This paper describes the combination of satellite borne lidar data from two instruments in combination with model wind field data and back and forward trajectory analyses to investigate the advection of a major dust storm across the Atlantic Ocean. The paper focus on a case study of a major dust storm to assess how the combined CALIPSO and Aeolus satellite products can be combined with ECMWF driven trajectories to describe dust transport and loss. The paper was previously submitted to ACPD and this version has been considerably improved.

I do, however, have a major reservation about section 4.2 and the accompanying statements in the abstract and summary sections. Section 4.2 presents lidar curtains at three locations across the sub-tropical north Atlantic on a day in the middle of the dust storm. The three curtains are close to the source region, over the mid-Atlantic and towards the west, in the far-field of the plume. However, the satellite overpasses presented are taken only 3 hours apart. The advection times between the most easterly lidar curtain and the most westerly are of the order of a week or more. The data in section 4.2 show the overall geographical distribution of dust across the Atlantic as a snapshot on the morning of 19/6/2020. What they do not do is say anything at all about the dynamics of the dust plume as it advects across the Atlantic region. The source region may have changed or emissions of dust varied and the transport pathways may be affected by changing atmospheric conditions over the course of the event. However, section 4.2 assumes the dust plume is time invariant and describes the scene as representing different ages of the plume. This is misleading and in any case is described much better in section 4.3. Either section 4.2 should be rewritten to illustrate geographical variability at a single point in time or removed. Furthermore, the way the results from this section are presented in the abstract and summary should be reframed or removed as they are written as though the data were taken in a pseudo lagrangian way and they were not.

AR: Thanks for the suggestion. Actually, we also think **the dust layers captured by Aeolus and CALIPSO during several hours on 19 June 2020 (cross-section 1, 2**

and 3 in Fig 6 (b), (c)) are relatively static compared with the whole dust plume transport process. Sorry for the misleading. According to your suggestion, **we rewrote the part of Section 4.2 and reframed the relevant conclusion in the abstract and the summary.** **Section 4.2 of the revised manuscript has been renamed as "Observation snapshot of the dust plume and dust advection calculation on 19 June 2020".** The description was reframed to **illustrate the overall geographical distribution of dust layers as a snapshot on the morning of this day**. The revised part of Section 4.2 is shown as below:

"**4.2 Observation snapshot of the dust plume and dust advection calculation on 19 June 2020**

In this section, the dust event observation snapshot captured by ALADIN and CALIOP on 19 June 2020 is introduced in detail. The quasi-synchronized observations from ALADIN and CALIOP on 19 June 2020 are presented in Fig. 6, where the purple lines indicate the scanning tracks of ALADIN and the green lines indicate the scanning tracks of CALIOP. It is found that the overpasses of each satellite are only around 3 hours apart. Hence, we captured the dust layers on the morning of 19 June 2020 quasi-simultaneously over the Western Sahara, the Middle Atlantic and the Western Atlantic, i.e., took a snapshot of the dust plumes. From the profiling of dust optical properties, discriminated by the CALIOP measurements, the dust geographical distribution over Atlantic Ocean on this day could be determined. The extinction coefficients and backscatter coefficients at the wavelengths of 355 nm, 532 nm and 1064 nm within the dust mass are also determined. From the profiling, it was found that the mean backscatter coefficients at 532 nm were about $3.88\times10^{-6} \pm 2.59\times10^{-6}\ \mathrm{m^{-1}sr^{-1}}$ in "cross-section 1", $7.09\times10^{-6} \pm 3.34\times10^{-6}\ \mathrm{m^{-1}sr^{-1}}$ in "cross-section 2" and $7.76\times10^{-6} \pm 3.74\times10^{-6}\ \mathrm{m^{-1}sr^{-1}}$ in "cross-section 3". On 19 June 2020, the dust layers existed over the Western Sahara, the Middle Atlantic and the Western Atlantic quasi-simultaneously, which indicates that the dust plume area over the Atlantic on the morning of this day is quite enormous and this dust transport event is massive and extensive.

……

In Fig. 7, the dust advection at different heights of the three cross-sections are presented. From the profiling, the mean dust advection value is about $1.91 \pm 1.21\ \mathrm{mg \cdot m^{-2} \cdot s^{-1}}$ in "cross-section 1" (over the emission region), $1.38 \pm 1.28\ \mathrm{mg \cdot m^{-2} \cdot s^{-1}}$ in "cross-section 2" (over the transport region) and $0.75 \pm 0.68\ \mathrm{mg \cdot m^{-2} \cdot s^{-1}}$ in "cross-section 3" (over the deposition region), respectively. In conclusion, on 19 June 2020, the dust layers over the Western Sahara, the Middle Atlantic and the Western Atlantic are observed by ALADIN and CALIOP nearly in the meanwhile. And the dust advections of the three cross-sections indicate the quasi-simultaneous transport of the dust plumes over the emission region, the transport region and the deposition region on the same day."

The revised parts of the abstract and the summary are shown as below:

"…From the measurement results on 19 June 2020, the dust plumes are captured quasi-simultaneously over the emission region (Western Sahara), the transport region (Middle Atlantic) and the deposition region (Western Atlantic) individually, which indicates that the dust plume area over the Atlantic on the morning of this day is quite enormous and this dust transport event is massive and extensive. The quasi-synchronization observation results of 15, 16, 19, 24 and 27 June by ALADIN and CALIOP during the entire transport process show good agreement with the "Dust Score Index" data and the HYSPLIT trajectories, which indicates that the transport process of the same dust event is tracked by ALADIN and CALIOP, verifies that the dust transport spent around 2 weeks from the emission to the deposition and achieved the respective observations of this dust event's emission phase, development phase, transport phase, descent phase and deposition phase. Finally, the advection value for different dust parts and heights on 19 June and on the entire transport routine during transportation are computed. On 19 June, the mean dust advection values are about $1.91\pm1.21\ \mathrm{mg}\cdot\mathrm{m}^{-2}\cdot\mathrm{s}^{-1}$ over the emission region, $1.38\pm1.28\ \mathrm{mg}\cdot\mathrm{m}^{-2}\cdot\mathrm{s}^{-1}$ over the transport region and $0.75\pm0.68\ \mathrm{mg}\cdot\mathrm{m}^{-2}\cdot\mathrm{s}^{-1}$ over the deposition region." (from the abstract)

"…From the measurement results on 19 June 2020, the dust plumes are captured quasi-simultaneously over the emission region (Western Sahara), the transport region (Middle Atlantic) and the deposition region (Western Atlantic) individually, which indicates that the dust plume area over the Atlantic on the morning of this day is quite enormous and this dust transport event is massive and extensive. The quasi-synchronization observation results of 15, 16, 19, 24 and 27 June by ALADIN and CALIOP during the entire transport process show good agreement with the "Dust Score Index" data and the HYSPLIT trajectories, which indicates that the transport process of the same dust event is tracked by ALADIN and CALIOP, verifies that the dust transport spent around 2 weeks from the emission to the deposition and achieved the respective observations of this dust event's emission phase, development phase, transport phase, descent phase and deposition phase.

Finally, the advection at different dust parts and heights on 19 June and on the entire transport routine during transportation are computed, respectively. On 19 June, the mean dust advection values are about $1.91\pm1.21\ \mathrm{mg}\cdot\mathrm{m}^{-2}\cdot\mathrm{s}^{-1}$ over the emission region, $1.38\pm1.28\ \mathrm{mg}\cdot\mathrm{m}^{-2}\cdot\mathrm{s}^{-1}$ over the transport region and $0.75\pm0.68\ \mathrm{mg}\cdot\mathrm{m}^{-2}\cdot\mathrm{s}^{-1}$ over the deposition region, from which we can infer the quasi-simultaneous transport of the dust plumes over the emission region, the transport region and the deposition region on this day…" (from the summary)

Specific recommendations

Lines 62-63: “Additionally, the CALIOP product Vertical Feature Mask product (VFM)” better to write

“Additionally, the CALIOP Vertical Feature Mask product (VFM)”

AR: Thanks, it is revised.

Line 74 “(e)motion”

AR: Thanks, it is revised.

Line 170-174 “Based on the dataset consists of the backscatter coefficients and extinction coefficients at the wavelengths of 1064 nm and 532 nm from CALIOP and the extinction coefficients at the wavelength of 355 nm from ALADIN, the aerosol volume concentration distribution can be calculated based on the regularization method which was performed by generalized cross-validation (GCV) from Müller et al. (1999).” A confusing sentence that needs to be rewritten

AR: This sentence has been rewritten as “Based on the dataset consisting of the backscatter coefficients and extinction coefficients at the wavelengths of 1064 nm and 532 nm from CALIOP and the extinction coefficients at the wavelength of 355 nm from ALADIN, the aerosol volume concentration distribution can be estimated based on the regularization method which was performed by generalized cross-validation (GCV) from Müller et al. (1999).”

lines 240-241: Figure 4a shows the majority of the dust has been lifted to a maximum of around 7km or less south of 20N on 18/6/2020, there is only a small proportion of the dust at the far north end of the overpass that has a maximum close to 10 km. This probably needs rephrasing.

AR: Thanks for the suggestion. We updated Fig. 4 with the VFM products on 16 June 2020 and 27 June 2020, to make them matched with part of the satellite cross-sections presented in Section 4.3. The modified Fig. 4 and the relevant description are shown as below:

"Figure 4 presents the vertical distribution of the dust plume during the development phase (16 June 2020) over the eastern Atlantic and during the deposition phase (27 June 2020) over the western Atlantic. From Fig. 4 (a), it can be seen that the dust plume has been lifted up to around 7 km. Figure 4 (b) presents the descending dust plume, the bottom of which may mix with marine aerosol and become dusty marine aerosol. Therefore, the VFM data of CALIPSO captures the dust plume vertically over the eastern and the western Atlantic and verifies the dust transportation process.

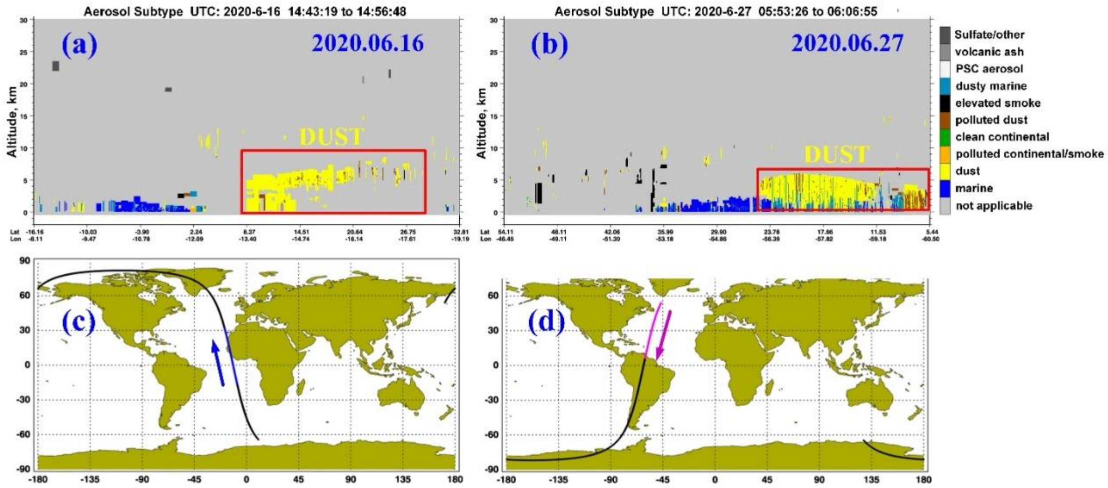

Figure 4. Vertical feature mask from CALIPSO L2 product (a) on 16 June 2020 over the west coast of Africa and the eastern Atlantic and (b) on 27 June 2020 over the western Atlantic (around the east coast of America). (c) and (d) show the corresponding CALIOP scanning tracks of (a) and (b) respectively, the arrows in which indicate the motion direction of CALIPSO (https://www-calipso.larc.nasa.gov/products/lidar/browse_images/production/, last access: 24 March 2022)."

Lines 276-282: The narrative in the section assumes a pseudo-langragian language but the lidar passes are on the same day so these are different slices of a dust event that has lasted several days (fig 3) and has a transit time of multiple days between the overpasses shown in fig 5. The wording here needs to better reflect that these are cross sections at different geophysical locations in the plume and do not directly represent plume evolution. This discussion is extended to report values of backscatter and advection for different phases of the dust plume. However, these don't reflect actual advection of the same air. The underlying assumption is the dust plume does not change with time. Clearly, this is not the case, so the determinations from the 3 different overpasses cant really be compared in the way that is done in the analysis in 4.2. At best this gives a snapshot of the plume at a single point in time across much of the Atlantic. This section needs to be rewritten in my view to make this clear and to convey why this is appropriate, otherwise it is best removed. This same approach is also followed up in the summary (402-406). The analysis is not pseudo-lagrangian and should not be inferred as such, the different phases of the storm were emitted many days apart and may have had very different conditions at source and during advection. This needs to be made explicit. The abstract also has the same errors between lines 22-25. This needs to be removed or corrected.

AR: Thanks for the suggestion. **We reframed and rewrote part of Section 4.2 and the relevant conclusion in the abstract and the summary to illustrate the overall geographical distribution of dust layers as a snapshot on the morning of this day.**

The revised part of Section 4.2 is shown as below:

"**4.2 Observation snapshot of the dust plume and dust advection calculation on 19 June 2020**

In this section, the dust event observation snapshot captured by ALADIN and CALIOP on 19 June 2020 is introduced in detail. The quasi-synchronized observations from ALADIN and CALIOP on 19 June 2020 are presented in Fig. 6, where the purple lines indicate the scanning tracks of ALADIN and the green lines indicate the scanning tracks of CALIOP. It is found that the overpasses of each satellite are only around 3 hours apart. Hence, we captured the dust layers on the morning of 19 June 2020 quasi-simultaneously over the Western Sahara, the Middle Atlantic and the Western Atlantic, i.e., took a snapshot of the dust plumes. From the profiling of dust optical properties, discriminated by the CALIOP measurements, the dust geographical distribution over Atlantic Ocean on this day could be determined. The extinction coefficients and backscatter coefficients at the wavelengths of 355 nm, 532 nm and 1064 nm within the dust mass are also determined. From the profiling, it was found that the mean backscatter coefficients at 532 nm were about $3.88\times10^{-6}\pm2.59\times10^{-6}\ \mathrm{m^{-1}sr^{-1}}$ in "cross-section 1", $7.09\times10^{-6}\pm3.34\times10^{-6}\ \mathrm{m^{-1}sr^{-1}}$ in "cross-section 2" and $7.76\times10^{-6}\pm3.74\times10^{-6}\ \mathrm{m^{-1}sr^{-1}}$ in "cross-section 3". On 19 June 2020, the dust layers existed over the Western Sahara, the Middle Atlantic and the Western Atlantic quasi-simultaneously, which indicates that the dust plume area over the Atlantic on the morning of this day is quite enormous and this dust transport event is massive and extensive.

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In Fig. 7, the dust advection at different heights of the three cross-sections are presented. From the profiling, the mean dust advection value is about $1.91\pm1.21\ \mathrm{mg\cdot m^{-2}\cdot s^{-1}}$ in "cross-section 1" (over the emission region), $1.38\pm1.28\ \mathrm{mg\cdot m^{-2}\cdot s^{-1}}$ in "cross-section 2" (over the transport region) and $0.75\pm0.68\ \mathrm{mg\cdot m^{-2}\cdot s^{-1}}$ in "cross-section 3" (over the deposition region), respectively. In conclusion, on 19 June 2020, the dust layers over the Western Sahara, the Middle Atlantic and the Western Atlantic are observed by ALADIN and CALIOP nearly in the meanwhile. And the dust advections of the three cross-sections indicate the quasi-simultaneous transport of the dust plumes over the emission region, the transport region and the deposition region on the same day."

The revised parts of the abstract and the summary are shown as below:

"…From the measurement results on 19 June 2020, the dust plumes are captured quasi-simultaneously over the emission region (Western Sahara), the transport region (Middle Atlantic) and the deposition region (Western Atlantic) individually, which indicates that the dust plume area over the Atlantic on the morning of this day is quite enormous and this dust transport event is massive and extensive. The quasi-synchronization observation results of 15, 16, 19, 24 and 27 June by ALADIN and CALIOP during the entire transport process show good agreement with the "Dust Score Index" data and the HYSPLIT trajectories, which indicates that the transport process of the same dust event is tracked by ALADIN and CALIOP, verifies that the dust transport spent around 2 weeks from the emission to the deposition and achieved the respective observations of this dust event's emission phase, development phase, transport phase, descent phase and deposition phase. Finally, the advection value for different dust parts and heights on 19 June and on the entire transport routine during transportation are computed. On 19 June, the mean dust advection values are about $1.91 \pm 1.21\ \mathrm{mg \cdot m^{-2} \cdot s^{-1}}$ over the emission region, $1.38 \pm 1.28\ \mathrm{mg \cdot m^{-2} \cdot s^{-1}}$ over the transport region and $0.75 \pm 0.68\ \mathrm{mg \cdot m^{-2} \cdot s^{-1}}$ over the deposition region." (from the abstract)

"…From the measurement results on 19 June 2020, the dust plumes are captured quasi-simultaneously over the emission region (Western Sahara), the transport region (Middle Atlantic) and the deposition region (Western Atlantic) individually, which indicates that the dust plume area over the Atlantic on the morning of this day is quite enormous and this dust transport event is massive and extensive. The quasi-synchronization observation results of 15, 16, 19, 24 and 27 June by ALADIN and CALIOP during the entire transport process show good agreement with the "Dust Score Index" data and the HYSPLIT trajectories, which indicates that the transport process of

the same dust event is tracked by ALADIN and CALIOP, verifies that the dust transport spent around 2 weeks from the emission to the deposition and achieved the respective observations of this dust event's emission phase, development phase, transport phase, descent phase and deposition phase.

Finally, the advection at different dust parts and heights on 19 June and on the entire transport routine during transportation are computed, respectively. On 19 June, the mean dust advection values are about $1.91 \pm 1.21\ \mathrm{mg \cdot m^{-2} \cdot s^{-1}}$ over the emission region, $1.38 \pm 1.28\ \mathrm{mg \cdot m^{-2} \cdot s^{-1}}$ over the transport region and $0.75 \pm 0.68\ \mathrm{mg \cdot m^{-2} \cdot s^{-1}}$ over the deposition region, from which we can infer the quasi-simultaneous transport of the dust plumes over the emission region, the transport region and the deposition region on this day…" (from the summary)

Line 293: "to calculate(d)"

AR: Thanks, it is revised.

Line 384: Affected not effected

AR: Thanks, it is revised.