We thank both the anonymous reviewer and Zhibo Zhang for their careful reading of the manuscript and their useful suggestions. We respond to each of the reviewer's comments and criticisms below:-

Anonymous Referee #1

Received and published: 2 April 2020

This manuscript compares satellite retrievals of above-cloud aerosol optical properties and underlying cloud properties with aircraft measurements over the South-East Atlantic during the CLARIFY-2017 field campaign. The main novelty of this work is the performance and limitations of aerosol and cloud properties from SEVIRI with aircraft data. This manuscript is well-written and is suitable for publication in ACP after ad dressing the comments. Please note the page and line number in my comments are based on version 1 of the manuscript, which can be found in the supplement.

We would like to thanks the reviewer for a careful review. We are glad that the reviewer found the work novel, and are pleased that they find the manuscript well-written. We have taken the reviewers comments into account is what follows:

Specific Comments:

P4 line 4-7: The filtering criteria for SEVIRI is used to remove non-opaque and inhomogeneous clouds. However, the discussion/conclusion section of this manuscript also mentions that algorithmic assumptions and technical limitations result in aerosol and cloud retrieval errors. Likewise, the Meyer MODIS retrieval also accounts for the uncertainty of retrieval errors. Is it possible for an opaque and homogenous cloud field to be removed simply due to falsely large AOT retrieval differences within a 0.1° grid?

In the review of Part 1, we have shown that the SEVIRI filters were efficient in removing the cloud edge effect. See the figure below where magenta corresponds to pixel removed by of the filter:

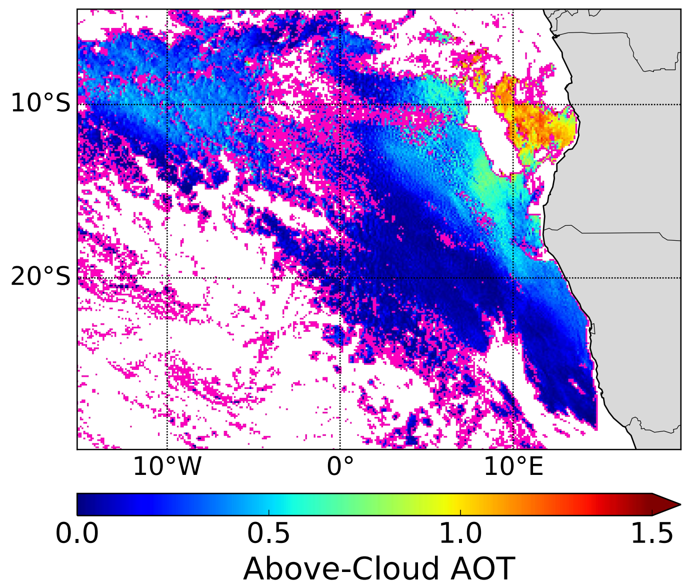

Figure R1: Above cloud AOT at 550 nm retrieved from SEVIRI measurements on the 28 August 2017 at 10:12 UTC over the SEAO. Pixels in magenta correspond to pixels removed with the cloud edge and cloud heterogeneity filters.

Theoretically, a homogeneous cloud field could be removed if the standard deviation of the AOT within the grid cell is too large, but one can see from the plot above that the filters tend to remove scenes close to the cloud edges in a coherent manner. However, what we are trying to achieve with our algorithm is a best estimate of the above sky direct radiative effect from SEVIRI that can be compared to e.g. modelled DRE effects from climate models. Such climate models typically have resolutions of ~100km at these latitudes and they tend to include 2-stream radiative transfer calculations which do not represent the effects of cloud inhomogeneities explicitly. Thus, we believe that it is reasonable to remove cloud edge effects.

For the MODIS retrieval, the filter on the AOT uncertainty is only applied to the AOT product.

P5 line 1-2: Which type of correlation coefficient is this? Sayer et al. (2019) indicated that Spearman's rank correlation coefficient is less sensitive to extreme outliers. Also, I suggest including the root mean square error in all of your scatterplots so that readers can have a better sense of your linear fit performance.

In both the text and the figures, we are using Pearson's correlation coefficients which measure the performance of the linear fits shown in the figure. The Spearman's correlation coefficient assesses how well the relationship between two dataset can be described using a monotonic function, whether linear or not. Consequently, we found that the Pearson's correlation coefficient is more appropriate here (now specified in the text and in the caption of the figures) and that the RMSE would be redundant.

P9 line 4-14: The use of atmospheric profiles from the NWP forecast model for retrievals is unique and is more representative to the realistic atmospheric conditions compared to the *tropical atmospheric profile in McClatchey. However, the tropical atmosphere is only one of several atmospheric profiles in the McClatchey database and is likely the least representative profile compared to mid-latitude summer, mid-latitude winter, sub-arctic summer, and sub-arctic winter profiles over the South-East Atlantic. Each of these four atmospheric profiles has less than 70% of column water vapor in the tropical profiles, so they would be closer to the dropsonde measurements. This paper will be significantly strengthened if the authors can determine the McClatchey profile/s that best represent the southeast Atlantic during the study period even if none of the profiles would perfectly agree with the dropsonde. Thus, I suggest the authors investigate and discuss the atmospheric profiles of the other four profiles.*

We are somewhat surprised by this comment. We are not focusing on a global retrieval. From the Figures in the manuscript (and that included above), the main area of interest is the equatorial Atlantic (Equator – 30°S). Using other McClatchey profiles such sub-Arctic summer and winter are not relevant as they are designed for latitudes of 50°-70°. A widely-accepted definition of mid-latitudes is from the tropics of Cancer/Capricorn polewards to the Arctic circles (south of 23.5°S for our area of interest). If one had to choose a single atmospheric profile for the modelling of irradiances, one would therefore definitely choose the tropical profile.

The reviewer should also keep in mind that the retrievals will only be sensitive to the column water vapour above the cloud. Yes – for the McClatchey mid-latitude summer, there is a reduction of water vapour over the tropical profile, but this is around 75% when summed from 3km-10km.

Our analysis has already incorporated retrievals of water vapour from the NWP model owing to the high degree of variability of water vapour in the atmospheric profile in this region. To start investigating the impact of inferior, non-temporally-varying water vapour profiles beyond with a single McClatchey profile would be a regressive step and would dilute from the focus and novelty of the research.

P12 line 3-5: Aerosol-cloud interactions involve the competing effects of semi-direct and indirect effects, so absorbing aerosols could even enhance cloud albedos. The authors need to provide a reference to support the statement. Alternatively, they need to broaden their arguments to different possibilities of cloud albedo change due to absorbing aerosols.

These sentences have been rephrased:

"Pollution within clouds tends to increase the cloud albedo by acting as cloud condensation nuclei but can also increase their absorption coefficient (Twomey, 1977). Although the brightening of the clouds is typically the dominant effect, the presence of absorbing smoke within the cloud could have an impact on the spectral variation of the cloud reflectance. Both the SEVIRI and the MODIS algorithms assume that the entire aerosol layer is located above an unpolluted cloud and do not account for aerosols within the cloud. Therefore, a reduction in the cloud albedo in the visible/SWIR range due to pollution within the cloud layer could be interpreted by colour-ratio based retrievals as an additional aerosol signal, leading to an overestimation of the above-cloud AOT."

Technical comments:

P2 line 33-36: spell out all the acronyms

Done

P2 line 40: Replace "between" with "among"

Done

P2 line 48: Sayer et al. (2019) also retrieved ACAOT from VIIRS

Done

P3 line 10: "observation of every"

We have kept "With an observation every 15 minutes …".

P3 line 11: what is MSG?

Done

P3 line 28: "SWIR" should have appeared in line 7

Done

P3 line 33: "platform" is unnecessary

Done

P3 line 37: "MODIS uses six channels, which"

Done

P4 line 5: "measurements of cloud edges….."

The sentence has been modified.

P4 line 11: Are optical thicknesses referred to 0.55µm using spectral AOT after the colour-ratio retrieval or before retrieval?

We are not quite sure what the reviewer is referring to here. We state "*Throughout this study, intrinsic optical parameters and derived extrinsic properties such as optical thickness refer to values at an optical wavelength of 0.55 µm.*" We believe that this is sufficiently clear.

P4 line 7: "sensors" seems to be a more suitable word than "methods"

Done

P4 line 18: "slot on the"

Done

P4 line 29: "correlation" should be accompanied by correlation coefficients. A visual agreement is not the same as a strong correlation.

Done

P4 line 33: "… .by about 1.5µm" – is this based on an average over the entire map?

Modified: *"However, the CER retrieved by SEVIRI are smaller than the MODIS CER by 2 µm on average over the map."*

P4 line 43: "days of observations"

Done

P5 line 9: "has a large impact"

Modified

P5 line 30: "there are more"

Done

P5 line 38: The values 0.937 and -1.460 do not match Figure 3d

Corrected

P6 line 16: "clouds become thicker"

Done

P6 line 38: "outlined the same"

Done

P7 line 11: "are used to remove"

Done

P7 line 41: "over the ocean"

Done

P7 line 50: What is "FASTEM"?

Added: "*the fast ocean emissivity model FASTEM*"

P7 line 50: Liu et al. (2011) is not in the reference list. However, Liu et al (2010a,b) are present. Please clarify the references.

Done (Liu et al, 2010)

P9 line 14: Remove "against"

Done

P9 line 26: "show that the"

Done

P9 line 26: "layer. However, no evidence"

Done

P10 line 6: It appears that the sign changes at about 2.7˚E rather than 4˚W

Corrected

P10 line 6: "After" is a confusing word. I suggest "From the west of"

Done

P10 line 24: "maneuvers"

We have kept manoeuvres as the rest of the paper is in British English.

P10 line 43-46: Is the standard deviation of the satellite retrievals based on only one group of 60km radius comparisons between satellite and aircraft measurements during each flight day?

The standard deviation is calculated for each flight with the all the AOT retrieved within the 60km radius. The sentence has been modified to:

"*... the error bars correspond to the standard deviation calculated for each flight of the MODIS and SEVIRI AOT retrieved within the 60 km radius.*"

P11 line 10: Is there a correlation coefficient or only an agreement?

It is an agreement. The sentence has been modified:

"This could explain why a better agreement is obtained between the in situ measurements and the satellite products on the AAOT than on the AOT for all flights except C044, C048 and C051."

P11 line 20-24: It is unclear about the type of data filtering that has been applied in this section. Was the inhomogeneity parameter applied in this section to remove low cloud fraction area? Are Meyer's retrieval uncertainties applied?

The satellite data filtering used in section 3 is similar to section 2. In the first paragraph of section 2.a, the following sentence has been added:

"Note that those filters have been applied to the satellite data used in both the section 2 and 3."

P11 line 29 – P12 line 5: This paragraph is disconnected from the rest of the section. It should either be a part of the cloud layer section (d. ii.) or a sub section of c.

The aim of this paragraph is to illustrate the impact of aerosols within clouds on the satellite retrieval of the AOT above clouds. For these reason, we prefer to keep this paragraph in the section about the aerosol layer. The following sentence has been added at the beginning of the paragraph:

"Information on the vertical profile of aerosols can be used to further investigate the differences between satellite observations and in situ measurements."

P12 line 22: "CDP is less than"

Done

P12 line 29: "In Figure 9c"

Done

P12 line 47: "useful in enhancing"

Done

P13 line 38-39: "is shown in Figure 10"

Done

P15 line 11: "significantly enhance"

Done

Figure 2: The figure label "cloud AOT" appears to be one word.

Done

Figure 3: The grey dash line is not explained in the figure caption and is very unclear in the printed version. I suggest changing the dashed line to black for clarity.

Done

Figure 6: The word "Longitude" is partially missing in the label of the horizontal axis

Done

Figure 8: There are 2 points on the CER=13 micron. Are those the maximum values?

These are the largest values of the data in these plots.

Figure 10: Describe panel a, b and c in the figure caption

Done

Table 3: "SEVIRI (no aerosol)"

Done

Zhibo Zhang (Referee)

zhibo.zhang@umbc.edu Received and published: 3 April 2020

This is the second part of a remote sensing study of the above cloud smoke aerosols in the South East Atlantic Ocean (SEAO) region based on the observation from the SE- VIRI satellite sensor. The first part documents the theoretical basis of the retrieval algorithm and relevant technical details. In this part, the SEVIRI retrievals results are evaluated first through comparisons with an independent satellite retrieval product based on MODIS observations. Then the retrievals are further compared with collocated in situ measurements from the recent CLARIFY-2017 field campaign. Overall, the SEVIRI based above-cloud aerosol (ACA) retrievals are in reasonable agreement with MODIS ACA retrievals and direct in situ measurements. The differences among each retrieval products are studied, and the potential reasons causing the differences are provided.

This paper is a useful addition to the studies on the ACA in the SEAO region. Because of its location and geostationary nature, the SEVIRI observations are ideal for studying the ACA and the underlying clouds, even though the algorithm used here is not really new and has been developed/applied in several previous studies. The manuscript is well organized and easy to read. Overall it is good shape. However, I have several questions and some major concerns regarding the methodology used in the comparisons, which should be explained and clarified before it can be accepted for publications. In addition, I have some thoughts about the differences between SEVIRI and other measurements/retrievals that are different from the paper. I would like to share them and hopefully, them can be helpful for improving the paper.

We would like to thank Zhibo Zhang for his useful and insightful review. He is right that the algorithm is not entirely new; however the spectral band differences and the geostationary nature of the satellite platform mean that SEVIRI does have some potentially unique capabilities for e.g. examining the diurnal cycle of ACI etc. We are glad that the reviewer finds the paper well organised, easy to read and in overall good shape. We have taken account of the reviewer's comments in what follows:

Questions/Comments/Suggestions:

1. Overall, the references cited in the Introduction and other parts of the manuscripts are rather old. A number of recent studies on the ACA in the SEAO region should be referenced here. For example, there are several recent studies on the direct radiative effects of ACA in SEAO region e.g., [Wilcox, 2012; Zhang et al., 2016b; Kacenelenbogen et al., 2019] should be cited here at line 26 when discussing the DRE of ACA. They are more relevant than Keil and Haywood (2003) in this context. When discussing the CALIPSO ACA retrievals, the three cited studies are based on the two-way transmittance method by Hu et al. (2007). But the operational CALIPSO Aerosol retrieval product, which is based on the "traditional" lidar ratio method, is much more widely used. It should be mentioned with reference here.

We have updated the reference in the introduction by adding the following text:

“These new observations have been used in recent satellite-based studies on the direct radiative effect of aerosols above clouds in the SEAO (Wilcox et al., 2012; Peers et al., 2015; Zhang et al., 2016b; de Graaf et al., 2019; Kacenelenbogen et al., 2019). However, validation exercises are needed to evaluate the accuracy of these new methodologies.”

“De Graaf et al. (2020) have compared the direct radiative effect of aerosols above clouds obtained from SCIAMACHY, OMI/MODIS and POLDER and have shown that differences can be expected from instruments with different spatial resolution due to 3D effects of clouds.”

> *2. I have several major concerns and comments about how the SEVIRI retrievals are compared with the MODIS retrievals in Section 2. They need to be clarified and some comparisons should be repeated if possible.*
>
> *a. Spatial collocation and data screening: as pointed in the paper, the two instruments have a significantly different spatial resolution, SEVIRI at 3x3km at nadir and MODIS at 1x1km. So roughly there are 9 MODIS pixels within each SEVIRI pixel. In this study, both retrievals are aggregated to 0.1o x0.1o common grid box (~10km). I understand that pixel-to-pixel collocation between SEVIRI and MODIS may be challenging. BTW, it is not a bad idea to explain to the readers why pixel-to-pixel collocation is difficult. But I believe there must be some quality assurance measures to filter out some “bad” or challenging grid boxes that are not suitable for comparison. For example, some 0.1o x0.1o grid boxes may be partly cloudy and others can have either bad SEVIRI or MODIS ACA retrievals. What are the conditions used here to filter out these “bad” grid boxes? If they are not filtered, what are the considerations to keep them and what are the potential implications of the ACA comparison results?*

The SEVIRI filters for partly cloudy observations, cloud edges and heterogeneous clouds are based on the observations aggregated onto the 0.1° × 0.1° grid. At pixel level, the MODIS algorithm uses the Partly Cloudy Pixel detection algorithm from the operational MOD06 cloud retrieval. In addition to those criteria, the observations not suitable for the comparison are rejected using the uncertainty on the retrieved AOT for MODIS and the quality of the fit for SEVIRI as described in section 2.a.

The following two sentences of text have been added to section 2.a:

“Cloud edges, fractional cloud coverage and heterogeneous clouds are also rejected from the SEVIRI results using observations aggregated at a 0.1° × 0.1° grid resolution.”

“Comparisons at the native resolution of the instruments is challenging notably because of the rapid evolution and advection of the clouds.”

In section 2.b.ii, we have introduced an additional filter on the CER to take into account the fact that the MODIS retrieval is limited to CER<30 µm:

“In addition to the filters described in section 2.a, observations associated with CER_{SEVIRI} > 30 µm are removed to be consistent with the upper limit of the MODIS retrieval.”

b. Sanity check on "clean" clouds: in my opinion, it is really difficult to understand the ACA retrieval difference between SEVIRI and MODIS without first understanding their differences for "clean" clouds (i.e., not aerosols above). For example, in Figure 3 there is some significant difference between the SEVIRI, and MODIS retrieved COT and CER. It is hard to tell whether these differences are caused by the ACA correction or something in the cloud retrieval part. To address this question, I'd strongly recommend a comparison of the COT and CER between the two satellite sensors for "clean" clouds, even only for some case studies.

Cloud properties from MODIS and SEVIRI have been compared for low above-cloud AOT (<0.05) and the results are shown in the figure below.

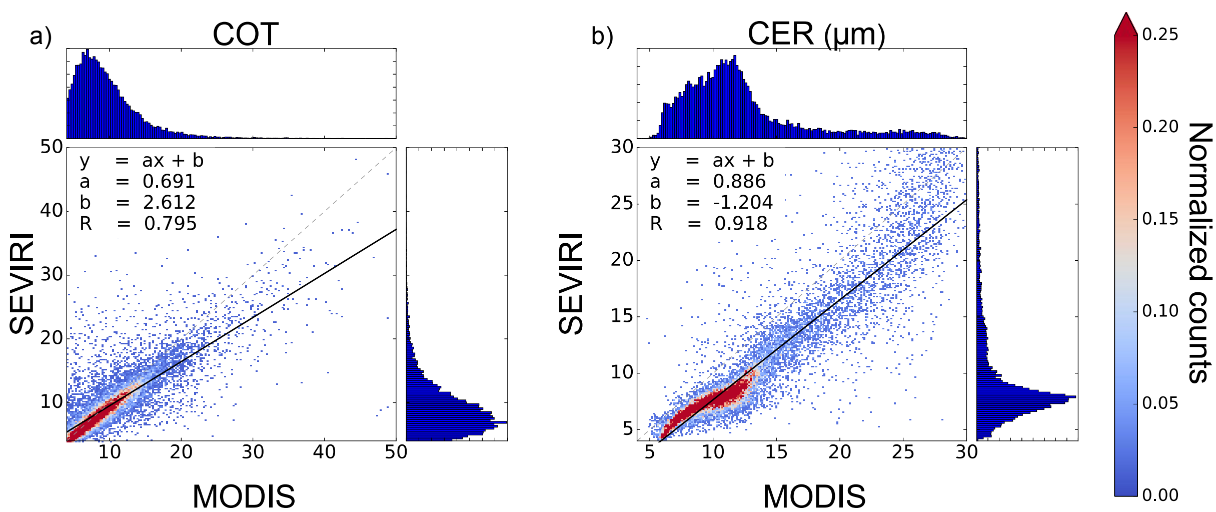

Figure R2: Scatterplots and data distributions for the comparison of the COT (a) and the CER (b) retrieved when the above-cloud AOT is lower than 0.05 by SEVIRI and MODIS (MOD06ACAERO) between the 28th August and 5th September 2017 over the area between 0˚N - 30˚S and 20˚W - 15˚E. The black lines represent the linear regression.

Note that the filter on the MODIS AOT uncertainty has been omitted for this analysis. The differences between the relationships observed with and without aerosols above clouds are small and could be related to the smaller size of the dataset. This confirms that the differences between the cloud properties from MODIS and SEVIRI mainly come from the assumptions in the cloud retrieval and the differences between the two instruments. The following text has been added at the end of section 2.b.ii:

"Note that the cloud properties from SEVIRI and MODIS have also been compared for low above-cloud AOT (AOT < 0.05) to separate the impact of the aerosol correction from the cloud retrieval itself. The Figure S1 in the supplement shows that similar relationships are obtained with and without aerosols above clouds."

c. The sampling rate of SEVIRI ACA retrieval needs to be analyzed and reported, and the implications explained. The SEVIRI sampling strategy is "The SEVIRI algorithm rejects both the aerosol and cloud products when the COT is lower than 3". Based on Figure 1 and Figure 2, it seems that this strategy would lead to a significant loss of samples. Note that, as pointed out in Zhang et al. (2016) the dramatic difference in sampling rate is an important reason for the fact that the DREs of ACA in the SEAO region reported in the literature differ so substantially. In fact, based on the combination of CALIOP and MODIS, Zhang et al. (2016) found that a large fraction of the ACA cases has COT smaller than 3 (See Figure 9a) of Zhang et al. (2016). The authors need to estimate the fraction of the ACA cases they sample vs. how many they filtered out. Moreover, it should be explained how this sampling strategy could impact the user of the data, for example, when calculating the DRE of ACA.

Using the operational SEVIRI cloud property retrieval from the Met Office (Saunders et al., 2006), we have estimated that the fraction of low level clouds associated with COT lower than 3 is 15.5% for the observation of the 4th September 2017 at 10:15 UTC. While we agree that removing these pixels is not ideal when comparing to GCM models, a 10 x 10 km resolution is getting close to the resolution limit for operational global NWP models that can examine the impacts of clouds. Thus, by clearly stating our assumptions, we argue that the same screening procedure can be applied to the models as applied to the SEVIRI algorithm when making an objective comparison. In the CLARIFY-2017 overview paper (Haywood et al., 2020), Figure R3 shows the above-cloud DARE comparison between POLDER and HadGEM. Note that all COTs lower than 3 from HadGEM were removed in order to be consistent with the satellite screening. This analysis has shown that the direct radiative effect from biomass burning aerosols is relatively independent of the resolution for GCMs.

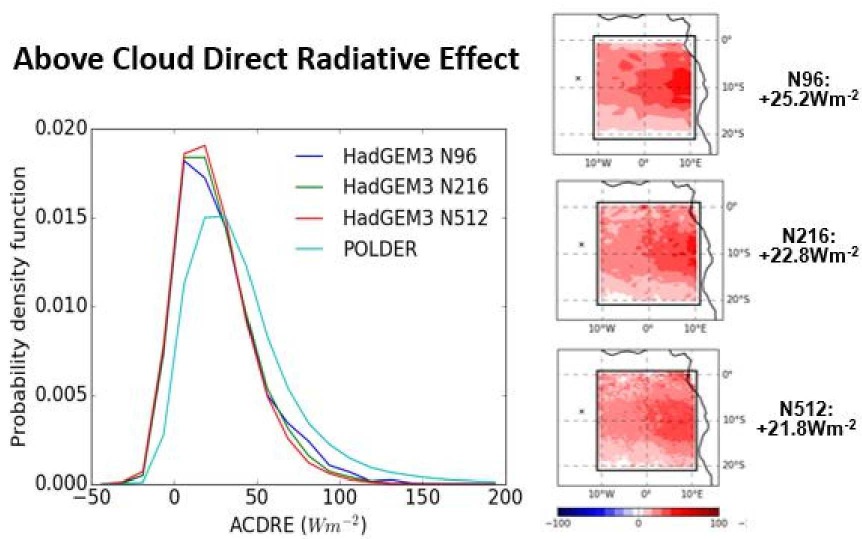

Figure R3: Above cloud direct radiative effect diagnosed from the Unified model (N96, N216 and N512 resolution) over the area shown in the panels in the right-hand column. The probability density function of the above cloud direct radiative effect is also shown from POLDER after (Peers et al., 2016). The intercomparison is for August-September 2006 and model data is matched to instantaneous POLDER retrievals. (From Haywood et al., 2020.)

The following statement has been added at the end of section 2.b.i:

"This difference in the cloud sampling between the two methods can lead to a significant difference when comparing the regional mean of the above-cloud direct radiative effect (Zhang et al., 2016). However, the 0.1° × 0.1° grid resolution used here is close to the typical resolution of global operational numerical weather prediction models that can examine the impact of clouds. Therefore, when comparing to global climate models (e.g. as per the model/POLDER comparison detailed in Haywood et al., 2020), users are advised to use a similar screening procedure to the satellite retrieval."

> *d. Uncertainty analysis is needed in the comparison: I didn't find any error bar associated either SEVIRI or MODIS retrievals. The signal to noise ratio for ACA retrieval is not very large. So, the uncertainty associated with either retrieval is considerably large. The comparison is only meaningful when they are put in the context of their error budget. Otherwise, the comparison may very well be comparing statistic noises. In particular, I'd suggest adding an error budget to both products in Figure 3. You may put the AOT into several bins and plot the uncertainty of AOT retrievals from each product as an error bar (x-axis error bar for MODIS and y for SEVIRI). Then, the differences between the two products need to be put in the context of the error budget.*

We agree. In Peers et al. (2019), the uncertainty on the AOT retrieved by SEVIRI due to the aerosol, the cloud model, the Rayleigh scattering (i.e. the altitude of the aerosol and the cloud layer) and the water vapour correction have been estimated to be 40%, 0.3%, 2.5% and 10% respectively. The uncertainty due to the measurements has been estimated by calculating the standard deviation of the SEVIRI AOT in Figure 3 for each AOT bin. The total uncertainty is obtained by combining the uncertainties listed above, assuming that they are independent (i.e. using the square root of the sum of squares). The MODIS uncertainty, which is provided by the algorithm, accounts for the Rayleigh scattering errors, the measurement errors and the errors due to the aerosol and the cloud model. The error bars have been added to Figure 3. The following text has been added to section 2.b.ii:

"The error bars in Figure 3a represent the uncertainty associated with the retrieved AOT. In Peers et al. (2019), the uncertainty of the AOT retrieved by SEVIRI due to the aerosol, the cloud model, the Rayleigh scattering (i.e. the altitude of the aerosol and the cloud layer) and the water vapour correction have been estimated to be 40%, 0.3%, 2.5% and 10% respectively. The uncertainty due to the measurements has been estimated by calculating the standard deviation of the SEVIRI AOT in Figure 3a for each AOT bin. The total uncertainty is obtained by combining the uncertainties listed above, assuming they are independent (i.e. using the square root of the sum of squares). The MODIS uncertainty, which is provided by the algorithm, accounts for the above-cloud column two-way transmittance errors, the Rayleigh scattering errors, the measurement errors and the errors due to the aerosol and the cloud model. As with SEVIRI, the aerosol model assumption is typically the largest source of uncertainty in the MODIS retrieval (Meyer et al., 2015)."

> *e. The explanation for the differences between SEVIRI and MODIS ACA and cloud retrievals in Figure 3 is not very convincing. There are a number of differences between the SEVIRI and MODIS ACA retrievals in Figure 3. First of all, AOT from the SEVIRI*

retrieval is significantly smaller than MODIS results by about 20%. The paper attributes this mainly to the difference in the aerosol model assumed in the two schemes, e.g., the aerosol model in the SEVIRI retrieval is more absorptive than that in the MODIS retrieval. But this explanation is not very convincing. The SSA difference between the two is only 0.01 (0.85 in SEVIRI vs. 0.86 in MODIS). This is equivalent of about 6% difference in absorption AOT (i.e., 0.01/0.15), which can only explain half of the ~11% difference between SEVIRI and MODIS AAOT in table 1. To provide a more convincing explanation, I'd suggest the authors run the SEIVIRI ACA retrievals using the same aerosol model as MODIS and then make comparisons. Secondly, the correlation between SEIVIRI and MODIS retrieval is clearly nonlinear. The authors are aware of this nonlinearity and pointed it out in the paper. However, no explanation is provided. BTW, the correlation between the two AAOT retrievals in Figure 3 b is also nonlinear. I wouldn't say this is "slightly". It is clearly and significantly nonlinear. In my opinion, this nonlinearity is partly, if not mainly, due to the sampling difference between the two retrieval algorithms, i.e., MODIS screens out retrievals based on retrieval uncertainty while SEIVIR keeps low-quality retrievals which are mainly low AOT. This goes back to my earlier comments on the sampling differences. Some quality assurance screening is clearly needed here.

In response to the reviewer's comments, the SEVIRI retrieval has been run using both the CLARIFY-2017 and the MOD06ACAERO aerosol model for the case study shown in Figure 2 in the manuscript, i.e. the 4th September 2017 at 10:15 and 11:45 UTC. Figures R4 below shows the comparison between MODIS and SEVIRI for the above cloud AOT. The slope of the regression line between SEVIRI and MODIS goes from 0.81 with the CLARIFY-2017 model to 1.05 with the MOD06ACAERO model. Moreover, the mean AOT for this case study is 0.44 for MODIS, 0.33 for SEVIRI using the CLARIFY-2017 model and 0.44 for SEVIRI using the MOD06ACAERO model. This confirms that, for AOT larger than 0.25, the differences between the SEVIRI and the MODIS retrieval are mainly due to the assumed aerosol properties.

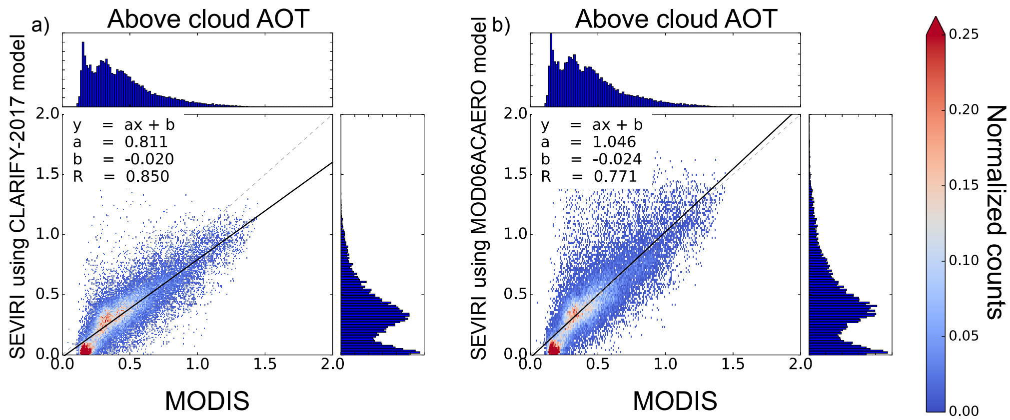

Figure R4: Comparison of the above-cloud AOT retrieved by SEVIRI and MODIS (MOD06ACAERO) in the morning of the 4th September 2017 over the area between 0˚N - 30˚S and 20˚W - 15˚E. The left plot (a) corresponds to the SEVIRI retrieval using the CLARIFY-2017 aerosol model and the right plot (b) shows the SEVIRI retrieval using the same aerosol model as the MODIS retrieval. The black lines represent the linear regression.

The non-linearity of the correlation between the SEVIRI and the MODIS AOT and AAOT is caused by the MODIS filter on the uncertainty and, to a lesser extent, by the AOT dependence of the MOD06ACAERO model. The correlation obtained when the uncertainty filter is not applied is shown in Figure R5 below.

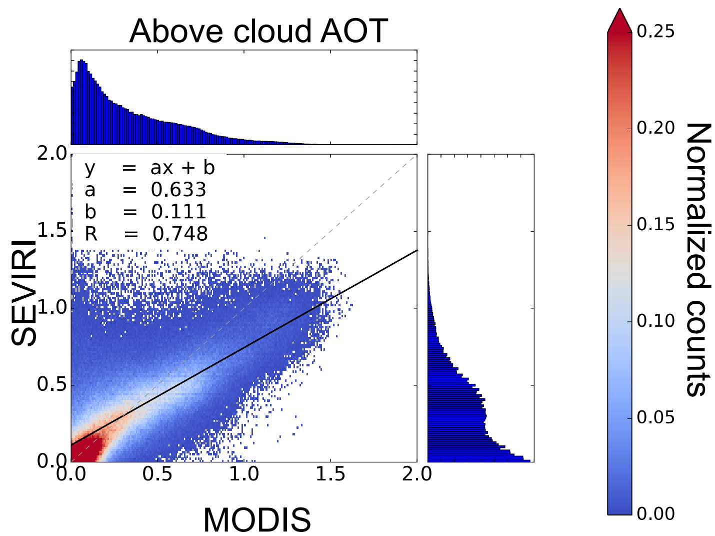

Figure R5: Comparison of the above-cloud AOT from SEVIRI and MODIS (MOD06ACAERO) retrieved between the 28th August and 5th September 2017 over the area between 0˚N - 30˚S and 20˚W - 15˚E. The filter on the MODIS uncertainty has not been applied.

Indeed, the signal to noise ratio is smaller for small AOT, leading to a larger fractional uncertainty. For the MODIS dataset, users are advised to consider that AOT=0 when the uncertainty is larger than 100%. Although no filters are applied to remove those results in the SEVIRI dataset, we expect their contribution to the total DRE over the South East Atlantic to be small. We have made a rough estimate of the above-cloud DRE using the AOT from the dataset used in section 2.b.ii and a COT of 11 and a CER of 8µm, which are close to the median values observed by SEVIRI (see Table 1 in the paper). Based on radiative transfer calculations performed with the CLARIFY-2017 aerosol model, a DRE by AOT of 109.65W.m^{-2}. τ^{-1} has been obtained. Figure R6 below shows the cumulative contribution to the total DRE as a function of the above-cloud AOT. The total DRE is 36.1W.m^{-2} using SEVIRI, with the AOT below 0.1 contributing to less than 1.2W.m^{-2}. Finally, when comparing to GCM, it is possible to exclude the low AOT from both the satellite observations and the models.

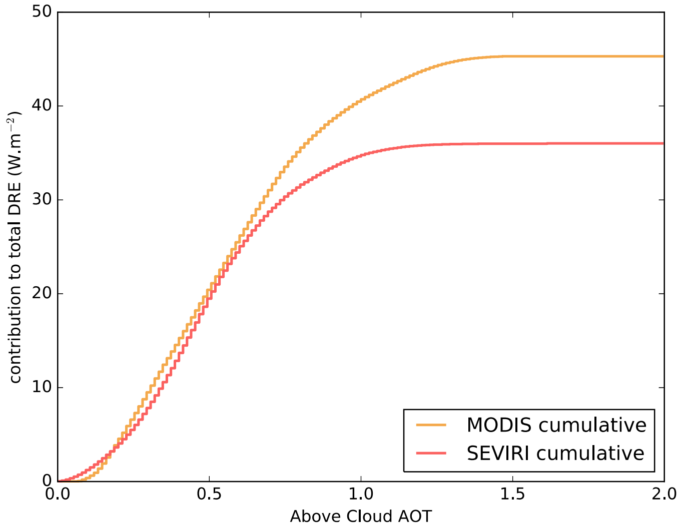

Figure R6: Cumulative contribution to the total above-cloud DRE as a function of the AOT for the dataset used in section 2.b.ii, considering a COT of 11 and a CER of 8µm.

This section has been modified to:

"To assess the impact of the aerosol assumptions on the retrieved AOT, the SEVIRI retrieval has been run using both the CLARIFY-2017 and the MOD06ACAERO aerosol model for the case study described in section 2.b.i. The comparison of the both sets of AOT with MODIS is plotted in Figure 4. The slope of the regression line between SEVIRI and MODIS is 0.81 with the CLARIFY-2017 model and it is 1.05 when the same model (i.e. MOD06ACAERO model) is used. Moreover, the mean AOT for this case study is 0.44 for MODIS, 0.33 for SEVIRI using the CLARIFY-2017 model and 0.44 for SEVIRI using the MOD06ACAERO model. This confirms that, for AOT larger than 0.25, the differences between the SEVIRI and the MODIS retrieval are mainly due to the assumed aerosol properties. While the CLARIFY-2017 and ORACLES observations provide a thorough and comprehensive analysis of the BBA optical properties, which are adopted by the SEVIRI and MODIS satellite retrievals, representing the level of complexity of the variation of optical properties owing to evolution of flaming to smouldering combustion during the biomass burning season (Eck et al., 2003) and the complexity of aerosol ageing processes (e.g. Wu et al, 2020; Taylor et al., 2020) is beyond current observational capabilities. The non-linearity of the AOT and AAOT comparison as well as the differences between the SEVIRI and MODIS distributions at low values can be partly explained by the MODIS filter on the AOT uncertainty. The signal to noise ratio being smaller at low AOT, the near zero AOT_{MODIS} are typically associated with an uncertainty larger than 100% and are discarded. Although no filters are applied to remove those results in the SEVIRI dataset, their contribution to the total DRE over the South-East Atlantic are expected to be small."

3. At line 25 of page 6, when discussing the plane-parallel bias, there are few much more recent studies that should be noted here, in particular [Zhang et al., 2016a] proposed a 2-D framework to account for the plane-parallel bias in both COT and CER retrievals caused by sub-pixel inhomogeneity.

The reference has been added.

4. In Figure 6, to what extent the longitudinal variation of delta_AAOT is caused by the variation of AAOT itself? It seems to me that the percentage difference is mainly determined by the denominator, i.e., the mean value of the AAOT. I'd suggest adding the climatological domain averaged AAOT to Figure 6 as a reference.

For this figure, we have selected AAOT > 0.03, which corresponds to $AOT_{SEVIRI}>0.2$, to minimize the effect of the denominator on the AAOT variation. The AAOT from SEVIRI and MODIS used to calculate ΔAAOT have been added to Figure 6.

5. At line 1 of page 13, can the authors explain why the aerosol absorption and its wavelength dependence have anything to do with the Twomey effect?

These sentences have been rephrased:

"Pollution within clouds tends to increase the albedo of clouds by acting as cloud condensation nuclei but can also increase their absorption coefficient (Twomey, 1977). Although the brightening of the clouds is typically the dominant effect, the presence of absorbing smoke within the cloud could have an impact on the spectral variation of the cloud reflectance. Both the SEVIRI and the MODIS algorithms assume that the entire aerosol layer is located above an unpolluted cloud and do not account for aerosols within the cloud. Therefore, a reduction in the cloud albedo in the visible/SWIR range due to pollution within the cloud layer could be interpreted by colour-ratio based retrievals as an additional aerosol signal, leading to an overestimation of the above-cloud AOT."

6. At line 22 of page 22, there are actually several more recent studies that suggest the CER retrievals are overestimated when there is significant sub-pixel cloud inhomogeneity [Zhang and Platnick, 2011; Zhang et al., 2012; 2016a].

The references have been added.

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