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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Untangling causality in midlatitude aerosol-cloud adjustments" *by* Daniel T. McCoy et al.

Anonymous Referee #2

Received and published: 24 September 2019

In this study, McCoy et al. used satellite observations and a GCM to quantify the LWP response to Nd in areas between NH midlatitude cyclones. A multi-variate linear regression model is used to reveal the covariance between LWP and other cloud-controlling factors. By performing sensitivity tests using a GCM, they tried to isolate the LWP response to aerosols due to scavenging from other microphysical processes. This approach provides a process-oriented analysis framework to evaluate the model. Overall I find the study very interesting, the results are well-supported by the analysis, and the presentation is good. So, I recommend publication in ACP.

I have several comments/questions for the authors to consider to improve the clarity of the paper:

1. Page 2, line 19-21: The sentence does not read well. The first half of the sentence

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stated that aerosol-cloud interactions play a minor role, but the second half of the sentence stated the importance of making data volume available. I don't understand the logic here. Moreover, it might be necessary to substantiate the statement "Aerosol-cloud interactions are likely to contribute a relatively small fraction of overall variability in cloud properties" by providing some references.

2. This study focuses on the interstitial regions between cyclones only, but there are many other cloud regimes where aerosols can have similar or different impacts on clouds. It might be helpful to add a paragraph to discuss the applicability as well as limitations of this study.

3. Page 4, line 13: add "to" before "explain"?

4. What is the effect of the degradation of spatial resolution (when all the data is regridded to 1-degree) on the covariance analysis? Is ACI derived from the gridded data still representing the physics? Could you discuss if this is an important issue (as discussed in McComiskey and Feingold, 2012) that affects the conclusion of the study?

5. Page 6, line 13-14: Do you mean aerosol emissions or concentrations are set to PI and PD for the two simulations? If emissions, please provide the reference for the emission data. If concentrations, please provide the reference for the concentration data.

6. Section 2.5, I understand that you intend to separate the scavenging effect from other microphysical processes. However, these processes of course are nonlinear. Could you provide a discussion on the applicability and limitation of the linear assumption here as well as the use of multiple linear regression?

7. In Fig. 4, where LWP decreases with increasing Nd due to precipitation effects, do you mean in terms of grid-box mean LWP and Nd or in-cloud LWP and Nd? I think I understand the effect in terms of grid-box means but not sure I understand in terms of in-cloud values. Could you please clarify?

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8. Page 14, line 22-23. This first sentence reads awkward. Please rephrase.

9. In discussion, the authors indicated that this study is in contradiction with several previous studies. Could you please discuss the disagreement? Is it because a different observational data, different GCM, different analysis framework, or different regime is used?

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