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## ***Interactive comment on “Aerosol vertical distribution and optical properties over M’Bour (16.96° W; 14.39° N), Senegal from 2006 to 2008” by J.-F. Léon et al.***

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*Page 3, left column, lines 28-30: The authors take the altitude 6.5 - 7 km, considered above the main aerosol layer, as the range to calibrate the LIDAR signal. However even in the free troposphere aerosol can be detected at those altitudes, and this can represent a source of systematic error in the LIDAR retrieval. The authors should dwell more on this topic, and give an estimation of the systematic error they may expect.*

We retrieve the extinction profiles following the method proposed by Klett (1981). In this method the reference signal for the lidar differential equation is chosen in the far

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Discussion Paper



field thus leading to a reduced sensitivity of the inversion to the reference. We did not detect significant variation in the lidar signal above 6.5 km which may be due to a high altitude aerosol layer.

Liu et al. (2008a) report from CALIPSO lidar data that the average altitude of dust transport over the Atlantic ocean is 4 km. Also from CALIPSO data, it has been observed that dust can reach a max altitude of 6.6 km (Liu et al., 2008) and that the top dust altitude drops as the dust moves eastward over the Atlantic ocean. So we expect very few contamination at this range of altitude.

This discussion and the cited references has been added in the text of our paper.

*page 3 right column line 11: more properly, the afterpulse effect (a.k.a. Signal Induced Noise) occurs whenever the light sensor has been exposed to a high luminous signal, irrespective from where it comes so even from the atmospheric near range (there is no need to quote this, in the present context, but you may be interested in reading Cairo et al. :A survey of the signal-induced-noise in photomultiplier detection of wide dynamics luminous signals, Rev. Sci. Instrum. ,67, 3274-3280, 1996.)*

We thank the reviewer for providing this reference.

*page 3 right column line 13: Here the authors states that, even after preprocessing the data to account for sky background, Signal Induced Noise, partial overlap, still the signal is not usable below 225 m. Then they should comment whether and how this impacts on the computation of the lidar AOD, in view of the iterative comparison with the sunphotometer AOD they implemented to assess the extinction. A quantitative assessment of the lidar AOD underestimation should be provided.*

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Interactive  
Comment

This remark was also raised by the first reviewer. We now provide more information on the accuracy of the retrieval and on the possible biases due to the blind area and the overlap function. We have added in the text : *The main sources of uncertainties in the retrieval come from the unknown lidar ratio profile, the uncertainty in the reference signal  $S(R_0)$ , the error in the overlap function and the missing first 255 m. The effective lidar ratio used in the iterative procedure is found to be on average 20% lower than the Sun photometer derived one. The effective lidar ratio is affected by the choice of the reference signal (Chazette, 2002). The reference signal uncertainty depends on signal to noise ratio at the given altitude (which depends on the transmission below that altitude) and on the possible occurrence of residual aerosols or clouds. In the bottom layer, the uncertainty in the overlap function is the primary source of error. The overlap function is estimated using the procedure explained by Pelon et al., (2008). We performed horizontal observations for clear (low optical depth) conditions and the overlap function is derived using the slope method (Kunz and de Leeuw, 1993). The overlap function is complete (100%) at 2 km. The correction remains large (20% of overlap) up to 600 m and the error is about 10% above 600 m while it is up to 50% close to the ground. The missing first 225 m introduces a positive bias in the retrieved extinction profile that depends on the aerosol vertical distribution and is on average 10%.*

*page 3 left column lines 6-9: Here it is not clear whether the authors implement the iterative procedure to derive the extinction profile from the lidar signal ONLY when the estimation of the lidar ratio from sunphotometric measurements is not available (see page 2 left column lines 38-43), or ALWAYS. In this latter case, I assume the lidar ratio is the one parameter to adjust in order to match the lidar and sunphotometer AOD. Then it would be of extreme interest to compare the lidar ratio obtained with the two different approaches, and I would invite the authors to do so.*

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As mentioned in the text page 3, we retrieve the extinction profile when the Sun photometer gives a measurement of the AOT, whatever the Sun photometer gives also an estimate of the lidar ratio. There are much more AOT than lidar ratio observations (a factor of 4 or even more depending on the period of time). It is correct that the so-called "effective" lidar adjusted in the iterative procedure can be compared to the one derived from the Sun photometer. In average, the effective lidar ratio is 20% lower than the sun photometer lidar ratio (see your preceding remark). It is now mentioned in the text but we didn't put the corresponding data on Figure 7 (see your last remark).

*page 4 left column lines 8: Use "altitude" instead of "area".*

Done.

*page 4 left column lines 28: "doest"?*

We mean "does not". Now corrected.

*page 4 left column lines 32: How do you consider the first 220 metres where the LIDAR is blind(ed) and the contribution to the AOT can be relevant? Here uncertainties should be quantified.*

The scale height approximates the vertical distribution of AOT to an exponential decrease. The error in the scale height can be large if the aerosol is confined in the lower layer. Considering the aforementioned sources of error, we estimate the relative a uncertainty below 20%.

We have added in the text:

*Considering the aforementioned sources of uncertainty in the extinction coefficient*

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retrieval, the uncertainty in  $H_{aer}$  is expected to be less than 20%.

*page 5 left column lines 2: Can this be explained in terms of different transport regimes? The authors should comment more on this.*

At this stage, we cannot explain such variation in conjunction with different transport regimes. A further analysis of the air mass history with backward air mass trajectories modeling is under investigation. We can expect such a variation depending on both the size distribution at the emission and the sedimentation process occurring during the transport. The aging of particles as they are transported may also explain a change in the Angström exponent. We have added in the main text the following sentence:  
*A variation in the transport regime and physical processes occurring the transport (like sedimentation of coarser particles or particle aging (Müller et al., 2007)) might also explain a change in the size distribution and then in the Angström exponent.*

*page 6, right column line 14: (See my comment on page 3 left column lines 6-9) Would it be possible to display in fig. 7 the iteratively derived lidar ratio?*

Figure 3,4,5, 6 and 7 presents the parameters retrieved by the Sun photometer and we don't want to overload the figures with additional parameters. On average the effective lidar ratio used in the lidar retrieval is 20% lower than the one given by the Sun photometer (it is now given in the text).

*Figure 9 and 11 have axis titles too small.*

We have improved every plot quality.

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