

Page 5008, Line 20: Are the authors suggesting that there is a cause and effect relationship between AOT and atmospheric stability? If not, words should be more carefully chosen in this line.

Technical Corrections: The authors cite work in the body of the work that is absent in the references section. They should make these corrections.

The x-axis label on Figures 1 and 4 (optical) is spelled wrong.

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Interactive comment on Atmos. Chem. Phys. Discuss., 11, 5003, 2011.

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