Anonymous Referee #2

We thank this Reviewer for his careful reading of the manuscript and for his suggestions to help us improve the paper.

The answers are given in a direct response (bold, italic).

The authors describe a case study of Saharan dust observed over the Caribbean with a dual wavelength lidar. In their paper, the authors describe time series of LIDAR (CIMEL and POLIS) measurements to highlight a study case (10 July 2013) and vertical profiles of this study case. They also provide a closure study based on the comparison of LIDAR retrieved parameters and in-situ measurements. This manuscript is of interest for the scientific community but need major revisions before submission to ACP.

MAJOR COMMENTS :

The scientific objectives of the study are limited to "provide detailed BL characterization as part of the vertical aerosol structure over Barbados during SALTRACE" as it play a significant role in the synergy between ground based, airborne and column integrated measurements. Could you state clearly how your results will help to link all these measurements? Could you also state if and how those results may be applied to different measurement campaign?

We changed the text to provide more infromation.

This paper is referring to LIDAR (POLIS and CIMEL), in-situ and radio-soundings measurements. There is no description of the used instruments, which is mandatory. Also every all the algorithms to correct the data, if existing, must be described in one specific section.

We included this information in the 'Instrumentation and Method' section.

Figure 4 : From the dust mass concentration shown in this figure, one can see that the variability is not important from day to day. The dust mass concentration is on average 40ug/cm3. Two outliers can be distinguished at 70and 100ug/cm3. That would have been really interesting to show the lidar profile for these two cases when dust are obviously mixed with sea salt.

We decided to not show another case study as we already showed a case with large dust contribution in the boundary layer. We included now the values from the case study in Figure 4 (now Figure 5).

Looking closely to the values for the study case (10/07/2013) the values are always below 40ug/cm3 and increasing throughout the day. Now from the profiles shown in Figure 2 the average mass concentration of dust within the CMBL is about 110ug/cm-3. This strong difference makes questionable the quality of the data used in Figure 2 or in Figure 4.

The reviewer is right that the value shown in Figure 2 is missing in Figure 4 (now Figure 5) as we used only synchronized lidar and radiosonde measurements for consistency of the analysis shown in Figure 3 and (now) Figure 5.

MINOR COMMENTS :

Could you provide a map to show the location where SALTRACE took place ?

Instead of showing a map of the SALTRACE location we referenced the SALTRACE overview paper in BAMS providing all necessary information about the SALTRACE campaign.

Although, Denjean et al 2015 found (based on model results) that optical properties of one dust plume particles were not modified during their transport over Atlantic, many studies have shown differences in the dust size distributions, in the dust morphology, and also on the dust optical properties including dust polarization (Bréon et al. 2013). Why you are stating that here ? Is it related to your choice of a mean depolarization ratio of 0.30 ? If yes then you should lead the reader into it cause I don't see the point here. Also, Burton et al. (2015), using HSRL measurements, highlight a dust particulate depolarization ratio of 0.32 over the Caribbean islands. You should spend more energy on why you choose 0.30.

We refered to the work of Denjean et al 2015 to justify that we do not consider changes in the particle depolarization ratio due to the high relative humidity. We thus took a mean value for the linear particle depolarization ratio of dust of 0.3 found during former studies (e.g.Freudenthaler et al., 2009; Liu et al., 2008, Groß et al., 2011) which is in good agreement with the values we found during the same campaign within the Saharan air layer over Barbados from our measurements (Groß et al., 2015). We tried to this more clear in the text.

P3, L8 Remains not remains

We changed that.

Dust volume and mass conversion: You use a conversion factor of 0.65.10-6 m. According to previous studies large aerosols do not reach the Caribbean coast (Maring et al. 2003). So this factor should not remain the same over the dust source and after few days of transport. Could you precise if the Gasteiger study was referring to fresh or aged dust ? Moreover it appears difficult to compare a factor obtained from measurements over the source (SAMUM) to a factor obtained after transport (SALTRACE). How did you calculate this factor ? It seems that you use the aerosol volume from AERONET measurements (integrated over the column) and an extinction coefficient from the LIDAR (at which altitude ?). What are the errors associated with this coefficient (AERONET volume errors + Lidar ratio errors + density errors)? Did you perform a closure with the AOD from AERONET and the AOD from your LIDAR data ?

From the measurements of size distribution we do not confirm that no large particles reach the Caribbean coast (see Weinzierl et al., 2016, van der Does et al., 2016). Analyses of the conversion factors from sunphotometer measurements confirm that the value does not change significantly during transport and that the conversion factor derived with the method described in Gasteiger et al. is still valid for long-range transported Saharan dust although the reference ensemble of Gasteiger et al. is referring to dust near the source region (measurements performed in Morocco). The conversion factor derived with the method described by Gasteiger et al. is the ratio of volume to extinction. The value from sunphotometer is also derived by first calculating the volume, the extinction, and the ratio of both using the aerosol mixture retrieved by the AERONET inversion algorithm for the calculation. We provide now an improved description of the method. For detailed information about the methods we included the references to the corresponding publications.

This factor is depending on the altitude, right ? Bigger SS at the surface, dust mixed with SS and pure dust over those layers.

We believe that in the convective marine boundary layer, which is characterized by mixing processes, we do not have to take any height dependency of the particle properties or conversion factors into account, especially not in the height ranges we are able to observe with our lidar system. Maybe this is different in the lowermost meters above ground, but we miss these height ranges with our observations.

You choose to use a density of 2.5g/cm3 assuming that dust are mixed with sulphate. Earlier you state that dust chemistry was not changing during the transport. If there is any sulphate on a dust particle, even a little bit, then the dust becomes hygroscopic (Roberts et al., 2001) and the optical properties are not the same than pure dust. You need to clarify this point

Measurements of the chemical properties of dust near the source region (Kaaden et al., 2009) and over Barbados (Kandler et al., in preparation) show that there is always a portion of sulfate externally mixed (Weinzierl et al., 2009) in the Saharan air layer. Thus, the statement that we do not see changes in the chemistry also includes that we do not see changes in this external mixture and that the dust particles are not coated with the sulfate at the end of the long-range transport across the Atlantic Ocean.

You need to show the data that provide you enough information to chose 0.65 .10-6 m for dust and 0.66 .10-6 m for sea salt particles.

We decided to not show all the measurements of the measurement period from 2007 to 2015. These measurements are freely available on the AERONET webpage and can be reviewed there.

Could you provide the extinction profile retrieved for the 10 July 2013 study case ?

We included the extinction coefficient profile in the case study.

P6 L4 You say that dust particles contribute to 100% of the total aerosol volume so why is there no pure dust in Table 2 ?

Table 2 only includes measurements within the CMBL while the dust contribution of 100% refers to height ranges above 1.6 km in the shown case study.

From what I understand, you used the wind speed to say that SS can be generated at the surface, the wind directions to say that wind are mainly coming from East / North- East, and the relative humidity is always larger than 60% and in average 80%. Does that need to be plotted ?

This information is already shown in Figure 3.

What can we learn based on your CMBL height retrievals ? You say that some cases are not well retrieved by the LIDAR and you say why. Is there a solution to avoid those mistakes with this kind of LIDAR ?

We do not think that you can avoid these mistakes. However what we show and also state in the text is that if the gradient is so small that it would lead to this kind of mistake, then the intense optical properties do not change significantly between the lower layer and the layer above.

Figure 5 : Could you change the scale of the Lidar ratio plot ? The values are between 15-35 and your scale is between 0-100. What are the green and blue dots represent?

We changed the scale for the lidar ratio to values from 0 to 50 sr. We clearly indicate the meaning of the different symbols in the figure caption.

Section 3.6 : What kind of in-situ measurement did you use ?

The description of the in-situ measurements is now added in Section 2.

- The correction you apply to these unknown in situ data is based on OPAC desert mixture and assuming 10um particles reach the barbadoes. What is this correction about? You cannot use a correction factor that please you without explaining the reader what you exactly did. - You are only looking to data that 'match in time'. What does that mean ? Is it a window of an hour, 10 minutes? - This closure doesn't conveniently take into account the larger values of dust concentration. In the figure caption remove the second 'dust'

For the derivation of this correction factor we use the OPAC desert mixture and calculate the aerosol volume of this mixture for upper cut-off radii of 5 and 10 micrometer. We calculate the ratio between both volumes, assuming that a cut-off radius of 10 micrometer is valid for dust reaching Barbados and a cut-off radius of 5 micrometer is valid for the instrument. This factor is about 1.25 and is applied to the PM10 measurements to calculate the ambient dust volume. However, as the uncertainty about the size distribution of dust after long-range transport is large, we consider an uncertainty of +-0.25 which also covers the case that no aerosol with r > 5 micrometer reaches Barbados.

The summary is not giving any conclusions or any clue to better improve the relation between ground base and remote sensing measurements. You should be careful in the summary and say that you were able with this case to link ground based measurements to remote sensing measurement but that for other cases it might not be as easy to achieve. You also need to tell the reader why you were able to do it (mixing condition with the BL, Just two type of particles etc.

We reworked the Summary.