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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Evaluation of aerosol and cloud properties in three climate models using MODIS observations and its corresponding COSP simulator, and their application in aerosol-cloud interaction" *by* Giulia Saponaro et al.

Anonymous Referee #1

Received and published: 4 October 2019

This manuscript uses a satellite simulator to evaluate cloud and aerosol properties from 3 models against MODIS-satellite-derived properties. Overall, it is useful to employ these simulators to translate the model properties to those derived by the satellites. The paper is generally publishable for ACP, but have one major issue regarding the use of MODIS AI over land as well as a number of more minor issues.

Major comment:

The methods section admits that the MODIS Angstrom Exponent product (used in the

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Discussion paper

Aerosol Index [AI] calculation) is not calculated over land due to its low data quality in these locations. However, Figure 5 still shows MODIS AI values over land. Why is this?

In Levy et al., 2013, which describes the collection 6 Dark Target product, it says, "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."

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

So did you calculate AE from the spectral AOD over land? Is this any good? Is there any value to compare MODIS AI to the model's AI over land if MODIS AE over land does not have skill?

I think that the AI values over land should be removed from Figure 5 and discussion unless these values are tested against e.g. AERONET.

Specific comments:

P2 L16: I'd remove "primarily" here as climate models serve many purposes.

P3 L16-17: This sentence makes it seem like ISCCP is itself a cloud simulator. However, ISCCP is much broader than this, and foremost it has observational data products. Could say "are the simulator developed as part of the of International Satellite. . ."

P3 L23 and many places throughout: The clause following "which" is a non-restrictive clause (it does not help specify which simulator you're writing about and only provides additional information about it), which means there should be a comma before "which". If it were a restrictive clause, it would continue to not have a comma, e.g., "We use the cloud simulator which was developed as part of CMIP" (the clause af-

ter “which” is necessary to know the specific simulator you are referring to). I found many non-restrictive clauses throughout that did not contain commas, so please update. http://www.cws.illinois.edu/workshop/writers/restrictiveclauses/

P3 L24: Should these acronyms be defined here?

P3 L33: I’m generally used to AIEs specifically referring to the radiative effects of ACIs rather then being a synonym for ACIs in general, as AIE is presented here.

P4 L20: Although Koren et al., 2007 is cited at the end of the sentence, it seems jargony to list “twilight zone” without definition. May be more clear to replace with “near-cloud impacts on radiative transfer”.

P5: I’m confused as to why the MODIS L2 products are discussed in detail after it is stated that L3 products were using in the paper. I assume it is because the L3 product is built from the L2 product (which is stated), but it would be good to make it clear why the L2 products are discussed in detail.

P5 L22-: Which aerosol product(s) are you using? Just the Dark Target product or also Deep Blue? I assume MAIAC is not used since it says the spatial resolution is 10x10 km. It looks like the Dark Target - Deep Blue combined product is used in Figure 5 based on there being AOD information over deserts etc.

P5 L27: Here it says that AE is only derived over ocean, which is correct, but why does AI have land values in Figure 5? See Major Comment above.

P7 L19: How are the model fields downscaled? It seems like there would be a lot of necessary assumptions to break a partially cloudy coarse gridbox into finer subcolumns. These assumptions should affect the results in theory. At a minimum, please add a statement such as, “details of this downscaling process and assumptions are provided in XX”, assuming that this process has been documented elsewhere. If these details haven’t been documented, please do so here or in the supplement.

P8 L4: “...referred to *here* as. . .”

P8 L23-25: This sentence didn't make sense to me. Please rewrite for clarity.

P8 L29: M7 should be mentioned/discussed in the previous subsection on ECHAM-HAM (without SALSA).

P9 L20: What does "aerosol life cycle scheme which calculations production tagged mass" mean? Is this an aerosol microphysics scheme? Does it track aerosol composition by its emission/process source in addition to chemical composition? Please rewrite for clarity.

P9 L34: Reference is missing a year.

P11 L22: "CER" isn't defined until below.

P12 L24-25: Is there a figure that we should be looking at to see these biases?

P13 L26: Do you specifically mean the *model* datasets here, or is the MODIS data being lumped into this comparison too.

P15 L22: It seems very subjective to say that a bias of -0.2 is "quite close" given that most of the globe has an AI below 0.2 according to MODIS (so this bias is larger than the AI value in nearly all locations. (Also, most of the locations with AI > 0.2 are over land, where we should not trust the Angstrom Exponent).

P17 L9: There is a discussion here about AI over land, but there is no acknowledgement that the MODIS aerosol team does not publish AE over land.

P18 L25-26: "possibly owing. . ." onward. It is unclear to me what this is saying.

P19 L3-4: What is the difference between "model calculation" and "cloud parameterization". These seem like synonyms? Or is the "model calculation" specifically referring to the COSP simulator (rather than the atmospheric model).

P19 L22: How does one select dry aerosols when using satellite-derived properties? Or is this a statement of when using modelled properties only?

P19 L34-35: What property is being underestimated?

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