Responses to Reviewer #2 Comments and Suggestions

Start review of acp-2021-418

Title: 15-year variability of desert dust optical depth on global and regional scales.

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We would like to thank the Reviewer for the helpful evaluation of the manuscript and providing us the opportunity to revise and improve the quality of our manuscript. Detailed responses are presented in the marked copy.

A general note for the Reviewer: It seems, based on the point to point Reviewer comments (comment lines), that a different submitted manuscript has been evaluated (up-to question 18). After the initial submission, based on the first comments from the reviewers, we had updated our manuscript with a new paragraph in the introduction in order to support the novelty as well as the scientific contribution of our study. Thus, the corrected submission has different numbering of the lines. However, we detected all pointed comments of Reviewer #2. Below, the old lines are referred to the updated submission and not to the initial one.

General Comments:

The authors describe trends in dust aerosol optical depth and aerosol optical depth as calculated from the MIDAS fine resolution dataset. They conduct several sensitivity studies including assessing differences between the geometric and arithmetic mean, variation in start year and timeseries length, filtering, impact of spatial resolution, and regional trends. Overall, I believe that this contributes meaningfully to the existing literature on this topic as it evaluates a new dust dataset and conducts sensitivity tests that have been under-utilized in previous satellite-derived dust climatology studies. However, I believe some additional analysis and revision to the manuscript is necessary.

While the authors present comparisons to several other dust datasets, many of them are also based on MODIS AOD and are therefore not independent from the MIDAS dataset. Additional comparison with datasets that do not incorporate MODIS data are warranted eg. CALIPSO DOD, AERONET, ground-based dust measurements. At a minimum, more acknowledgement in the text of the lack of independent comparison is necessary.

We follow the Reviewer’s suggestion and in the revised manuscript we have added an evaluation analysis of MIDAS DOD trends. We used, as reference data, ground-based measurements from AERONET network and more specifically the coarse mode AOD from AERONET SDA algorithm. The following evaluation analysis is presented in Section 3.1.3.

“2.2 AERONET

On a regional basis, the reliability of MIDAS DOD trends has been evaluated using ground-based measurements from AERONET (Holben et al., 1998). AERONET provides information for the spectral columnar AOD using direct spectral solar irradiance. In addition, the physical and optical properties of aerosols can be derived by applying the Dubovik and King (2000) inversion algorithm. DOD ground-based measurements can be approached using AERONET retrievals, however, an aerosol classification scheme is mandatory. Through MIDAS evaluation procedure, the discrimination of dust load from non-dust aerosol species has been performed in terms of the Ångström wavelength exponent at 440-870 nm ($AE_{440\text{-}870\ nm}$) and the difference between single scattering albedo at 440 nm ($SSA_{440\ nm}$) and 675 nm ($SSA_{675\ nm}$). $AE_{440\text{-}870\ nm}$ has been used as an indicator of particles size (coarse or fine aerosols) in numerous aerosol classification studies (Basart et al., 2009; Mielonen et al., 2009; Lee et al., 2010; Giles et al., 2012; Hamill et al., 2016; Zheng et al., 2017; Che et al., 2018; Logothetis et al., 2020). In addition, the aerosols origin can be acquired using either the difference between SSA at different wavelengths or specific spectral SSA thresholds. In Gkikas et al. (2021a), the pure dust conditions have been succeeded using a very restricted threshold limit of $AE_{440\text{-}870}$ nm (≤ 0.75) along with a positive difference of $SSA_{675\ nm} - SSA_{440\ nm}$. Despite the favorable dust conditions retrieved through the SSA retrievals, the data availability strongly decreases causing difficulties in trend calculations. In the current study, the evaluation of MIDAS DOD trends is performed by using the AERONET coarse mode AOD at 500 nm, derived from the spectral deconvolution algorithm (SDA) (O'Neill et al., 2001, 2003). The performance of the SDA algorithm, in terms of segregating the fine and coarse aerosol modes, has been justified against ground-based observations (Kaku et al., 2014). Only quality assured data (cloud-screened), including pre-field and post-field calibrations (Level 2.0, L2) from AERONET Version 3 (V3) (Giles et al., 2019) are used. It should be mentioned that cAOD does not represent profoundly the dust load due to the presence of sea-salt particles.”

“3.1.3 Evaluation of MIDAS trends vs. AERONET

The validity of the computed MIDAS DOD trends is thoroughly analyzed in this section. For evaluation purposes, the coarse mode AOD, hereafter referred as cAOD, retrieved through the AERONET SDA algorithm is applied. The two datasets are collocated by spatially averaging MIDAS DODs included in an area of 3x3 pixels around each AERONET site, and also temporally combined using solely the same daily values. DOD and cAOD trends are calculated using the methodology described in Sect. 2.3. Figure 4a illustrates the geographical distribution of the AERONET stations (in total 41) satisfying the defined temporal criteria (see Sect. 2.3) and finally used in the assessment analysis. According to Fig. 4b, a good linear correlation ($R = 0.86$) of the derived trends is observed accompanied with low bias ($MBE = -0.04x10^{-2}$). In order quantify the performance of MIDAS in capturing the cAOD trends, the total accuracy (TA) of the correct trends (identical sign) is calculated. More specifically, TA is defined as the percentage of the stations with correct trends sign (the sum of B1 and A2 quadrants numbers in Fig. 4c divided by the total number of stations). MIDAS trends can capture the correct cAOD trends signs with a TA of 80.5% (Fig. 4c). In addition, the percentages of each quadrant in Fig. 4c shows the number of the correctly detected stations per sign. The overwhelming majority of the AERONET stations encompassed negative trends (30 out of 41 stations). MIDAS trends capture the 26 out of those 30 (86.7%) stations denoted *with negative cAOD trends. Lastly, there are only 11 sites with positive cAOD trends, and MIDAS proved able to detect them at 7 out of 11 (63.6%) stations.*

Table S1 provides the point-to-point trend results for each collocated MIDAS-AERONET sites. It should be mentioned that among the revealed stations, few indicate dust particles as the predominant aerosol type. Based on Logothetis et al. (2020), the station of Solar Village, Arabian Peninsula, is primarily a "dusty" site revealing significantly high percentages of coarse absorbing particles. Across this station, the trends between AERONET cAOD (0.0126 yr^{-1}) and MIDAS DOD (0.0107 yr^{-1}) are in good agreement in terms of magnitude, but both are non-significant at the 95% confidence level. Similar findings are also observed in the "dusty" site of Tamanrasset, Algeria, showing increasing cAOD and DOD trends of 0.0062 yr^{-1} and 0.0044 yr^{-1}, respectively. One of the advantages of MIDAS is that it provides the dust aerosols burden information in downwind regions of the planet. For instance, most of the stations located in South Europe receive dust particles transported towards the Mediterranean from Sahara and Middle East deserts, encompassing identical trend signs (Fig. 4a). Moreover, there are many downwind regions across different regions of the globe with similar trends magnitude such as Ispra, Italy (cAOD= −0.0013 yr^{-1}, DOD= −0.0015 yr^{-1}), Kanpur, India (cAOD= −0.0027 yr^{-1}, DOD= −0.0029 yr^{-1}), SERC (cAOD= −0.0023 yr^{-1}, DOD= −0.0020 yr^{-1}) in US, Shirahama, Japan (cAOD= −0.0020 yr^{-1}, DOD= −0.0012 yr^{-1}), and XiangHe, China (cAOD= −0.0028 yr^{-1}, DOD= −0.0018 yr^{-1}).

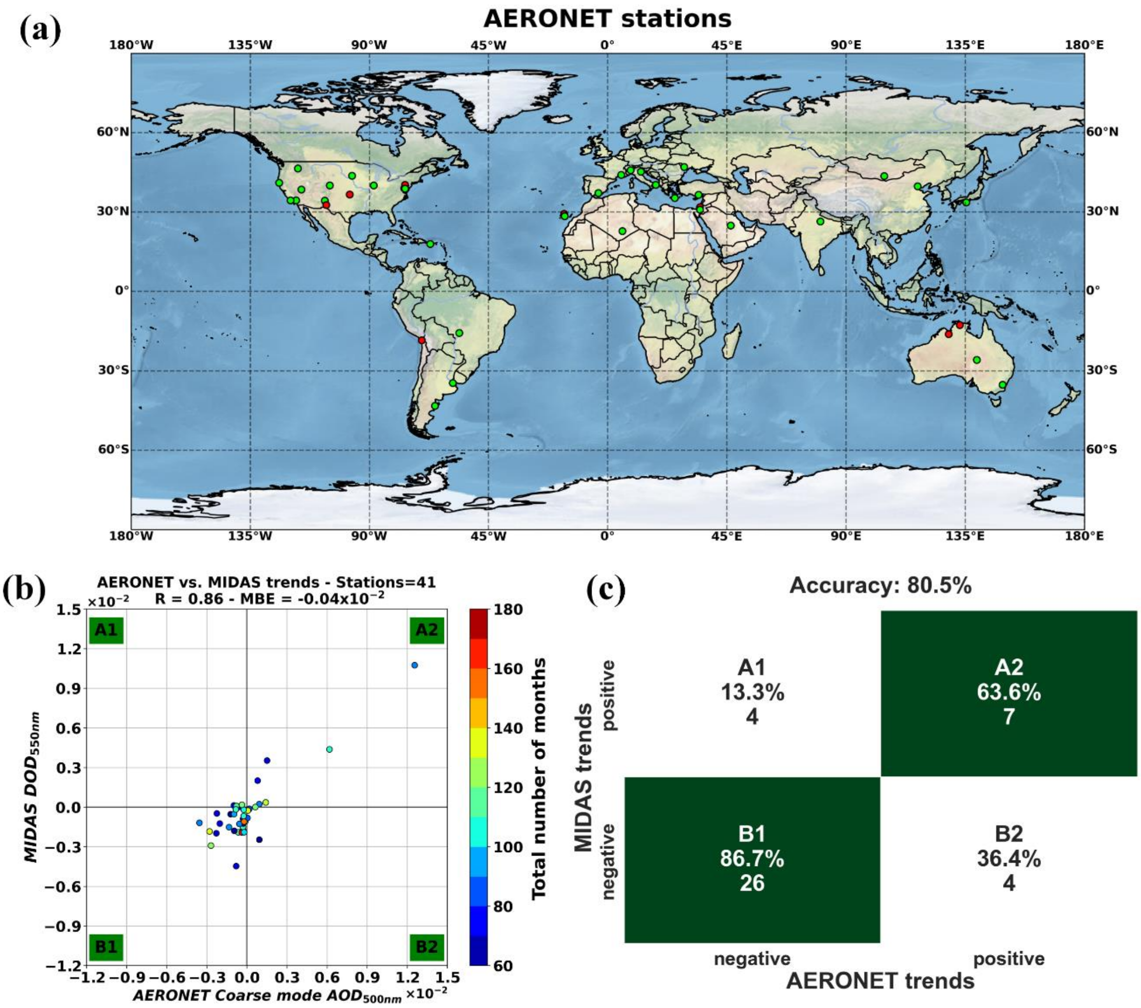

Figure 4: (a) Geographical location of the available AERONET stations in which the temporal trends of DOD and cAOD are calculated. Green and red dots refer the stations with the similar and different trend sign,

respectively. (b) Scatter plot between MIDAS DOD and AERONET cAOD trends. The color bar indicates the total number of months. (c) Confusion matrix of possible trend signs among the two datasets."

The discussion of the differences resulting from the use of the geometric vs. arithmetic mean of DOD is important and that analysis should be presented completely in the body of the paper.

We agree with Reviewer's opinion and we have added the following paragraph in Section 3.1.1 to support our analysis.

"*The overwhelming majority of the published AOD/DOD trend analysis studies have been relied on arithmetic mean in order to produce coarser spatial (e.g. 1° x 1°) and temporal (e.g. monthly values) resolutions. In this study, a sensitivity analysis on the aggregation method (i.e. arithmetic vs geometric mean), has been performed by utilizing the daily coarse spatial resolution (1° x 1°) MIDAS DODs. Figure 1 depicts the frequency histogram of MIDAS DODs in log scale using all the available data over the period 2003–2017. It is apparent that the shape of the DOD distribution is close to a log-normal distribution (Fig. 1). The latter considers the extreme dust episodes which force the distribution curve to be right-skewed. Arithmetic mean is about 4 times higher than the geometric mean, highlighting the importance of which metric is more representative of the population and how this can affect the results for specific applications (e.g. radiative forcing). When geometric standard deviation is considered, 65.43% of DOD values range between 0.002 and 0.027 while 81.04% encompassed within –0.033 and 0.099 for arithmetic mean, indicating an overstating of the variability (Sayer and Knobelspiesse, 2019). The averages and the standard deviations are calculated using weighted aggregation exrpessions with the weighting factors in terms of latitude (see Sect. 2.3). An additional point, revealing that the selection of normal statistics can lead to a misrepresentation of the population for a positive-definite quantity (i.e. dust optical depth), is that the lower bound (−0.033) is negative, which has not any physical meaning.*

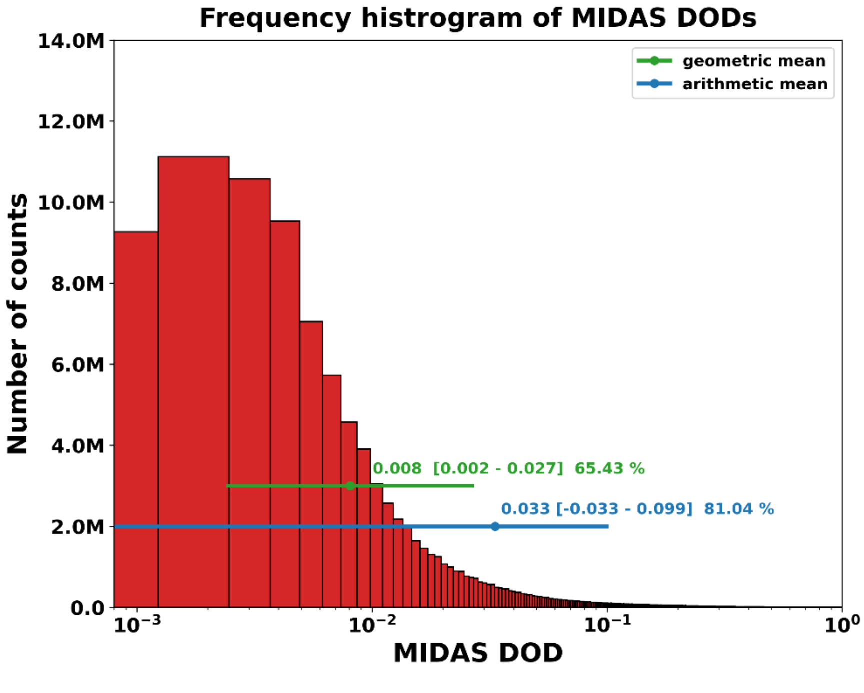

Figure 1. Frequency histogram of MIDAS DODs reported at 1° x 1° spatial resolution over the period 2003 – 2017. The computed geometric mean (green) and arithmetic mean (blue) are given along with ranges

corresponding to geometric mean/geometric standard deviation and geometric mean*geometric standard deviation for the geometric mean and ± standard deviation for the arithmetic mean.

In agreement with Sayer and Knobelspiesse (2019), the calculated trends for AOD and DOD are consistent in terms of sign between fine (Fig. 2) and coarse (Fig. 3) spatial resolution data. However, in terms of magnitude this is not the case. Figure S1, S2 depicts the frequency histograms of the deviations between the arithmetic and geometric trends. When geometric AOD/DOD averages are considered, the deseasonalized trends are suppressed by up to 91.77% with the respect to the corresponding levels obtained from the arithmetic means, regardless the underlying surface type. The only exception is found for AOD at 1° spatial resolution and across oceanic territories (Fig. S2c) where geometric trends overestimate those of arithmetic by 71.63%."

In the methods section, more discussion of the uncertainty, strengths, and weaknesses of the MIDAS data should be included. Some of the methods were not completely described.

Some modifications on the revised manuscript have been applied. We think that we are providing sufficient information to the reader without overloading the relevant section since most of the discussion is better suited to Gkikas et al., (2021).

I also believe the authors should elaborate more on the motivation for this work. There have already been several studies on dust optical depth trends using MODIS-derived datasets. Please discuss why this one is a valuable contribution beyond being a different spatial resolution.

After the initial submission of the paper an additional paragraph discussing on the novelty of the current study is added in the introduction. The modified aforementioned paragraph in the revised manuscript is presented below:

"This study's main objective is to investigate the dust temporal variations at global, regional, and seasonal scales, using the newly MIDAS DOD product from 2003–2017. A few aspects regarding the innovative points of this research are highlighted below to support the scientific contribution to the relevant research field. First, in contrast to the existing studies, this trend analysis relies on fine spatial resolution data, making it feasible to depict in detail the spatial patterns of the DOD variations. Such information can be critical for interpreting the perturbations of the radiation fields, environmental impacts, and health effects attributed to dust particles. One more advantage of the high resolution DOD analysis is the flexibility of the final grid size selection depending on data availability, which is a critical aspect when satellite observations are used. MIDAS data can be easily upscaled at coarser spatial resolutions in order to match spaceborne observations, which have been commonly used in other trend analyses available in the literature (Hsu et al., 2012; Yoon et al., 2014; Notaro et al., 2015; Pozzer et al., 2015; Klingmüller et al., 2016; Alfaro-Contreras et al., 2017; Che et al., 2019; Guo et al., 2019; Voss and Evan 2020; Song et al., 2021). In addition, fine spatial resolution data ensure a more realistic collocation with ground-based measurements for validating the obtained DOD trends. Second, quite a few studies concentrate on pure DOD (Xi and Sokolik 2015; Guo et al., 2019; Lakshmi et al., 2019; Voss and Evan 2020; Song et al., 2021) rather than AOD to analyze the trends of mineral particles' load. Even though the consideration of the latter parameter is quite reasonable across deserts, its representativeness over downwind

areas is questionable due to the coexistence of other aerosol types. Such types can also affect the DOD trend uncertainty. In MIDAS, this issue is addressed by the adjustment of MODIS AOD to DOD in terms of the MERRA-2 dust fraction, while in other studies, aerosol size and natural optical properties, which their quality above land is downgraded, are used in parallel. Third, taking advantage that MIDAS provides DOD and quality assured AOD, their trends are discussed jointly for assessing the contribution of dust burden temporal variations to those of the total aerosol load. It should be mentioned that this is the first study assessing the effect of DOD to total AOD trends across the major desert dust areas of the planet, highlighting the potential role of desert dust particles in past, present, and future AOD trend studies. Fourth, the investigation of the potential impact on trends' magnitude, sign, and statistical significance when different DOD aggregations (i.e. arithmetic mean vs. geometric mean) are considered among various spatial and temporal scales. Fifth, the DOD interannual variations are discussed for the entire study period on a seasonal basis and sub-periods for detecting alternations on DOD trends within the period of interest."

The manuscript needs substantial editing for grammar. There were uncapitalized proper nouns, improperly used or missing articles, and generally confusing sentences throughout the text. I have included some of these in my detailed comments but this list is far from exhaustive.

We would like to thank the Reviewer for giving us the opportunity to correct our submitted manuscript. Overall, the manuscript has been corrected in many points and highlighted with yellow color.

Detailed comments:

1. **Line 21: Changed to "The effect of DOD on the total aerosol optical depth (AOD) change is determined by calculating the…"**

Thank you. This sentence has been revised as:

"*The effect of DOD on the total aerosol optical depth (AOD) change is determined by calculating the calculating the DOD to AOD trends ratio*".

2. **Line 23: change to "…Gobi Deserts) the ratio value is approximately 0.6."**

Thank you. We did the correction.

[old lines: xxx-xxx; revised lines xxx-xxx]

3. **Line 28: remove "which sounds a critical aspect when satellite-based measurements are utilized."**

Done.

4. **Line 31: Change to "are a major contributor to the atmospheric aerosol…"**

Thank you. We did the correction

5. **Line 48: Capitalize “Van der Does”**

Thank you for the correction. However, in the literature the name is written with lowercase v.

6. **Line 52: South America**

Done

7. **Line 108: remove “it” in “it is reasonable”**

This sentence has been changed in the initial submitted manuscript.

8. **Line 111: change language “taking advantage that” to something grammatically correct**

This sentence has been changed in the initial submitted manuscript.

9. **Line 141: Please elaborate on the “highly accurate” MODIS AODs by providing information on error statistics and validation studies**

MIDAS implements the MODIS aerosol products in which AOD is derived using the Dark Target (DT) and Deep Blue (DB) algorithms. Globally, these products have been thoroughly validated against AEronet RObotic NETwork (AERONET), providing a very good agreement either over oceanic areas for DT (R=0.880; MAE=0.055; RMSE=0.083) or over land for DT (R=0.920; MAE=0.066; RMSE=0.107) and DB (R=0.904; MAE=0.062; RMSE=0.107) (Wei et al., 2019b).

10. **Line 141: Instead of saying “trustworthy”, consider providing specific information about the uncertainty in the product, based on uncertainty in MODIS AODs and MDF**

Please see our previous replies. We would like to avoid the repetition of parts which have been already discussed in detail in Gkikas et al. (2021). About the uncertainty, the formulas and the concept are given in the paper presenting MIDAS development.

11. **Line 143: note that validation with MERRA-2 is not independent since the MDF is used in the calculation of MIDAS DOD**

Please note that both in the submitted and the revised document we are talking about an intercomparison and not for validation. There are several reasons explaining that MERRA-2 DOD is not very similar with those of MIDAS. For instance, MERRA-2 assimilates MODIS bias-corrected MODIS AOD from Collection 5 instead of Collection 6.1 used in MIDAS. Moreover, MERRA-2 assimilates MODIS AOD and then the increments are distributed among the simulated five aerosol species. Focusing on dust, the mineral particles' load in the atmosphere is driven by the GOCART aerosol model and the GEOS-5 meteorological driver which are independent at a large degree by the derived MIDAS DOD. In addition, the MDF is regulated also by the non-dust aerosol species simulated in MERRA-2. It is reminded, that MERRA-2 assimilates MODIS AODs derived by the Dark Target algorithm (vegetated land and oceans) excluding the bright desert surfaces where the sources are located. In the aforementioned regions, spaceborne and ground-based AOD retrievals from MISR and AERONET, respectively, are assimilated.

12. Line 145: Describe how you minimize contribution of non-dust aerosol species

We have added the methodology that dust particles are separated with non-dust species in Section 2.2.

"Through MIDAS evaluation procedure, the discrimination of dust load from non-dust aerosol species has been performed in terms of the Ångström wavelength exponent at 440-870 nm ($AE_{440\text{-}870\ nm}$) and the difference between single scattering albedo at 440 nm ($SSA_{440\ nm}$) and 675 nm ($SSA_{675\ nm}$)."

[old lines: xxx-xxx; revised lines xxx-xxx]

13. Line 152: Change the language of "it has been justified the reliability of …" for grammatical reasons

We have revised the mentioned sentence as:

"*Summarizing, the reliability of the MIDAS DOD justified in Gkikas et al. (2021a) strengthens its applicability for investigating the temporal trends of dust aerosol burden over long-time periods and at various spatial scales.*"

[old lines: xxx-xxx; revised lines xxx-xxx]

14. 206: Please show this analysis in the supplementary material

We decided to perform this analysis in the main body of the revised manuscript (Section 3.1.1, Fig. 1).

15. Figure 1: Consider showing differences in trend between geometric mean and arithmetic mean instead of showing values

The differences between geometric-based and arithmetic-based trends are shown in Figures S1 and S2 over land and ocean respectively.

16. Lines 267-269: Please rephrase for clarity.

These lines have been deleted in the revised manuscript.

17. **Line 298: Please indicate, with grey shading for example, where seasonal trends were not calculated due to data gap**

In order to clearly present the data availability either for yearly or seasonal trends we have modified the Figures S4 and S14. Now, the pixels with not available data (data gap; gray color) or fail to meet the availability criteria (greenish color) are clearly presented for long-term (Fig. S3) and seasonal (Fig. S4) analysis. In these pixels the DOD trends are not calculated and are presented with white (blank) color in all maps (e.g. Fig. 2). Also, the following lines are included in the caption of the revised Figure 2 to explain more explicitly the color bar.

"The pixels with: 1) non-significant trends, 2) the temporal criteria are not met and 3) not available data are colored as white (blank) in each map of trend analysis. Neutral trends, ranging between −0.002 and 0.002 DOD yr^{-1}, are colored with light yellow (or cream) (the central color of the color bar). Figs S3a, S3b and S4 present the differences between the aforementioned colors at fine, coarse spatial resolution as well as for the seasonal trends, respectively. Based on those Figs, the pixels with not available data are colored with gray color while those of failing to meet the availability criteria are colored with greenish."

18. **Line 310: Please provide some values in the text for these trends in order to make it easier to understand without flipping between the manuscript and the supplementary material. For example, "increase trends of up to X yr^-1" or similar language.**

In order to reduce the bonding between the manuscript and the supplementary material, we have transferred this table to the revised manuscript.

19. **Line 327: Rephrase the final sentence of this line to reflect that the MERRA-2 dust fraction in MIDAS overestimates dust as compared to the DOD values derived from CALIOP retrievals.**

We have revised the pointed sentence as:

"However, the trend magnitude along the Gulf of Guinea as well as in the northern regions (from Ghana to Cameroon) seems to be unreliable due to the reduced performance of MDF, surface contamination in the received radiances by MODIS and to the co-existence of aerosols and clouds (Gkikas et al., 2021b)."

20. **Line 337: Consider discussing the relationship between cyclone activity and dust eg. Pan et al. (2018) Journal of Climate; Evan et al. (2006) GRL**

We followed the Reviewer suggestion and we have added the following text in the revised manuscript:

"In addition, dust aerosol burden originated form Sahara Desert is directly related to tropical cyclones (TCS) over Tropical Atlantic Ocean, but their relationship is not unambiguously clarified (Evan et al., 2006). Based on model simulations, Pan et al. (2018) investigated the role of dust aerosols for the genesis of TCs over tropical Atlantic basin, by comparison of dust and non-dust model simulations. They revealed that dust amount is directly related to TCs, revealing a bimodal pattern. More specifically, favorable conditions for TCs formation are documented by increasing the midlevel moisture and decreasing the vertical wind shear while

unfavorable conditions are encompassed by decreasing the low-level vorticity and potential intensity."

21. Line 400: Why not state the global trend over ocean for MIDAS DOD here?

At the beginning of paragraph (Section 3.3.1), we state that the global DOD trends both over land and ocean are small. In particular, the global (GLB), over land (GLB-L) and over ocean (GLB-O) DOD trends are also presented in Table 3 and Fig. 8a.

22. Line 413: 5 years is a very short period over which to calculate a trend.

We agree with Reviewer's reflection that 5 years is a very short period to calculate trends. The reason of choosing the short 5-year period in trend analysis is just to perform the sensitivity analysis under different periods, varying the number of years and the initial year. Nevertheless, we have added the following sentence in the revised manuscript:

"Nevertheless, the time window is very short to infer the amplitude of the calculated trends."

23. Line 460: change "do not contradict with" to "are consistent with"

Done.

24. Line 462: "resulting in"

Done.

25. Lines 567-568: Overestimate as compared to what? What are you considering to be the "truth" dataset/value? Also, please rephrase to correct grammar

In this study, the implications in the implementation between geometric mean and arithmetic mean to trend calculations is discussed (Section 3.1.1). According to Fig. 1, the shape of the DOD distribution deviates from an exact log-normal distribution but less than a normal one. Thus, we have concluded that the use of geometric mean for the temporal averaging of daily DOD values is most representative than the use of arithmetic mean. For this reason, we have used the geometric-based DOD trends as a reference DOD trend value. Lastly, we have revised the following text as:

"In addition, the sensitivity analysis on the different aggregation approaches revealed that the arithmetic-based trends are larger than those of the geometric-based ones (from 52.87 to 91.77%) all over the globe."

26. Line 574: "and globally"

Done.

27. 575: Redundant sentence

We have removed this sentence in the revised manuscript.

28. Figure 5: explain hatching in figure caption

Thank you. We have added that hatched pixels indicate the statistically significant trends.

29. Lines 582-583: Please rephrase for clarity and grammar

We have rephrased the pointed sentence as:

"In the majority of the regions of interest, including also downwind areas, the variations of the total aerosol load are driven by those of mineral particles."

30. Lines 588: Please explain further how these trend results could be incorporated into chemical models and why this is valuable

We have added in the revised manuscript the following text:

"Our results could be incorporated in chemical models, either for assessing the various impacts of dust and non-dust particles or for evaluating trends based on numerical simulations, and to further improve their calibration and forecast performance. Moreover, the obtained findings here can be used for the interpretation of the trends of the radiation fluxes at the surface and at the top of the atmosphere obtained by observations or atmospheric-aerosol models (Chaibou et al., 2020). The recently published Sixth Assessment Report (AR6) of the Intergovernmental Panel on Climate Change (IPCC) states that the increase of the global dust load causes a reduction of the effective radiative forcing (ERF) by $-0.25\ Wm^{-2}$ (Andrews et al., 2017; Forster et al., 2021). Therefore, fluctuations of the dust atmospheric load provide a valuable information in order to understand the associated impacts on past, current and future climate"

References

Chaibou, A. A. S., Ma, X., and Sha, T.: Dust radiative forcing and its impact on surface energy budget over West Africa, Scientific Reports, 10, https://doi.org/10.1038/s41598-020-69223-4, 2020.

Forster, P., Storelvmo, T., Armour, K., Collins, W., Dufresne, J. L., Frame, D., Lunt, D. J., Mauritsen, T., Palmer, M. D., Watanabe, M., Wild, M., Zhang H.: The Earth's Energy Budget, Climate Feedbacks, and Climate Sensitivity. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S. L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M. I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J. B. R. Matthews, T. K. Maycock, T. Waterfield, O. Yelekçi, R. Yu and B. Zhou (eds.)]. Cambridge University Press. In Press, 2021.

Evan, A. T., Dunion, J., Foley, J. A., Heidinger, A. K., and Velden, C. S.: New evidence for a relationship between Atlantic tropical cyclone activity and African dust outbreaks, Geophysical Research Letters, 33, https://doi.org/10.1029/2006GL026408, 2006.

Pan, B., Wang, Y., Hu, J., Lin, Y., Hsieh, J.-S., Logan, T., Feng, X., Jiang, J. H., Yung, Y. L., and Zhang, R.: Impacts of Saharan Dust on Atlantic Regional Climate and Implications for Tropical Cyclones, Journal of Climate, 31, 7621-7644, 10.1175/jcli-d-16-0776.1, 2018.