Atmospheric Chemistry and Physics Discussions

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Comment on acp-2022-53

Anonymous Referee #1

Referee comment on "Dust transport and advection measurement with spaceborne lidars ALADIN and CALIOP and model reanalysis data" by Guangyao Dai et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2022-53-RC1, 2022

The combination of two space-based lidars (CALIPSO and Aeolus) is new and deserves attention. The Saharan dust transport across the Atlantic Ocean is a well-known large-scale phenomenon and suited to demonstrate the novel approach. Personally, I welcome the resubmission of the now improved version of the manuscript. However, there are still some major reviews necessary till the final publication.

Major comments:

- The comparison of the 3 cross sections on 19 June 2020 is misleading (Section 4.2). With the 3 cross sections just some hours (<4 h) apart, you get a snapshot of an existing dust plume whose maximum is currently over the central Atlantic. Lower values of the backscatter coefficient above the Sahara and the Caribbean (cross section 1 and 3) can not be directly linked to emission and deposition (named by you “emission phase” and “deposition phase”). Usually, there are several days between emission and deposition and not just some hours. So, there is no benefit in reporting the backscatter values for the 3 cross sections. I would consider removing these values from the abstract and the conclusion.
  Your next Section 4.3 is better suited to follow the dust from emission to deposition.
- The calculation of the mean mass concentration is not well defined. How do you define your dust layer? Or do you take an average over the whole cross section? You mention some upper and lower threshold values for the mass concentration based on previous observations. However, if you observe such an intense dust event (“Godzilla”), the mass concentration may exceed the upper threshold. To calculate a mean mass concentration, you should define your dust layer, probably with a lower backscatter or extinction coefficient threshold and then take the average over the entire dust layer.

  It is positive, that you compare two different methods. In order to judge the differences, you should add uncertainties to both derived mean mass concentrations (Table 1+2).

For the factor method, do you use the extinction coefficient provided by CALIPSO or the extinction coefficient calculated with the adapted lidar ratio (58 sr)? The later would be preferable to be consistent with your advection calculation procedure.

- In Section 4.3, you should make sure that the same dust was observed in all the cross sections. The description stays a bit vague. A so-called Lagrangian case study was presented in Weinzierl et al., BAMS 2017, there an aircraft observed the same dust sample at the coast of Africa and some days later over the Caribbean. You have all the trajectory calculations ready, just use them in a more quantitative way to show that you track the same dust event. For example, you could add dots to the trajectories marking intervals of 24 h in Fig. 9. The dots alone won't be sufficient.
- The CALIPSO examples introduced in Fig. 4 and 5 are later on not used anymore. It would be better to show in Fig. 4 some dates used in Section 4.3. In Fig. 5 you should definitely show the case of 19 June 2020 because it is later on used in the case study of Section 4.2.
- It is a great step forward to use the lidar ratios for (Western) Saharan dust instead of global averages. The lidar ratio of 60 sr at 1064 nm seems a good estimate as recently confirmed by Haarig et al., ACP 2022 (57 – 69 sr). Although, a higher ratio of LR1064/LR532 was reported. Nevertheless, the values used seem to be reasonable.
- Aeolus aerosol products are usually reported on a very coarse horizontal resolution. How do you make sure that your profiles are not influenced by clouds? You are talking about the cloud screening in the case of CALIPSO, but not for Aeolus. Please add some comments on the cloud and aerosol separation in the case of Aeolus.
- Please add uncertainties to all your calculated values, especially to the mean dust advection values. Otherwise, you can't draw conclusions on changing values.

Minor comments

- Text insides some figures (especially Fig. 3 + 4) is quite small and hard to read.
- Figure 7 and 10 are quite complex and hard to follow. The text is understandable even without these figures. In case of the wind speed and direction, you have the nice Fig. 12, and the other information from Fig. 7 and 10 are not necessary to understand the paper. I would consider removing these figures to make the paper easier to read.
- L55: A reference about SHADOW is missing. What about Veselovskii et al., ACP 2016?
- The technical details about Aeolus could be moved from the introduction to Section 2.1. Just keep the most important facts about Aeolus as you have done it for CALIPSO.
- 4 VFM – please write vertical feature mask
- 4 "west coast of Africa"
- 5 The term "source" might be misleading, because you show a "position" along the CALIPSO track and the corresponding profiles at this position. And then you use this position as source for your trajectories. Reading "source" reminded me on dust sources.
- 6a – it is not a "vertical" view and HYSPLIT trajectories are not shown.
- L286 Explain u and v component of wind vector to readers not familiar with these conventions.
- L310 "Godzilla" – a nice piece of information which could already be placed in the introduction.
- 8 The color plots are shown on the CALIPSO or Aeolus tracks?
- L341 "dust mass" – you're not showing the dust mass, but "enhanced backscatter and

extinction values indicating the presence of dust”

- 9d It is almost impossible to capture the latitudinal component in the plot – I would consider to show it on altitude – longitude plane (this is the interesting information!) and indicate the different positions in latitude by different lines, e.g., position A in dashed lines, position B in dotted lines, …
- The “Saharan dust westward transport tunnel” (L.383) is somehow linked to the “Saharan Air Layer”.