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Interactive comment on "Understanding the seasonality and climatology of aerosols in Africa through evaluation of CCAM aerosol simulations against AERONET measurements" *by* Hannah M. Horowitz et al.

Anonymous Referee #1

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This paper evaluates the performance of the CCAM model at simulating aerosols over Africa, by comparison to AERONET data. The paper's title and some of the text set it up to be primarily a description of the aerosol cycle in Africa. However most of the real content is in the evaluation against AERONET, where we see that there are some shortcomings for CCAM's representation of dust. As a result, I don't think it makes sense to present this as a paper about the seasonality of aerosols in Africa. It's really a model evaluation exercise, which establishes some problems with dust and the timing of biomass burning, but better performance for other aerosols. So perhaps there will be a follow up in a few years when these issues have been improved and the model is

more in the application phase than the evaluation phase. As a result this paper might fit better thematically in GMD than in ACP, but it is within scope for ACP as well.

The paper is interesting and scientifically does not have major problems. However, the organization should be improved. There are parts where it is a bit lengthy and unclear, and contains statements which are either slightly incorrect or information that is not necessary (it reads as very descriptive and not very analytical, sometimes, if that makes sense). This makes it difficult to read and pick out the main points. The whole paper could be streamlined to improve readability and clarity. I have included some suggestions for where to do this in my comments below. These rewrites should make it easier to judge the paper and pull out the main conclusions, which I have a bit of a hard time doing now. As a result I recommend major revisions since some of the suggested rewrites will alter the structure of the paper somewhat and some things may become clearer. I would like to review the revised version.

Title: See above comments. I recommend changing the title to make clear that the focus is the evaluation of the model, rather than "Understanding the seasonality and climatology of aerosols in Africa".

Abstract: This should ideally be one paragraph which concisely summarises the key points of the paper. This abstract is three long paragraphs covering about a page. I suggest that this can be condensed somewhat. For example, the entire middle paragraph is more or less well-known results (e.g. where and when dust comes from) and can be deleted. I would then merge the remaining two paragraphs, which contain more overview and then the main results of the paper.

Section 2.1: In my Quick Report comments I had suggested adding more AERONET sites; the authors added most of these (thank you for this effort), but not one of the key Saharan dust outflow sites which I had suggested (Capo Verde). I see that this is just outside of model domain listed here in the paper, so perhaps that is why it is not included. But presumably the model was run globally so perhaps the analysis domain

could be extended another few degrees to include this site? It is one of the key long-term sites which has been used by many researchers to examine Saharan dust and evaluate models (among other things) so would be useful to have the comparison there as a point of reference, if possible. While not essential, I mention this specific site again for this reason. It could help confirm the hypothesis about dust lifetime in CCAM, since this site is a way away from the sources.

Izana is not a useful site for model evaluation and can be removed.   It is on the top of a mountain and not representative of the surrounding area.   See e.g. https://aeronet.gsfc.nasa.gov/new_web/photo_db/Izana.html .

Page 5 line 26: Strictly AERONET does not measure AOD. It measures the direct solar irradiance, and then does a (very accurate) retrieval to determine AOD. Even this direct-Sun AOD product is a retrieval, not a direct measurement. Also, the wavelength range given here is wrong (the range depends on the specific instrument). I suggest rewording to say that AERONET provides spectral AOD at multiple wavelengths, depending on instrument, from the UV to the swIR. A key point being changing the word "measured" here and in line 28 (plus other places I might have missed) to a more correct term such as "provides".

Equation 2: The definition of AOD seems superfluous here so can probably be deleted as assumed background knowledge.

Page 6 lines 30-31: "was considered, and were aligned as possible" does not make sense. I suggest rewording this paragraph (perhaps it is just this first sentence which is causing confusion). If I understand correctly then the model provides 6-hourly output and a daily average was constructed from the output from 'daytime' hours over this domain. The key point being here is that sampling is daytime only to match AERONET, but the specific AERONET days are not being matched directly. Is that correct?

Page 7, lines 12: Likewise, I think the definition of Pearson correlation coefficient is not necessary. For the specific analyses performed in the paper (i.e. assessing to

what extent the seasonality of AERONET is reproduced by CCAM), the coefficient of determination (r2) may be useful than r anyway.

Page 7, lines 22-23: since AOD distributions are not Gaussian, might it be better to show interquartile range or similar rather than standard deviation?

Page 7, lines 24-25: This is another example of a slightly misleading/inaccurate statement. Ångström exponent (AE) is related to the optical dominance of fine vs. coarse aerosols in the column. This is subtly different from what is written in the paper which says that it gives information on size. For example, an AE around 1 could be either an indicator of monomodal mid-sized aerosols, or an indicator of a column containing similar amounts (in optical terms) of fine and coarse aerosols. These are quite different things. I suggest rewording.

Page 8, lines 2-3: "regional trends". It would be better to say "regional patterns" or something, since the term "trend" is most commonly used to refer to analyses of time series for changes.

Section 3: I don't think that the general description of aerosol seasonality in the model is that necessary, since the main aerosol sources in Africa and their timings are reasonably well-known, and the model has some biases anyway. (Really, the evaluation should have come before this descriptive section anyway, since you have to establish the validity of the model before you can use it to answer science questions.) It would be better in my view to present and discuss model and AERONET seasonality for each region simultaneously. Then we can get to the interesting stuff of whether the model is reproducing the patterns seen in AERONET. Essentially, merge in the current Section 4.2 with the existing Section 3 and rewrite.

Section 3.1: as an example of some stylistic issues throughout the paper (applicable to much of the discussion, not just here): 1. The word "values" appears a lot here and can probably be deleted. There isn't a real difference between saying "the AOD values" or just saying "the AOD", for example, and the latter is more concise and readable.

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2. Similarly, the subscripts for AOD and AE are the same all the time so can be omitted for brevity and clarity. (For example, just say once at the start of the data set description the wavelength or wavelength range being considered and don't repeat it every time).

3. The text in this section also doesn't specify whether AERONET or model data are being referred to. The related Figure 3 caption also doesn't say. This should be listed explicitly. I infer it is the model.

Page 14, line 5: As another style example, "The Pearson's correlation coefficient" could have "The" and probably "Pearson's" deleted as well.

Page 14, line 16: is the beta here intentional? If so, what does it mean?

Figure 3: In general I don't see the point of these figures. Seeing one line per site here is not very informative. If the purpose of the paper is to compare with AERONET, the same basic information for AOD is repeated in Figure 6. Or am I misunderstanding something? It would be better to show, for each site, the model and AERONET together so a direct comparison can be made. So something like Figure 6, for both AOD and AE.

Figure 7: It would be better to overplot the AERONET AOD on top of the model component lines, rather than shifting it off to the right, to allow a more clear visual comparison of aerosol amount and seasonality.

Table 1: It would be useful to perform the AERONET/model comparison at ALL the sites shown, not just a subset. Otherwise what is the point of including them in the paper if the AERONET data are not used?

Table 3: I am not sure it is useful to report significance of correlation coefficients here. I don't think that it adds anything to the analysis or discussion, and due to strong autocorrelation of the data (which I don't think is accounted for) it is possible that the significance estimates are incorrect anyway.

General: as noted in my Quick Report, I suggest the authors also perform some anal-

ysis using daily (rather than monthly) data. This can be simple visual scatter plots for each site, or something similar to Table 3. This will help to tell to what extent biases in the monthly data are due to aerosol events that are missed in the model, and to what extent they are systematic biases in component loadings or optical properties. Going to daily data here also helps to avoid some of the sampling differences.

Interactive comment on Atmos. Chem. Phys. Discuss., doi:10.5194/acp-2017-250, 2017.