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Reply on RC1

Patrick Chazette et al.

Author comment on "Mesoscale spatio-temporal variability of airborne lidar-derived aerosol properties in the Barbados region during EUREC⁴A" by Patrick Chazette et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2021-706-AC2>, 2021

The authors would like to thank the reviewers for their valuable comments which helped improving the quality of the manuscript. Our point-by-point responses to the reviewer's comments appear in bold below. The text modified in the revised version of the MS and included in the response appears in quotes.

Reviewer 1

The results are in good agreement with many other studies performed within former field activities (SAMUM, SALTRACE), However, these previous activities are not mentioned. This should be improved. A paper is much more exciting when a more complex overview of forgoing work is given and how the presented work fits into the big picture and what are the new findings compared to the older ones.

We agree this material is missing. We have included in the revised version of the MS most of the references suggested by the referee, and more, in connection with SAMUM-2, SALTRACE and NARVAL.

Minor revisions are required and may further improve the paper.

Detailed comments and suggestions:

Abstract: The abstract should summarize observations and solid results!

Lines 21 to 25: Are these statements based on observations? or is this just your conclusions (opinion) from your observations? I mean, I do not find the respective figures in which the strong spatial heterogeneity in the aerosol fields is clearly documented. Maybe, I overlooked it! I also do not find any (correlation) study in which the impact of relative humidity on the aerosol properties is presented.

As the role of humidity is one hypothesis among others, we do not include it in the abstract. It is indeed too speculative. On the other hand, it is clear from the figures that the horizontal aerosol field represented by their optical properties is heterogeneous in the presence of aerosol plumes. In the background situation, this is indeed less true.

Page 2, line 19: Please have a look into the SALTRACE overview article of Weinzierl et al., BAMS, 2017 (<https://doi.org/10.1175/BAMS-D-15-00142.1>), and check the many

references regarding SAMUM 2 and SALTRACE, especially Haarig et al. (2017, ACP), Rittmeister et al. (2017, ACP), Tesche et al. (2011, Tellus) and (2009, JGR). There many more papers on smoke transport over the tropical Atlantic, in addition to the papers of Ansmann et al. and Baars et al. you mentioned already.

We have re-written the beginning of the introduction to take the suggested studies into account. To comply with similar comments made by Referee #2, we have included a discussion on the seasonal transport (and the difference between wintertime and summertime dust and BB transport). The part of the text related to the transport of smoke and the importance of dust-BB mixtures in the atmosphere composition is now introduced earlier in the Introduction, i.e. After the 1st sentence.

"Long-range transport of SD and BBA aerosols from West Africa across the equatorial North Atlantic occurs all year long, but exhibits a marked seasonal cycle. For instance, summertime and wintertime SD aerosol transport characteristics have been shown to differ significantly, with SD being transported at higher latitude and coarser particles being advected further west during the summer (van der Does et al., 2017) in the African Easterly jet-driven Saharan air layer (e.g. Prospero and Carlson, 1972). In contrast, during wintertime, SD is transported at lower altitudes (below 3 km amsl) and further south (owing to the equatorward migration of the intertropical Convergence Zone) towards northeast South America (e.g. Swap et al., 1992; Ansmann et al., 2009; Baars et al., 2011) and the Caribbean (Haarig et al., 2016). SD in the Caribbean is generally observed to be mixed with BB aerosols from West Africa and South America, with BB-SD mixtures generally being carried above dust layers in the winter (Tesche et al., 2009, 2011; Weinzierl et al., 2017; Haarig et al., 2017)."

Page 3, line 3: After this paragraph we need a paragraph on all the SAMUM 2 and SALTRACE observations (maybe with focus on lidar only) of complex dust and smoke mixtures over the tropical Atlantic (from Africa to the Caribbean). Please have a look into the special issue of SAMUM 2 (in Tellus, 2011) and especially into the SALTRACE overview paper of Weinzierl et al. (2017). The results of the SALTRACE campaign plus the ship cruise (Rittmeister et al., 2017) must be considered later on in the discussion as well.

Agreed. We have significantly enhanced this part of the Introduction to include all relevant past field campaigns and references. This part of the Introduction now writes:

"These measurements were very soon followed by numerous lidar observations across the North Atlantic acquired as part of dedicated campaigns such as SAMUM-2 (Saharan Mineral Dust Experiment, Ansmann et al., 2011), SALTRACE (Saharan Aerosol Long-Range Transport and Aerosol-Cloud-Interaction Experiment, Weinzierl et al., 2017) and NARVAL (Next-generation Aircraft Remote-Sensing for Validation Studies, Stevens et al., 2019). Such observations were made from ground-based lidar measurements in the Cape Verde region (Ansmann et al., 2009, 2011), in Barbados (Groß et al., 2015; Haarig et al., 2017) and over Amazonia (e.g. Ansmann et al., 2009; Baars et al., 2011), from ship-borne lidar measurements (Rittmeister et al., 2017) and from nadir-pointing airborne lidar measurements (Chazette et al., 2001; Tanré et al., 2003; Weinzierl et al., 2011, 2017; Gutleben et al., 2019)."

Page 5, line 5: Please provide some information about the regression function V_0 . What do you exactly mean with this regression function?

This term is not appropriate, we have replaced by "linear fitting".

Page 5, lines 20-24: Tesche et al. (2009, 2011) already studied complex mixtures of dust and smoke during the high winter months (January-February), but over Cabo Verde in 2008. Haarig et al. used the Caribbean SALTRACE winter campaign in February-March 2014 to study again dust-smoke mixtures coming from Africa.

These references are now included in the Introduction. The immediate link with the MS text cited here is not clear to us, as on page 5 lines 20-24 we only introduce the type of aerosols composition context in which the ATR42 aircraft flew during EUREC⁴A. They are also added later on in Section 4.3 when the CALIOP-derived aerosol identification is discussed.

A new, at least not well studied aspect you may want to stress in more detail is the following: Usually it is assumed that dust is transported towards South America in January- February, south of the Caribbean, and the tropical Atlantic towards North America is dust free, but you show that this is not (or no longer) the case. Big plumes of dust and smoke (because of the dry season or burning season in central western Africa) are transported even towards North America during wintertime.

Indeed, we find a more northerly transport than usually reported in the scientific literature. We have emphasized this point in the abstract, in section 5 and in the conclusion.

In the figures captions (or maybe in the plots), one should provide dates and also the times of observations (periods in UTC).

The missing date and time of the flights have been added in the figure captions.

'Terrigenous' is a bit unspecific, you mean: dust? Or even smoke from continents? You want to say, non-marine aerosol?

Agree, terrigenous has been replaced by dust.

I appreciate the exhausting analysis, including all the MODIS, CALIOP, and CAMS products!

Thank you.

Page 26: In the discussion section 5, one should integrate the SAMUM and SALTRACE findings, what was similar, what are the news points of your study (additional and complementary aspects). Such a discussion will improve significantly the visibility of this paper later on.

This is now done. In particular, we are now comparing our findings related to aerosol optical properties to those of Haarig et al. (2017, 2019) in Section 3 also. It is worth noting that there are very few studies of the aerosol optical properties in Barbados in wintertime. Hence, we agree that is important to mention them.

All in all, a good study based on high quality observations, analysed by experienced scientists!

Thanks again for your constructive comments.

References added in the text:

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