First we would like to thank the reviewer, Dr. Hiren Jethva, who took a major part in the improvement of this article. Particularly, we modify the whole section 2.4 to discuss the potential errors induced by the assumption made in the retrieval and especially the one concerning the weak sensitivity of polarized measurements to aerosol absorption. We hope that our comments and modifications will fully answer to his questions and suggestions.

It has to be pointed out that some figures presented in this review are not in the manuscript as they only favor the understanding of specific questions of the reviewer.

General comments:

While the present work brings new information on the character of particles (SSA) of ACA scenes, I find a fundamental limitation of the POLDER approach presented in this paper. First, author retrieves scattering AOT on the basis of retrieved total AOT and assumed SSA using an algorithm developed by Waquet et al. (2008). The retrieved total AOT has been shown to be sensitive to the assumption of real and imaginary part of the refractive index (Table 1 in this manuscript). In the second step, the total radiance measurements and 'retrieved' scattering AOT was used to estimate the imaginary part of the refractive index and aerosol-corrected COT. In this way, the retrieval logic makes a full circle, i.e., starting with an assumption about SSA to retrieve total/scattering AOT and use the scattering AOT again to retrieve back SSA.

Actually, polarized radiances translate the scattering AOT. The method described in the study of Waquet et al. [2013] consists in the retrieval of the scattering AOT based on polarized measurements. Then, the total AOT is estimated using an assumption on the SSA. As stated in the section 2.1 of the manuscript, polarization is mostly sensitive to the first order of scattering. Also, in Fig. 2, one can see the weak contribution of the aerosol absorption to polarized radiances, especially at side scattering angle. This part of the signal (i.e. for scattering angle under 130°) is the one used in the polarized part of the retrieval for fine mode particles. In this way, the first step of the algorithm consists in the retrieval of the scattering AOT and the aerosol size from polarized radiances while the second part rests upon the adjustment of the absorption to fit the total radiance measurements.

Waquet, F., Cornet, C., Deuzé, J. L., Dubovik, O., Ducos, F., Goloub, P., Herman, M., Lapyonok, T., Labonnote, L., C., & Vanbauce, C. (2013). Retrieval of aerosol microphysical and optical properties above liquid clouds from POLDER/PARASOL polarization measurements. *Atmospheric Measurement Techniques*, *6*(4), 991-1016.

In order to clarify this point, the section 2.3 of the manuscript has been corrected. In pages 25540-25541, lines 23 to 4 have been replaced by:

The retrieval of the scattering AOT is attempted for each 6km × 6km POLDER's pixel when the COT given by MODIS is larger than 3.0. If fine mode aerosols have been identified, the estimation of the scattering AOT is based on the signal measured for scattering angle lower than 130°. At that point, a first estimation of the extinction AOT is made based on the absorption assumed for the selected aerosol model (i.e. $k_{assumption}$). Results are then subjected to several filters in order to improve their quality: data must be well fitted, clouds have to be homogeneous and both cloud edges and cirrus are rejected according to criteria based on POLDER and MODIS products. Filtered AOT are then aggregated from 6 km × 6 km to 18 km × 18 km and pixels with a Standard Deviation (SD) of the AOT larger than 0.1 are excluded in order to prevent cloud edge contamination. Eventually, the scattering AOT is recovered using the SSA of the aerosol model with the same absorption assumption used at first (i.e. $k_{assumption}$):

$$\tau_{scatt,\lambda} = \varpi_{0,\lambda,k_{assumption}} \tau_{ext,\lambda,k_{assumption}} \tag{2}$$

Estimation of SSA of aerosols above cloud requires independent direct measurements of AOT such as from airborne sunphotometer or High Spectral Resolution Lidar (HSRL)-like extinction retrieval which are free from assumption about aerosol model.

Kaufman et al. have already shown that it is possible to retrieve aerosol SSA from passive measurements. He developed two methods to retrieve the aerosol absorption with passive satellite instruments. Both technics rely on the attenuation of the signal above a bright surface. On the one hand, the first one (Kaufman, 1987; Kaufman et al., 2001) allows the evaluation of the SSA of dust aerosols above a bright surface as long as the scattering phase function and the surface reflectance are known (derived during a clear day for instance). On the other hand, Kaufman et al. (2002) suggest using the sunglint to retrieve the aerosol absorption above the ocean. The spectral contribution of the glint is derived from reflectance measured in a spectral band in which aerosols are transparent. In addition, the scattering properties of the aerosol layer, such as the scattering optical thickness and the size distribution, are retrieved with off-glint reflectances. Finally, the aerosol absorption is derived from the attenuation of the measurements acquired in the glint. In one sense, our method follows the same idea with the cloud used as a bright surface.

Kaufman, Y. J. (1987). Satellite sensing of aerosol absorption. *Journal of Geophysical Research: Atmospheres (1984–2012)*, *92*(D4), 4307-4317.

Kaufman, Y. J., Tanré, D., Dubovik, O., Karnieli, A., & Remer, L. A. (2001). Absorption of sunlight by dust as inferred from satellite and ground‐based remote sensing. *Geophysical Research Letters*, *28*(8), 1479-1482.

Kaufman, Y. J., Martins, J. V., Remer, L. A., Schoeberl, M. R., & Yamasoe, M. A. (2002). Satellite retrieval of aerosol absorption over the oceans using sunglint. *Geophysical Research Letters*, *29*(19), 34-1.

Author highlights in the paper that the uncertainty in scattering AOT can be greater due to wrong assumption of SSA for larger aerosol loading which is frequently observed over the south-eastern Atlantic Ocean. Under these circumstances, the reliability of SSA retrieval and further estimation of DRE is questionable. Additionally, the manuscript is devoid of an uncertainty analysis of SSA retrieval given the realistic bounds of error in the scattering AOT.

It is right that the approximation according to which polarized measurements only translate the scattering processes become less consistent when the aerosol layer is very absorbing (i.e. large AOT and low SSA). In order to qualitatively assess the impact of this approximation, we have made a statistical analysis of the events sampled in the middle of the fire season 2006 over the South-East Atlantic Ocean (August to September, 5°N to 30°S, 20°W to 20°E). This sample is expected to gather the most unfavorable cases for our algorithm since large amount of very absorbing aerosols are emitted during that period. The distribution of the AOT above clouds is presented in Fig. 1. Events with AOT lower than 0.2 at 865 nm constitute around

75% of the observed scenes. Then the distribution decreases dramatically with the AOT so that only 2.7% of events have an AOT larger than 0.4. This analysis confirms the validity of the approximation regarding polarized radiances for most cases.

In parallel, we have extended the sensitivity analysis of the manuscript to absorbing aerosol layer with increasing AOT. Aerosols with an effective radius of 0.1 µm have been considered with an imaginary part of the refractive index of 0.02 and 0.03, corresponding to a SSA at 865 nm of 0.836 and 0.772 respectively. The cloud used to model the signal has an optical thickness of 10.0 and a droplet effective radius of 10.0 µm. Figure 2 shows the error on the retrieved SSA (i.e. $\Delta SSA = SSA_{retrieved} - SSA$) and the retrieved absorption AOT as a function of the AOT. For AOT = 0.05, the SSA is overestimated of about +0.036. The retrieved scattering AOT with polarization is correct but the aerosol size is slightly overestimated (0.12 µm instead of 0.10 µm). When the aerosol layer is thicker, the SSA is always underestimated. For AOT = 0.2, we observe a bias of −0.017 and −0.029 for SSA equal to 0.836 and 0.772 respectively. In case of an extreme event with AOT around 0.5 at 865 nm (i.e. 1.3 at 550 nm), the bias is valued at −0.055 for SSA = 0.772. However, it has to be pointed out that the underestimation of the SSA always goes together with an underestimation of the scattering AOT. Because total radiances are sensitive to the absorption of the aerosol layer, the algorithm compensates the error on the scattering AOT due to the first part of the retrieval by an underestimation of the SSA. The absorption AOT is thus less impacted by the approximation on polarized radiances than the SSA. According to Eq. (1) in the manuscript, the absorption AOT is the leading parameter in the estimation of the DRE for large values of the underneath surface albedo. Figure 1 is not shown in the manuscript to keep the general character of the sensitivity analysis and for now on, Fig. 2 is a part of the new Fig. 5.

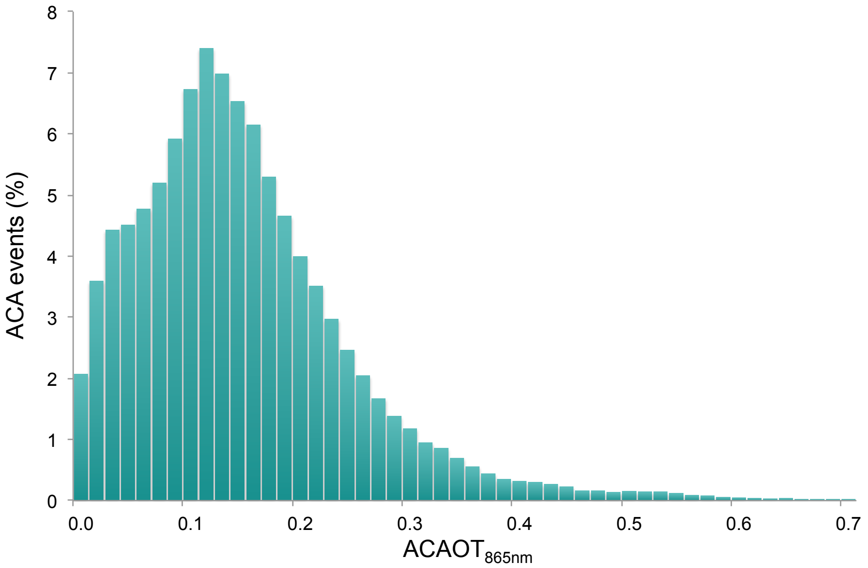

Figure 1. Distribution of the Above Cloud Aerosol Optical Thickness at 865 nm ($ACAOT_{865nm}$) from August to September 2006 over the South-East Atlantic Ocean (5°N to 30°S, 20°W to 20°E).

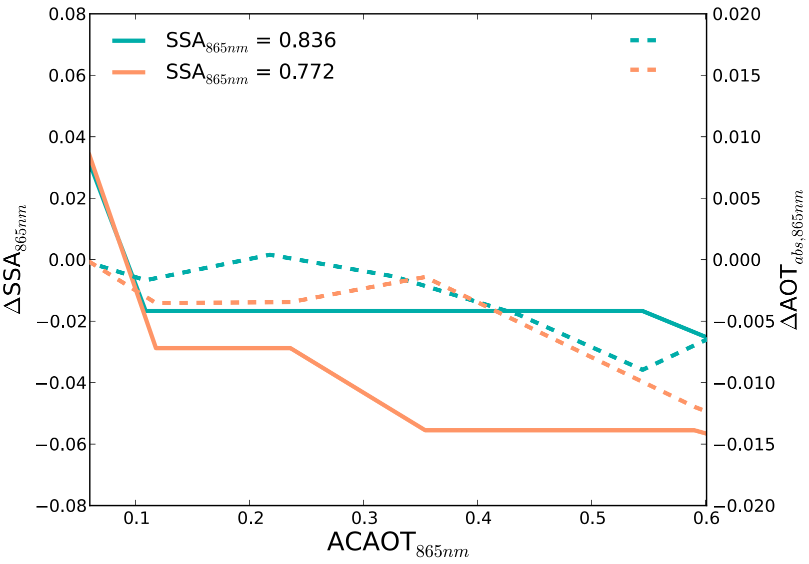

Figure 2. Error in the retrieval of the SSA (i.e. $\Delta\mathrm{SSA} = \mathrm{SSA}_{\mathrm{retrieved}} - \mathrm{SSA}$; solid lines) and the absorption AOT (i.e. $\Delta\mathrm{AOT}_{\mathrm{abs}} = \mathrm{AOT}_{\mathrm{abs,\ retrieved}} - \mathrm{AOT}_{\mathrm{abs}}$; dashed lines) as a function of the Above Cloud AOT at 865 nm for aerosols with SSA of 0.836 and 0.772 (green and orange lines respectively).

The sensitivity analysis in section 2.4 has been modified (see Specific comments).

Specific comments:

Page 25534, Line 2: While most satellite retrievals of above cloud aerosols...

The beginning of the abstract has been rephrase:

This study presents an original method to evaluate key parameters for the estimation of the direct radiative effect of aerosol above clouds: the absorption of the aerosol layer and the albedo of the underneath cloud.

Page 25534, Line 19: +33.5 W/m2 (warming)

The clarification has been added to the manuscript, thank you.

Page 25535, Line 11: Since the DELTA_RHO is a strong function of AOD and SSA of aerosols above cloud, adding the simulation for SSA of 0.9 would highlight the sensitivity of TOA reflectance to the aerosol SSA. What is the value of AOD assumed for this simulation? Since the interest here is to estimate aerosol forcing above cloud, a similar plot as a function of cloud optical depth is desirable.

Lines corresponding to SSA of 0.9 have been added to Fig. 1 of the manuscript. The simulations processed for this figure are independent from the AOT since the horizontal axis represents the ratio of the albedo difference on the AOT.

Although we are interested in aerosol forcing above cloud, we have chosen not to plot the Fig. 1 as a function of the Cloud Optical Thickness (COT) in order to preserve the qualitative and general scope of this analysis. Moreover, the albedo of a cloud depends not only on the COT but also on the solar zenith angle and the wavelength. The simulations used to plot the figure have been made by considering single values of the SSA and g. Using a realistic cloud as the underneath surface would require to spectrally integrate the albedo of the scene and consequently, to consider the spectral variation of the aerosol properties.

Page 25535, Line 19: contribution instead of importance

Page 25537, Line 6: Jethva et al. (2014) have carried out a multi-sensor comparison of the above-cloud AOT retrieved from different sensors on board NASA's A-train satellite.

Page 25537, Line 8: "..results have shown good consistency over the homogeneous cloud fields".

These sentences have been corrected as suggested by the reviewer.

Page 25537, Line 20: While this method is expected to work efficiently for the fine mode aerosols as their interactions at longer wavelengths are minimal or even nil. it may not work for coarse mode dust aerosols due to their radiative interference at longer wavelengths.

The sentence has been rectified in accordance with the reviewer proposition (expect for the word "interference" that has been replaced by "influence").

Page 25541, Eq 2: Here, I have a fundamental question to the author: First, the POLDER retrieval algorithm retrieves total AOT assuming a model with a fixed value of SSA. What is the sensitivity of the AOT retrieval to the assumed value of SSA? Figure 2 has demonstrated the sensitivity of polarized radiances to the imaginary index around the scattering range angle 140-145 deg.

The answer to this question is partly given in the general comment response and the manuscript has been edited accordingly. Regarding the sensitivity of polarized radiances to aerosol absorption in the cloud bow (i.e. for scattering angle around 140°), it has to be noticed that this part of the signal is not used to retrieve the scattering AOT for fine mode aerosols. As mentioned in Waquet et al. (2013), the algorithm does the discrimination between the fine mode and dust in the first place. When fine mode aerosols are detected, only the polarized signal measured for scattering angles lower than 130° is used to retrieve the scattering AOT. For dust particles, the whole signal is used to retrieve the scattering AOT. However, the assumption on the absorption of dust at 865 nm is the same in the polarized and the total radiance part of the retrieval.

Waquet, F., Cornet, C., Deuzé, J.-L., Dubovik, O., Ducos, F., Goloub, P., Herman, M., Lapyonok, T., Labonnote, L. C., Riedi, J., Tanré, D., Thieuleux, F., and Vanbauce, C.: Retrieval of aerosol microphysical and optical properties above liquid clouds from POLDER/PARASOL polarization measurements, Atmos. Meas. Tech., 6, 991–1016, doi:10.5194/amt-6-991-2013, 2013.

Page 25541, Line 25: provide an appropriate citation.

The reference to the paper of Rossow et al. [1989] has been added.

Rossow, W. B., Garder, L. C., and Lacis, A. A.: Global, seasonal cloud variations from satellite radiance measurements, Part I: Sensitivity of analysis, J. Climate, 2, 419–458, 1989.

Page 25541, Line 27: Do author retrieve ACAOT over sun-glint areas?

Yes, we retrieve the ACAOT over sun-glint areas since we take into account the reflectance of the ocean as a function of the wind speed. The uncertainty regarding the wind speed estimation should impact weakly the reflectance owing to the attenuation of the signal caused by the cloud layer.

Page 25542, Line 15: Where is the UV wavelength in Figure 4? I can see 490 nm (visible) and 865 nm (SWIR) in this figure.

The denomination UV has been changed by visible line 15 and line 18.

Page 25542, Line 18-19: This is called the 'color ratio' effect. Since aerosol absorption has a spectral signature, it produces stronger absorption effects at shorter wavelengths than at longer ones.

The sentence has been rephrased to include this specification:

However, one can notice the increasing gap between visible and SWIR radiances as the absorption grows called the color ratio effect. Since aerosol absorption has a spectral signature, it produces stronger absorption effects at shorter wavelengths than at longer ones.

Page 25543, Line 1-5: What is the SSA for the reference case?

The SSA for the reference case is equal to 0.911 at 865 nm.

Page 25543, Line 13: Author should list the % change in AOT and SSA retrieval in Table 3. It is easier to understand.

Page 25543, Line 20: The climatological value of SSA at 865 for the AERONET station 'Mongu' situated in the central Africa region is about 0.78. The ratio of AOT between 865 and 500 nm for the biomass burning season (July through September) is about 0.35. During active burning period the AOD at 500 nm often exceeds a value of unity. Under these high aerosol loading conditions, the wrong assumptions of both real and imaginary part of the refractive index will lead to significant error in the retrieval of scattering AOD and then in the SSA estimation using the present method. Also, it is desirable to have a simulation in which the real as well as imaginary part of the refractive index go wrong in such a way that it results in the total error in scattering AOT and SSA. This will give an estimation of the bounds of errors. Author should also mention here that though the retrieval of AOT is less sensitive to the assumption of imaginary part of the refractive index, the error is much larger due to wrong assumption of the real part of the refractive index.

Page 25543, Line 24: how the dust retrievals are impacted by assumption of real and imaginary part of the refractive index? A sensitivity analysis, similar to smoke particles, is needed here.

For the sake of clarity, the sensitivity analysis has been extended and the whole section 2.4 has been replaced by:

The method developed hereinbefore requires assumptions at different stages of the retrieval. The aim of this section is to analyze the resulting impact on the retrieval. To serve this purpose, POLDER's observations have been modeled with the same radiative transfer code used for the LUT, considering several aerosol and cloud models. Errors due to the polarization part of the retrieval are investigated and then, impacted on the total radiances step.

We first examine the assumption regarding aerosol properties. In order to retrieve the scattering AOT, it is assumed that polarized measurements are weakly sensitive to aerosol absorption. This approximation is expected to become less consistent when the aerosol layer is very absorbing (i.e. large AOT and low SSA). This leads to an error in the estimation of the scattering AOT that could affect the retrieval of the SSA. The second assumption concerns the real part of the refractive index m fixed at 1.47 for the retrieval. To assess the impact of these assumptions, we have considered 3 absorbing aerosol models with different refractive indices n: 1.42 − 0.03i, 1.47 − 0.03i and 1.52 – 0.03i corresponding to a SSA at 865 nm of 0.735, 0.772 and 0.801, respectively. The real parts of the refractive indices have been chosen to be representative of the variability observed within the aerosol fine mode [Dubovik et al., 2002]. Aerosols have an effective radius of 0.1µm and their mean altitude is 3 km. The cloud layer used to model the signal has a top altitude at 0.75 km, an optical thickness of 10 and a droplet effective radius of 10 µm. Total and polarized radiances have been simulated for absorbing aerosol layers with increasing AOT. Finally, the DRE of aerosols has been processed using the radiative transfer code GAME [Dubuisson et al, 2004], based on the properties of the modeled scene on the one hand, and those retrieved by the algorithm on the other hand. In Fig. 5, the aerosol and cloud parameters retrieved (green lines) and used in the input simulations (grey lines) are plotted as a function of the AOT at 865 nm. The middle column (i.e. n = 1.47 – 0.03i) shows the biases due to the approximation that polarized radiances translate the scattering process only while the left and the right ones (i.e. n = 1.42 – 0.03i and 1.52 – 0.03i) present also the effect due to the assumption on the real part of the refractive index.

- The first two rows display the total and the scattering AOT. For m = 1.42 and 1.47, the algorithm underestimates the AOT. This error comes from the underestimation of the scattering AOT during the polarized part of the retrieval. For AOT lower than 0.2, we observe a bias around 20% on the AOT. In case of extreme events, with AOT around 0.6 (i.e. 1.5 at 550 nm), the AOT is underestimated of 26.7% for m = 1.47 and 24.1% for m = 1.42, respectively. On the opposite, the algorithm overestimate the AOT when m = 1.52. It has to be noted that the retrieved aerosol radius is larger than the one use to model the signal (0.12 µm instead of 0.1 µm). In that case, the largest error on the AOT (i.e. 25.3%) is observed at AOT = 0.2. Then, the error slowly decreases with the AOT because of the compensation with the aerosol absorption, reaching 16.8% at AOT = 0.6.
- Rows 3 and 4 of Fig. 5 show the absorption AOT and the SSA versus the total AOT. In spite of the error on the scattering AOT, it is interesting to observe that the biases on the absorption AOT are small. Because of the sensitivity of total radiances to the absorption of the aerosol layer, the algorithm compensates the bias on the scattering AOT due to the first part by an error on the SSA. As a consequence, a negative error (resp. positive) in the scattering AOT goes together with an underestimation (resp. overestimation) of the SSA. For AOT = 0.6, a bias of −0.055 has been observed for m = 1.42 and 1.47 and +0.033 for m = 1.52, respectively.

- Plots of the 4th row represent the retrieved COT. They reveal that both the approximation regarding polarized radiance and the assumption on the real part of the refractive index have a limited impact on the COT estimation. In this analysis, the largest bias is ±0.3 on the COT.

- Finally, the last row focuses on the evolution of the DRE of aerosols with the modeled AOT. The DRE estimated with aerosol and cloud properties retrieved by the algorithm is close to the one processed with the properties of the modeled scene. This can be explained by the reliable estimation of the aerosol layer absorption: as suggested by Eq. (1), the absorption AOT is the leading parameter in the estimation of the DRE for large values of the albedo of the underneath scene. The largest bias (+9.7 W.m^{-2}) has been obtained for AOT = 0.6 and m = 1.52. Otherwise, the bias is always lower than ±6.4 W.m^{-2} for AOT lower than 0.2 and lower than ±1 W.m^{-2} for AOT lower than 0.1.

In a second place, we look at the assumption on the size distribution of the coarse mode particles. For the retrieval, we only consider one model for dust. It is defined by a bimodal lognormal size distribution with an angström exponent of 0.36 [Waquet et al., 2013a]. The signal has been modeled for coarse mode particles with an angström exponent of 0.02 and 0.6 and an AOT = 0.6. The method appears to allow a consistent evaluation of the SSA at 490 nm (error < 1%) in spite of the error on the optical thickness and on the angström exponent (error on AOT around 24% and on angström exponent 100%).

The last assumption about aerosols that has been investigated concerns the vertical distribution of the aerosol layer. We have processed the signal for an aerosol top altitude of 4 and 6 km and the algorithm has retrieved the correct aerosol and cloud properties. In polarization, the bands used to retrieve the scattering AOT (i.e. 670 and 865 nm) are weakly impacted by the molecular contribution. Aerosols in the clouds do not contribute to the creation of polarized signal at side scattering angle. Hence the polarized radiances are not impacted by the aerosol vertical distribution as long as the aerosol layer is distinct from the cloud.

Regarding the cloud hypothesis, we test the impact of considering only one cloud droplet effective radius ($r_{\text{eff,cld}} = 10$ µm) for the estimation of the aerosol absorption and the ACCOT by modeling the signal for $r_{\text{eff,cld}} = 6$ and 20 µm with a COT = 10. The approximation regarding the effective radius of cloud droplet is the main source of error on the COT estimation. While the error on the COT due to aerosol hypothesis does not exceed 3%, this one may lead to a bias of ±10% for the COT, which is in agreement with the study of Rossow et al. [1989]. However, statistical analysis of the scenes studied hereafter have shown that more than 70% of the clouds have an effective radius ranging between 8 and 16 µm. Lastly, we have investigated the influence of the cloud top altitude by considering $z_{\text{top,cld}} = 2$ and 4 km. For each case, the algorithm has retrieved the correct parameters for clouds and aerosols.

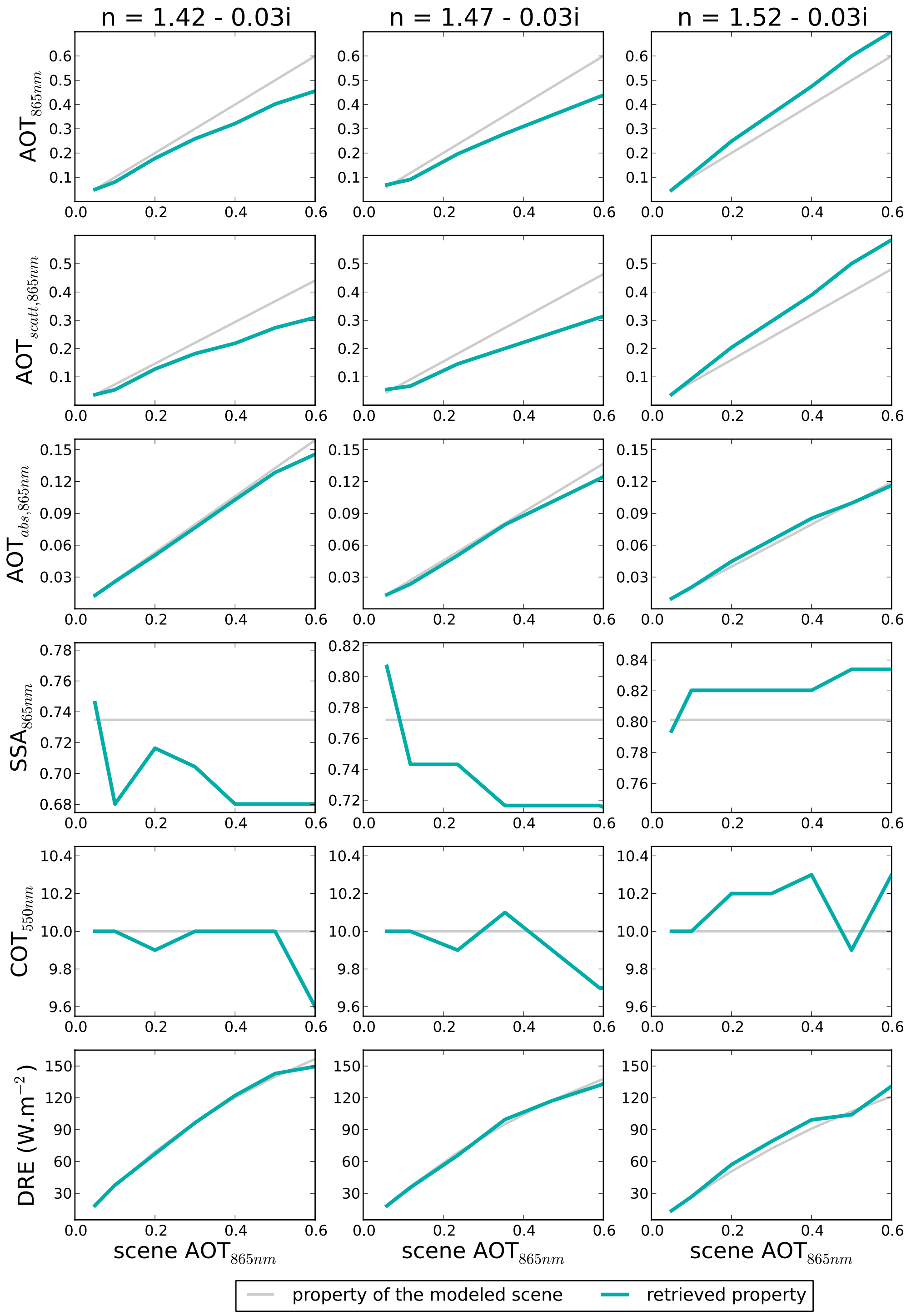

Figure 5. Sensitivity of the retrieved properties of an AAC scene with different aerosol models. From top to the bottom: total AOT, scattering AOT, absorption AOT and SSA at 865 nm, COT at 550 nm and the short wave DRE of aerosols. Grey lines correspond to the properties of the actual modeled scene and green lines to those retrieved by the algorithm. The aerosol model of the first column has a refractive index n equal to 1.42 – 0.03i, the second, n = 1.47 – 0.03i and the third, n = 1.52 − 0.03i. Aerosols have an effective radius of 0.1 µm and the effective radius of the cloud water droplets is 10 µm.

Page 25545, Line 7: What is the range of wavelengths considered as 'shortwave'?

The solar fluxes are integrated from 200 nm to 4 µm. This information has been registered in the manuscript page 25545 line 7:

Instantaneous shortwave radiative forcing (i.e. from 0.2 to 4 µm) has been precomputed for several solar zenith angles.

Page 25545, Line 9: It implies that author assumes 'grey aerosols' for the DRE calculation. For smoke particles, it means that the black carbon is assumed to be a sole component of carbonaceous aerosols.

The sentence page 25545 lines 8-10 has been modified to include this clarification:

Regarding fine mode aerosols, they are assumed to be only composed of black carbon. In other words, the imaginary part of the refractive index is constant in the shortwave (grey aerosols) and corresponds to the one retrieved by our algorithm.

Page 25545, Line 23: "..weakly impacted by the change in cloud top height"?

In the paper of Waquet et al. [2009], the cloud top heights retrieved by several methods (i.e. MODIS IR technique, [Menzel et al., 2006], POLDER Rayleigh [Goloub et al., 1994] and POLDER O2 [Vanbauce et al., 2003] techniques) are shown together with CALIOP observations for an aerosol above cloud scene. This comparison reveal that aerosols above clouds highly disrupt the retrieval of the cloud top height by the IR and the Rayleigh methods while the values retrieved with the O2 method remain close to the CALIOP observations (accuracy of ±350 m for the case study). The sentence page 25545 lines 21-23 has been rephrased:

The cloud top height is derived from the POLDER apparent O2 cloud top pressure [Vanbauce et al., 2003] since the O2 retrieval allows a reliable estimation of the cloud top height in the presence of an aerosol layer above [Waquet et al., 2009].

Goloub, P., J.-L. Deuzé, M. Herman, and Y. Fouquart (1994), Analysis of the POLDER polarization measurements performed over cloud covers, IEEE Trans. Geosci. Remote Sens., 32, 78–88.

Menzel, W. P., R. A. Frey, B. A. Baum, and H. Zhang (2006), Cloud Top Properties and Cloud Phase Algorithm Theoretical Basis Document, Version 7, 55 pp. [Available online at: http://modisatmos.gsfc.nasa.gov/ docs/MOD06CT:MYD06CTATBDC005.pdf, last access: August 2012].

Vanbauce, C., B. Cadet, and R. T. Marchand (2003), Comparison of POLDER apparent and corrected oxygen pressure to ARM/MMCR cloud boundary pressures, Geophys. Res. Lett., 30(5), 1212, doi:10.1029/ 2002GL016449.

Waquet, F., J. Riedi, L. C. Labonnote, P. Goloub, B. Cairns, J.-L. Deuzé, and D. Tanré (2009), Aerosol remote sensing over clouds using the A-Train observations, J. Atmos. Sci., 66, 2468–2480, doi:10.1175/2009JAS3026.1.

Page 25546, Line 1: Either rephrase or remove this sentence.

The sentence has been removed.

Page 25546, Line 13: It is winds that favor the transport of smoke over ocean and not stratocumulus cover.

The sentences page 25546 line 11-14 have been rephrased:

From June to October, biomass burning particles from man made vegetation fires are frequently observed above the persistent deck of stratocumulus covers off the South West African coast.

Page 25547, Line 2: Did author check the value of SSA (870 nm) retrieved by AERONET at Mongu-an inland station for the Aug 4, 2008 time frame?

On 4th August 2008, the SSA retrieved by AERONET at Mongu station is 0.716 at 870 nm, which is larger than the value observed for that case study (averaged value of 0.840 and minimum value of 0.73 near the coast). Also, the angström exponent at the inland site is found to be larger than the one observed with POLDER (2.19 for AERONET against 1.94 over the scene) that may be due to the increasing of the aerosol size during its transport. Sayer et al. [2014] have already notice larger value of the aerosol radius between Mongu and Ascension Island. This AERONET station is closer to our case study but no measurements are available in that time frame. Although, the study of Sayer et al. [2014] also notes that the SSA values retrieved at Ascension Island range from 0.73 and 0.83 at 870 nm, which supports POLDER's results. The reference to this paper has been added page 25547 line 3 as well as Johnson et al. [2008] line 4.

Johnson, B. T., Osborne, S. R., Haywood, J. M., & Harrison, M. A. J. (2008). Aircraft measurements of biomass burning aerosol over West Africa during DABEX. *Journal of Geophysical Research: Atmospheres (1984–2012)*,*113*(D23).

Sayer, A. M., Hsu, N. C., Eck, T. F., Smirnov, A., & Holben, B. N. (2014). AERONET-based models of smoke-dominated aerosol near source regions and transported over oceans, and implications for satellite retrievals of aerosol optical depth. *Atmospheric Chemistry and Physics*, *14*(20), 11493-11523.

Page 25547, 2nd paragraph: The absolute difference between two COTs does not tell the full story. A plot of % change in COT (ACCOT minus MODIS MYD06 COT) as a function of retrieved AOT would explain how the absorption is impacting the standard MODIS cloud product.

Figure 3 deals with the relative difference between POLDER ACCOT and the MODIS COT as a function of the absorption AOT. As expected, the bias increases with the absorption AOT. Also, we can see the large negative differences at low absorption values. For clouds with a small optical thickness (i.e. lower than 7), the scattering due to the aerosol layer may lead to a brighter scene. However, POLDER and MODIS are different by nature (different instruments and assumptions for the COT retrieval). For clean-sky, differences have been observed between the POLDER and the MODIS estimation of the COT [Zeng et al., 2012]. Even in case of very low aerosol content, we do not expect a perfect consistency between the two COT estimations. Consequently, Fig. 3 does not only translate the impact of aerosol absorption on the COT retrieval.

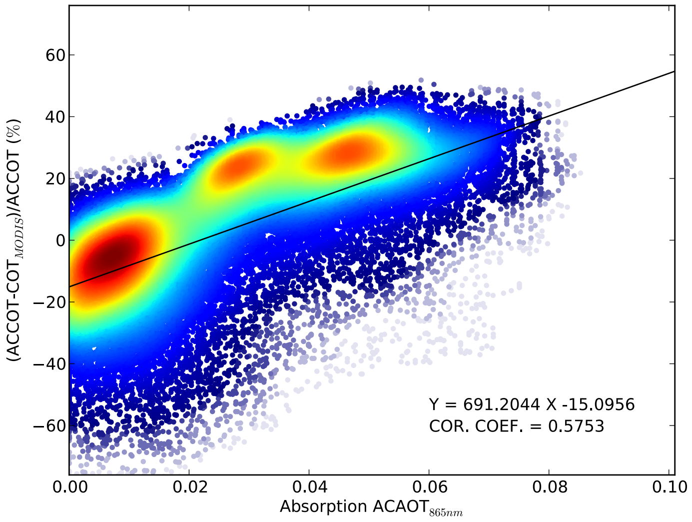

Figure 3. Relative difference between POLDER AACOT and MODIS COT as a function of the absorption AOT above clouds for biomass burning aerosol the 4th August 2008.

Zeng, S., C. Cornet, F. Parol, J. Riedi, and F. Thieuleux (2012). A better understanding of cloud optical thickness derived from the passive sensors MODIS/AQUA and POLDER/PARASOL in the A-T rain constellation, *Atmos. Chem. Phys.*, 12, 11245–11259, doi:10.5194/acp-12- 30 11245-2012.

Page 25548, Line 5: "..significant production of smoke particles".

Page 25548, Lin8: "On 3rd July, aerosols have been..."

These corrections have been made, thank you.

Page 25548, Line 15: Did author compare MODIS cloud-free ocean retrieval nearby above-cloud aerosols retrieved by POLDER. Since the smoke plume is lofted well above the surface, both retrievals should provide consistent range of AOT retrievals over ocean.

We have chosen to carry out the comparison with cloud-free AOTs retrieved with measurements with the same instrument. A new algorithm to retrieve aerosol properties (AOT, angström exponent, SSA …) in clear-sky scenes with POLDER is under development. The AOT retrieved with both methods has been compared for the Siberian biomass burning episode on 3rd July (Fig. 3) and for dust event on 4th August (Fig. 4). The continuity between the two retrievals shows a good consistency over ocean. The new POLDER approach over clear-sky will be the subject of an upcoming publication together with a comparison analysis with the above cloud results.

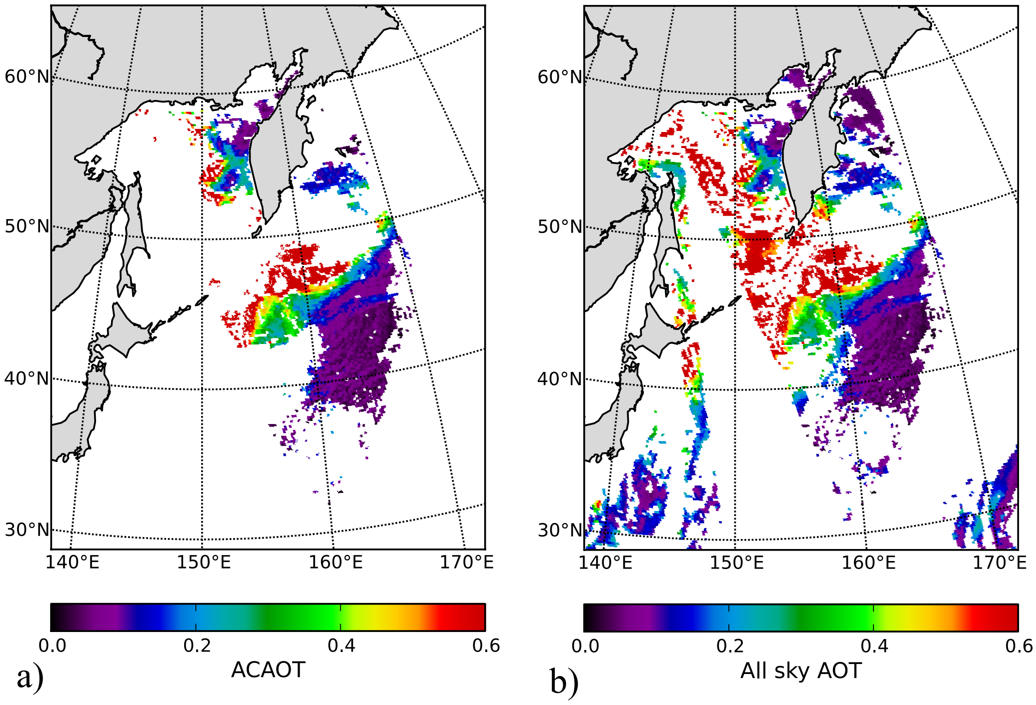

Figure 4. Above clouds (a) and all sky (b) AOT at 865 nm retrieved with POLDER for biomass burning aerosols from Siberia the 3 July 2008.

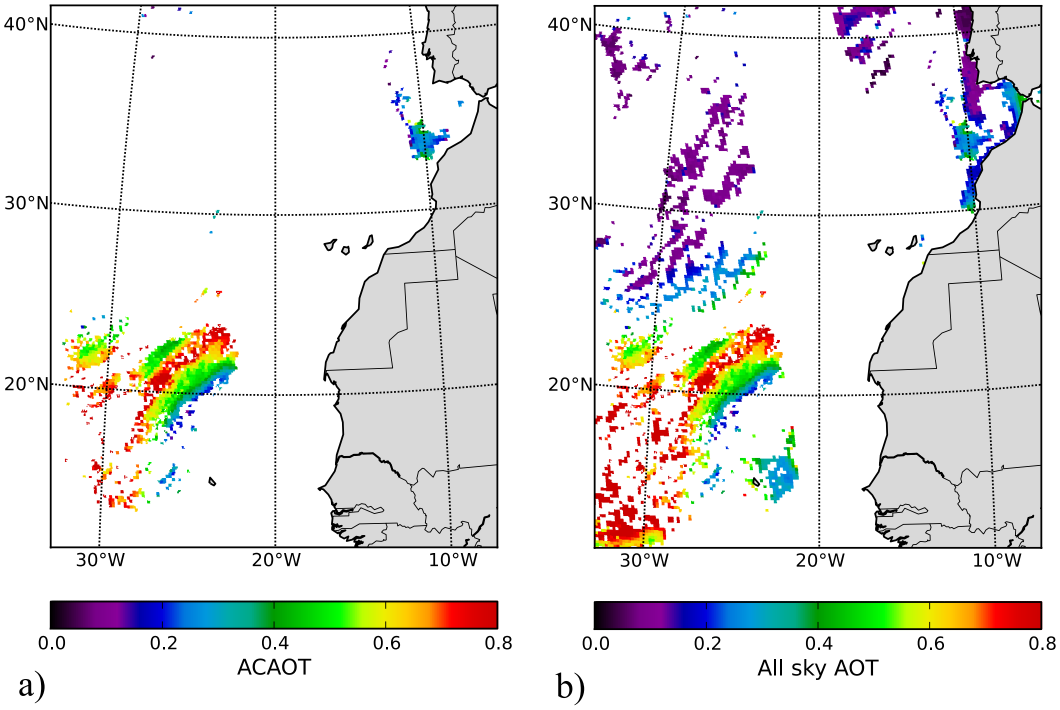

Figure 5. Same as Fig. 3 for the dust event the 4 August 2008.

Page 25550, Line 1: "in the visible (490 nm)"

The sentence has been corrected, thank you.

Page 25550, 1st paragraph: Again, author should check what MODIS retrieves over the clear ocean and what AERONET provides in terms of SSA at stations around the source region.

The SSA values obtained at the AERONET station at Tenerife are 0.936 and 0.969 at 490 (interpolated value) and 870 nm, respectively. These estimations are close to the POLDER ones in the southern part of the scene (i.e. 0.947 at 490 nm and 0.965 at 865 nm). However, comparisons between above cloud and clear-sky retrievals have to be considered carefully because of potential contamination of low-level aerosols.

Page 25551, Line 19-20: This is very much consistent with the results of de Graaf et al. (2012)

The reference has been added to the manuscript.

Page 25552, Line 14: What is the minimum value of COT considered in the estimation of DRE?

The minimum value considered for the COT is 3. This clarification is now mentioned in the manuscript.

Page 25555, section 6: A brief discussion on the uncertainty bounds of the AOT and SSA retrieval, and then after on DRE estimation, is missing in the conclusion section. This discussion should highlight the strength and limitation of the present approach.

The following paragraph has been added page 25555, line 20:

Nevertheless, the impact of the approximations and the assumptions of the method have been assessed. The largest incertitude about the SSA is due to the approximation about the weak sensitivity of polarized radiances to absorption. When the aerosol size distribution is dominated by the fine mode, an underestimation of −0.055 can be expected for extreme event of absorbing aerosols above clouds (i.e. $AOT_{865nm} = 0.6$ and $SSA_{865nm} = 0.77$). Otherwise, the bias on the SSA is below 0.03. It has to be pointed out that the underestimation of the SSA always goes together with an underestimation of the scattering AOT. As a consequence, the algorithm presented here provides a reliable estimation of the absorption AOT, which is among the most important parameters to evaluate the DRE of aerosols above clouds.

Page 25555, Line 20-21: Author needs to be little more cautious here. Before these retrievals are validated against independent direct measurements of AOT above cloud, one cannot arrive at a conclusion about the accuracy of the satellite product.

“Accurately” has been removed from this sentence.