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Atmospheric Chemistry and Physics
Discussions

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Interactive comment

Interactive comment on "Is Positive Correlation between Cloud Droplet Effective Radius and Aerosol Index over Land Due to Retrieval Artifacts or Real Physical Processes?" *by* Hailing Jia et al.

Anonymous Referee #2

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Before getting to the review of the manuscript, I want to say. . . why do people accept papers to review and then not review them (and don't let the editor know this quickly)? It seems like this happens way too often, as it did here.

Ok, now to the manuscript...

This manuscript explores the differences between land and ocean regions in the correlation of near-cloud aerosol index (AI) to cloud effective radius (CER) and liquid water path (LWP). The paper looks various potential reasons (real and artificial) for the positive correlations between AI and CER are over land, as opposed to the more-expected negative correlation over oceans. While no precise reasons are found, several hypothe-

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Discussion paper

ses were able to be eliminated. I feel that the paper may be useful, though I have one major concern and several minor comments that I feel need to be addressed before publication.

Major comment:

The Angstrom exponent, used for deriving the aerosol index, is notoriously bad over land for MODIS Dark Target land retrieval (not sure about Deep Blue retrievals, and I'm unsure about which retrieval products were used here, though I believe that the 3 land regions used in this paper will mostly be Dark Target rather than Deep Blue). In the Levy et al. 2013 paper describing collection 6: "On a global basis, we and others have found little quantitative skill in MODIS-retrieved aerosol size parameters over land (e.g., Levy et al., 2010; Mielonen et al., 2011). We have decided to discontinue further attempts at validating Ångström Exponent (AE) and fine-AOD. A user can still choose to derive AE (from spectral AOD) or fine-AOD (from product of τ η) and evaluate the results themselves." In Levy et al. 2010, they show that the Rˆ2 of the Angstrom exponent over land is only 0.3 with AERONET.

Levy et al. 2013: https://www.atmos-meas-tech.net/6/2989/2013/amt-6-2989-2013.pdf
Levy et al. 2010: https://www.atmos-chem-phys.net/10/10399/2010/acp-10-10399-2010.pdf

Related, for research on estimating surface-level PM2.5 from AOD, it would be useful to use the Angstrom exponent or fine-mode AOD products to help filter coarse PM from the PM2.5 estimate. However, due to the poor ability for MODIS to retrieve these products over land, the AOD-PM2.5 community uses just AOD as using the Angstrom exponent or fine-mode products adds noise to evaluations. It is unclear why the aerosol-cloud interactions community should have more confidence using the MODIS Angstrom exponent over land.

It seems that the aerosol index over land used here may be very poor (due to the Angstrom exponent uncertainty_, and this could be contributing to counterintuitive results over land. There is no mention of this in the paper. I feel that the authors should evaluate their aerosol index data in their 3 regions against AERONET to show if their aerosol index product has any skill in their land regions, and discussion needs to be added.

Minor comments

L29: “Earth” should be “Earth’s”

L31-33: It is more precise to say that ACIs are the largest forcing uncertainty to present climate change. I’m nearly certain that the uncertainty in what humans will do (e.g. in terms of how much CO2 we will emit and other changes) is the biggest uncertainty in the anthropogenic contribution to *future* climate change.

L50-51: Kohler theory only describes the relationship between a particle and its critical supersaturation for activation. Cloud droplet number at the cloud base depends on the number distribution of critical supersaturations and the updraft velocity. The second part of the sentence discusses these effects, but I feel that this sentence can be rewritten to be more precise.

L64: “Loosely related”. Is it possible to be more quantitative here (e.g. using numbers from the Stier reference)?

L68: Same, can you be quantitative?

L125: Which MODIS AOD retrieval algorithms are you using (dark target, deep blue, MAIAC)?

L268: “Become*s*”

L269: Either “*the* collision-coalescence process” or “collision-coalescence process*es*”.

Figure 7 and associated discussion: It is unsurprising that the slope of CER-AI is stronger when including all data vs. when binning to >14um and <14um. If the slope is positive, more observations will move from the <14um to >14um with increasing AI. With increasing AI, a CER of 13.9 um (which would be at the large end of the <14 um bin) would shift to 14.1 um (which would be on the low end of the >14 um bin), so increasing AI removes some of the higher <14um cases and creates new lower >14 um cases. . . the all prevents the CER for the two size bins from change much with AI. Hence, the slopes for the binned sizes are buffered from changes with AI. A similar phenomena will occur of a negative slope. Thus, the discussion in lines 274-278 seems unnecessary.

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