Responses to RC1:

The paper makes an important contribution to the literature and can provide input to the modeling community regarding the sea-salt emissions.

Some minor comments before publication:

Using ECMWF model constraints for RH would not necessarily remove clouds from L2A measurements (it is well-known that clouds are not well-represented in models)

AR: In this study, it is considered that clouds should be adequately removed as far as possible to retain aerosol extinction/backscatter coefficients, and to avoid the clouds' possible impact on the marine aerosol optical properties-wind relationship exploration.

According to the recommendation in Flamant et al. (2020), which is the Aeolus Level-2A Algorithm Theoretical Basis Document, there is a high probability that a cloud be present if RH > 94%. Because of this probability of cloud existence under the atmospheric condition of high RH, the Aeolus L2A aerosol optical properties data bins with RH > 94% were eliminated to avoid the clouds' impact.

Actually, the RH data from ECMWF model is considered as the auxiliary criterion in the cloud screening procedure, while the backscatter ratio is the main criterion as it is from Aeolus measurement. In the revised manuscript, we put the "backscatter ratio" before the "RH" both in Fig. 2 (Fig. 1 in the old version) and in the relevant description to clarify the order of importance, which are shown as below:

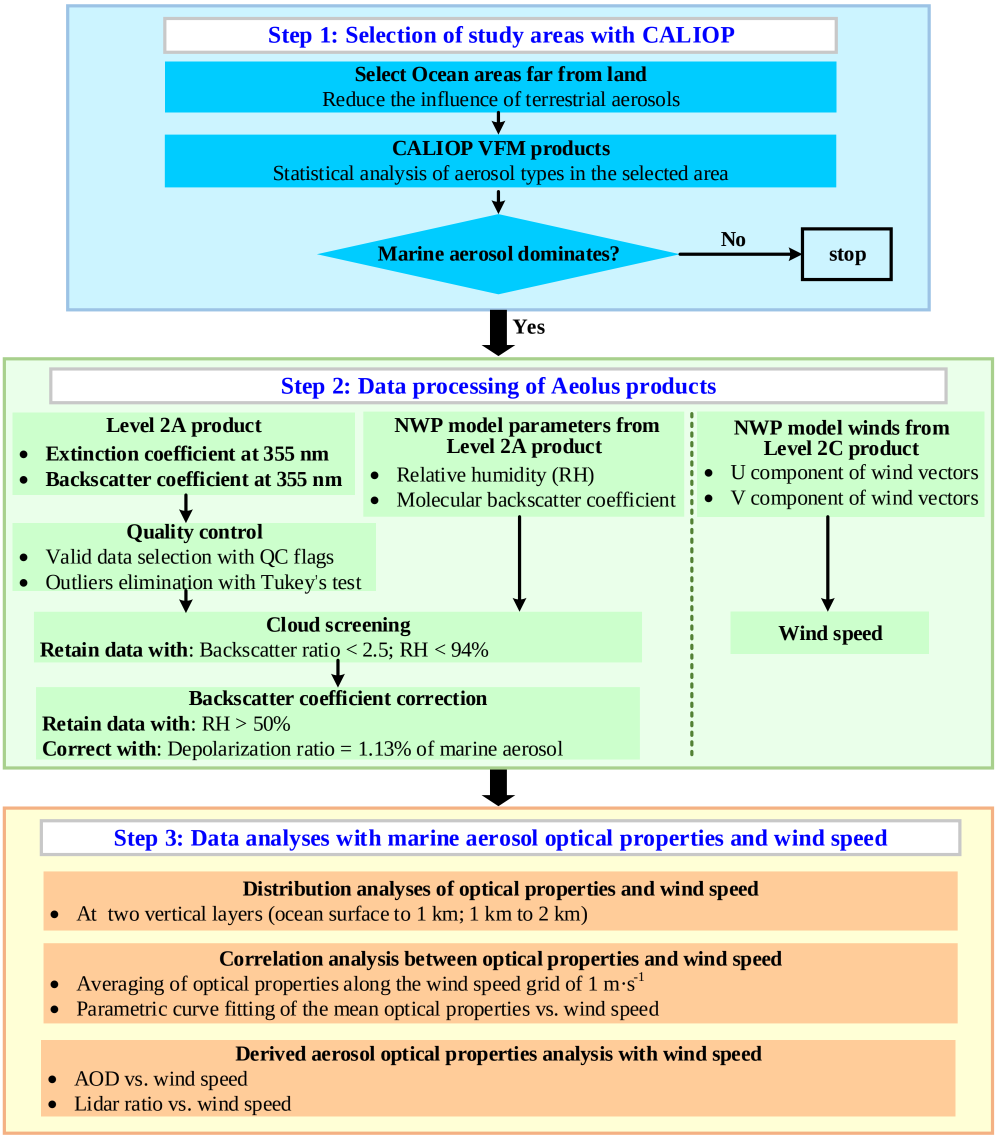

Figure 2: Flowchart of the study methodology

"It is considered that a cloud is quite likely to exist if the backscatter ratio (BR) (total backscatter coefficient/molecular backscatter coefficient) at 355 nm is larger than 2.5 or the RH is larger than 94% (Flamant et al., 2020). Therefore, in this study, when the BR is larger than 2.5 or the RH is higher than 94%, the corresponding data bin is regarded as cloud contaminated and is eliminated."

Reference: *Flamant, P. H., Lever, V., Martinet, P., Flament, T., Cuesta, J., Dabas, A., Olivier, M., Huber, D., Trapon, D., and Lacour, A.: Aeolus Level-2A Algorithm Theoretical Basis Document, version 5.7, https://earth.esa.int/eogateway/documents/20142/37627/Aeolus-L2A-Algorithm-Theoretical-Baseline-Document (last access: 9 November 2022), 2020.*

It is better to use marine particle depolarization at 355nm from the Delian model (Floutsi et al., 2023). Gross' paper reports depol values at 532nm (even though the difference is not large, 1.3 vs 2%).

AR: Thanks for the suggestion. We have re-processed all the results with the marine particle depolarization at 355nm of 1.3 % from Floutsi et al. (2023). The figures and the relevant descriptions have been replaced and rephrased in the revised manuscript.

CALIPSO cannot verify the presence of a specific aerosol type, since the aerosol type is inferred based on assumptions on the surface type. Even though the regions selected are dominated by marine particles, it is better to rephrase as it concerns CALIPSO and further validate through a global model that there are no other types present (e.g. from ship emissions).

AR: According to Kim et al. (2018), the aerosol types discrimination of CALIPSO is based not only on surface type, but also on the particulate depolarization ratio, integrated attenuated backscatter coefficient at 532 nm, layer top altitude and layer base altitude. As shown below, Fig. 1 is Fig. 1 in Kim et al. (2018), which presents the Flowchart of the CALIPSO aerosol subtype selection scheme for tropospheric aerosols and the method was well studied and discussed in this paper. Therefore, the aerosol types discrimination of CALIPSO is not totally based on assumptions, but mainly infers from the lidar measurement and combines with the assumptions on the surface type. It is considered that the aerosol subtype data provided from CALIPSO is reasonable.

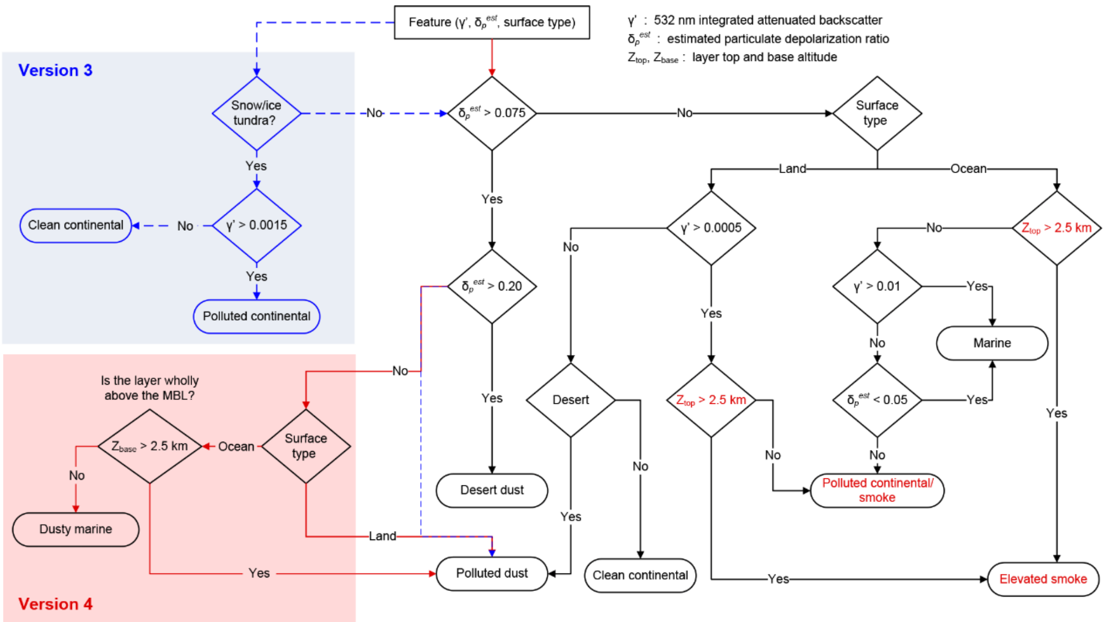

Figure 1: Flowchart of the CALIPSO aerosol subtype selection scheme for tropospheric aerosols (Fig. 1 from Kim et al. (2018)).

As for the shipping emission aerosol, the Intergovernmental Panel on Climate Change (IPCC) Fifth

Assessment Report provided the average value of international shipping emission aerosols, which is 5.5 $Tg \cdot yr^{-1}$ with the minimum of 3.6 $Tg \cdot yr^{-1}$ and the maximum of 8.7 $Tg \cdot yr^{-1}$. Comparing to the estimated sea spray aerosol emission of 1400-6800 $Tg \cdot yr^{-1}$, it is considered that the shipping emission aerosol is negligible.

Reference: *Kim, M.-H., Omar, A. H., Tackett, J. L., Vaughan, M. A., Winker, D. M., Trepte, C. R., Hu, Y., Liu, Z., Poole, L. R., Pitts, M. C., Kar, J., and Magill, B. E.: The CALIPSO version 4 automated aerosol classification and lidar ratio selection algorithm, Atmos. Meas. Tech., 11, 6107–6135, https://doi.org/10.5194/amt-11-6107-2018, 2018.*

In 4.2 the comparison of Aeolus with CALIPSO on extensive properties (a, b), should be restricted for backscatter only (CALIPSO cannot deliver extinction). Extinction could be evaluated against passive sensors such as MODIS AODs over the region.

AR: The purposes of the section of "Marine aerosol optical depth vs. wind speed" is to compare the AOD-wind speed relationship acquired from Aeolus with the result in a peer reviewed, published work. We quoted the AOD-wind speed relationship in Kiliyanpilakkil and Meskhidze (2011), which is acquired from the combination of AOD at 532 nm from CALIOP and 10 m wind speed from AMSR-E. The reason of choosing the result from Kiliyanpilakkil and Meskhidze (2011) for the comparison is that the AOD data source (from spaceborne lidar observation), the study areas (remote ocean regions globally), and the wind speed range (0 m/s- 29 m/s) of the AOD-wind speed relationship exploration in Kiliyanpilakkil and Meskhidze (2011) are all quite similar with those of this study. This comparison is considered capable to verify the AOD-wind speed relationship from Aeolus, and exactly, further to highlight the advantage of Aeolus on the AOD-wind speed relationship exploration, as the CALIPSO cannot deliver extinction precisely.

Fig. 11 from the revised manuscript (as shown below) shows the comparison between these two relationships. Indeed, AODs provided by CALIPSO-CALIOP are retrieved with the combination of the measurements of total attenuated backscatter coefficients and the assumptions of aerosol lidar ratios. Though the CALIOP AODs are based partly on assumptions, the AOD values from Aeolus are quite close (though slightly higher at low wind speed) to those from CALIOP and the tendencies of the two relationships are similar. The difference between AODs from CALIOP and from Aeolus are discussed in the manuscript as:

"The lower AOD_{mar} from CALIOP after wavelength conversion at low wind speed may arise from using a fixed LR_{mar} of 20 sr at 532 nm used for CALIOP AOD_{mar} retrievals while the LR_{mar} can vary with the particle size. Possible underestimation of the CALIOP retrieved AOD_{mar} at 532 nm is discussed in detail in Kiliyanpilakkil and Meskhidze (2011). Besides, as discussed in Section 4.4.2 of this paper, the particle size and the LR of the marine aerosol will vary with wind speed, so using the CALIOP AOD_{mar} retrieved with the fixed LR_{mar} may generate additional error in the exploration of the relationship between the AOD_{mar} and the wind speed. Therefore, using Aeolus retrieved AOD_{mar}, which is integrated by independently retrieved extinction coefficient without the assumption of LR_{mar}, could make the AOD_{mar} - ws relationship more reliable." From the comparison and the description, the marine AOD-wind speed relationship from Aeolus is verified while the advantage of Aeolus that it can retrieve AOD without any assumptions than CALIOP is illustrated.

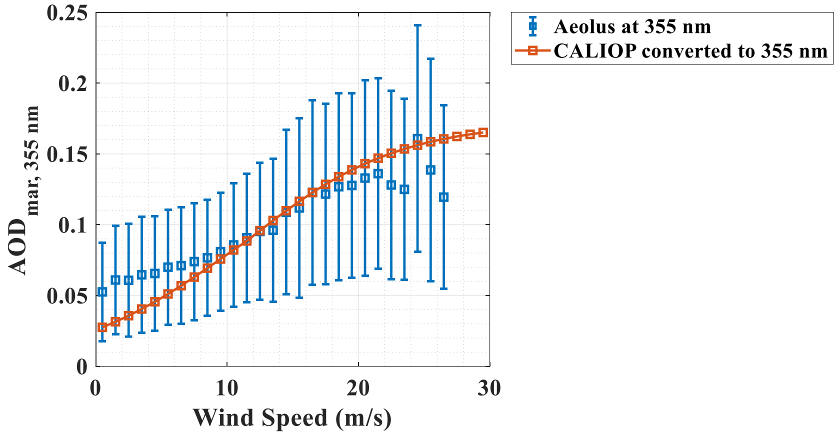

Figure 11: AOD_{mar} at 355 nm versus wind speed. The blue squares and the corresponding error bars represent the AOD_{mar} means and standard deviations along the ws grid of all the three study areas in this study; the red squares and line represent the AOD_{mar} at 355 nm along the ws grid converted from the regressive relationship between the AOD_{mar} at 532 nm and the ocean surface wind speed reported by Kiliyanpilakkil and Meskhidze (2011).

Reference: *Kiliyanpilakkil, V. P. and Meskhidze, N.: Deriving the effect of wind speed on clean marine aerosol optical properties using the A-Train satellites, Atmos. Chem. Phys., 11, 11401–11413, https://doi.org/10.5194/acp-11-11401-2011, 2011.*

Responses to RC2:

1. **Original Submission**

1.1. Recommendation

Major Revision

1. **Comments to Author:**

Correlation between marine aerosol optical properties and wind fields over remote oceans with use of spaceborne lidar observations

Overall opinion: The paper elucidates the relationship between marine aerosol optical depth (AOD) and near surface wind speeds using Aeolus. In short, you demonstrated that Aeolus can unveil positive relationship between aerosol optical properties and wind speed over oceans efficiently. Aeolus can resolve gradient of the aerosol optical variations depending on the wind speed as well. The differences between marine boundary layer and the layer above can be unveiled nearly exclusively by relying on Aeolus, which is a promising finding considering low signal to noise ratio of Aeolus. However, your current effort should be carefully revised because of poorly justified methodological choices, ambiguities (and, even more critically, inconsistency) in the research aim, introduction gaps, and text that is unfriendly to general readers. Most notably, some results are not persuasive; the relationship between marine AOD and wind speed has not been quantified in some cases, and only displayed in figures and discussed in the text in others without trends being quantified or correlations/causal connections being reported. Conclusions are just short and plain version of results (no summary, no overview, no holistic opinion presented in conclusions). Further details are outlined below.

AR: Thank for your careful review. According to your suggestions, we have revised the manuscript carefully. We have explained and modified the methodology, clarified the research scope as much as possible. Besides, the gradients of marine aerosol optical properties with wind speed (shown in the panel (c) and (d) of Fig. 8, Fig. 9 and Fig. 10) are supplemented in the revised manuscript to quantify the variation tendency. The abstract, result section and the conclusion section were rephrased to quantify the results and to clarify the research scope and the conclusion. The point-to-point responses are shown below.

2.1. Comments:

1. **Abstract:** Although the paper is submitted to the special issue dedicated to Aeolus, I think you should foremost think about general readers. Please emphasize your research aim boldly, ensure this research aim agrees with what you state in the end of the introduction and in the end of the paper. Logically, there is little sense to start your abstract by introducing satellite-specific terms such as Level 2A product. At least, please mention Aeolus first. Ideally, state in the first sentence of the introduction why you think marine aerosol – wind speed relationship is important and Aeolus is a good choice to address it.

AR: Thanks. According to your advice, we have stated in the first sentence why marine aerosol – wind speed relationship is considered important and Aeolus is a good choice to address it, and removed the introduction of satellites' products. The revised abstract is shown as below:

"**Abstract.** Marine aerosol is mainly produced by wind, which is also a vital element impacting the transport, evolution and dissipation of marine aerosol. The understanding of the accurate relationships between marine aerosol optical properties and wind speed will improve the global aerosol transport models, the satellite-retrieved AODs, the atmospheric correction of ocean color and the study of biogeochemical cycles. Aeolus, the worldwide first ever wind detection lidar satellite, had the ability to measure wind information and particulate optical properties simultaneously, which provide the opportunity to explore the absolutely synchronous relationships between marine aerosol optical properties and wind speeds. Furthermore, thanks to the Aeolus measurement of vertical profiles, the relationships can be discussed in different vertical layers. In this paper, utilizing Aeolus data, the relationships between the optical properties at 355 nm of marine aerosol and the corresponding instantaneous co-located wind speeds of three remote ocean areas are explored and discussed at two sperate vertical atmospheric layers (0-1 km and 1-2 km, correspond to the heights within and above marine atmospheric boundary layer (MABL)), revealing the marine aerosol related atmospheric background states. The marine aerosol extinction/backscatter coefficients and the background wind speeds show positive relationships and they were fitted by power law functions, of which the corresponding R^2 are all higher than 0.9. Both the MABL and the higher layer above the MABL will receive the marine aerosol produced and transported by the wind from the air-sea interface. The marine aerosol load at the lower layer (MABL) is stronger than at the higher layer. The marine aerosol enhancements caused by the background wind are more intensive at the MABL. The gradient change points of marine aerosol extinction/backscatter coefficients appear during the growth of them with wind speed, above which the growth rate becomes lower. It might illustrate that the enhancement of marine aerosol driven by wind includes two phases, among which one is rapid growth phase with high dependency of wind, and another is slower growth phase after the gradient change points. As derived data from Aeolus, the averaged marine aerosol optical depth along with wind speed is acquired and utilized to verify the results by the comparison with CALIPSO retrieved results reported in previous work, and besides, the averaged marine aerosol lidar ratio at 355 nm along with wind speed is discussed for the relationship between marine aerosol particle size and wind speed."

2. **Introduction:** Three problems here.

   - First, there is an extreme ambiguity on which aspect of AOD_mar and wind speed relationship you want to address. You include so-called highlights, which actually erode the clarity of your research aim. State directly: do you want to examine whether there is a relationship between AOD_mar and wind speed using Aeolus? If yes, say it boldly and underpin all highlights (i.e., objectives) to this research aim please.

   AR: The basic research aim is to explore the relationship between marine aerosol optical properties (extinction coefficient, backscatter coefficient, lidar ratio) and wind speed within two vertical layers using Aeolus. As introduced in the introduction, almost all the previous studies mainly focused on the layer integrated optical properties (AOD) and ocean surface wind speed.

This study is going to explore the relationship between the vertical marine aerosol optical properties and the corresponding spatiotemporally synchronous wind speed using vertical profiles of Aeolus measurements, which could represent the marine-atmospheric aerosol background state and may reveal the transport and evolution of the marine aerosol vertically. To clarify the research aim, the highlights has been revised as:

"Generally, the highlights of this work mainly include 1) acquiring the spatiotemporally synchronous relationship between the aerosol optical properties (extinction coefficient, backscatter coefficient, lidar ratio) and the instantaneous wind speeds, which could indicate the background atmosphere states within and above the MABL over remote ocean, 2) conducting analysis at two separate height layers above ocean surface to explore the vertical differences in aspect of the wind-drive marine aerosol evolution."

- Second, it looks like you placed everything what is related to AOD_mar – wind speed relationship, Aeolus and CALIPSO aerosol observations of aerosol together, but in barely comprehensible logic. To be more specific, your introduction is neither centered over your research aim, nor logically guides a reader to this research aim paragraph by paragraph though showing important milestones and gaps made in this research field. In other words, it is related to the study topic, but chaotically structured.

AR: Thanks for your comments. Actually, it is considered that the introduction section was organized by guiding readers from research significance to research aim paragraph by paragraph.

The first paragraph states the necessity of studying marine aerosol.

The second paragraph introduces the significance of marine aerosol-wind relationship, then by analyzing some previous studies in this field, the shortcomings of those, mainly in the measurement of marine aerosol optical properties, are summarized in this paragraph as: for the passive measurements, "The passive instruments lack the abilities of distinguishing marine aerosol from other aerosols, acquiring vertical profiles of aerosols, and retrieving aerosol optical properties without sunlight (except for lunar-photometer) and under cloudy conditions (Kiliyanpilakkil and Meskhidze, 2011; Winker and Pelon, 2003)."; for the active measurements (lidar), the shipborne lidar's measurements can not be representative for the global ocean results while CALIOP measurements are restricted by the assuming lidar ratio. So, the key notes and what can be improved in the marine aerosol-wind speed relationship exploration were summarized as: "In summary, to explore the accurate relationship between the marine aerosol optical properties and the wind speed, it is essential to conduct global continuous observations and obtain the information of aerosol type identification, while vertical profiles of aerosols can provide extra spatial information for further analysis. Moreover, previous studies mostly focused on the layer AOD_{mar} and ocean surface wind speed, exploring the probable production of marine aerosol driven by surface wind. The relationship between the vertical marine aerosol optical properties and the corresponding spatiotemporally synchronous wind speed is still to be investigated, which represents the marine-atmospheric background state and may reveal the transport and evolution of the marine aerosol vertically."

To overcome the shortcomings and make some progress in the exploration of the relationship between marine aerosol optical properties and wind speed, the third paragraph introduces a spaceborne instrument, ALADIN, firstly used in this field, which had the ability to measure global aerosol and wind field vertical profile simultaneously. The fourth paragraph describes the data and the method used in this paper briefly and states the highlights of this work. It is considered that the third and the fourth paragraph raised a new approach which will solve some previous shortcomings in this study field.

To conclude, the framework of the introduction section was organized as: introduce the study subject (marine aerosol, the relationship between marine aerosol optical properties and wind speed), summarize the shortcomings of the previous studies, raise a new approach trying to overcome the shortcomings and make some progress.

Reference:

Kiliyanpilakkil, V. P. and Meskhidze, N.: Deriving the effect of wind speed on clean marine aerosol optical properties using the A-Train satellites, Atmos. Chem. Phys., 11, 11401–11413, https://doi.org/10.5194/acp-11-11401-2011, 2011.

Winker, D. M. and Pelon, J.: The CALIPSO mission, Geoscience and Remote Sensing Symposium, IGARSS '03, Proceedings, IEEE International, 2, 1329-1331, https://10.1109/IGARSS.2003.1294098, 2003.

- Third, you discuss marine aerosol optical properties – near wind relationship from lidar perspective, but omitted a large corpus of works dedicated to this issue. In particular, Josset et al. (2008) demonstrated that there is inverse relationship between wind speed and surface attenuated backscattering; while both these parameters have direct link to aerosol optical depth and this paper shows the formula how they are linked. Further works of Josset et al. (2008, 2010, 2018); Hu et al. (2008), Venkata and Reagan (2016) have elucidated this relationship in detail for CALIPSO and there were pre-launch Aeolus works on this topic such as Li et al. (2010). Moreover, some yet unfinalized studies, but ongoing efforts of Labzovskii et al. (2022) and Dionisi et al. (2022) addressing ocean surface-aerosol optical properties-wind interplay can be found as conference proceedings. By omitting all these CALIPSO and Aeolus-focused efforts, you hint that you are not aware about a hidden fundamental link between AOD and wind speed over oceans if your AOD is calculated using lidars. This can be a pitfall and a single point of failure for your methodology if this link does exist. Please check all the aforementioned works (I provided references in the end of this document) and incorporate their experience in your introduction, where the interpretation is up to you indeed.

AR: Thanks for the recommendation of these works. The research objective of this study is to explore the relationship between marine aerosol optical properties and wind speed using Aeolus, based on the physical principle that marine aerosol is produced and developed by the drive of wind. We have reviewed all of them and it is found that all indeed focus on spaceborne lidar

(CALIPSO, Aeolus) and are about ocean, but none of them are related to the relationship between marine aerosol optical properties and wind speed.

The three works of Josset et al. (2008, 2010, 2018) mainly talked about the aerosol optical depth retrieval method using ocean surface or land surface echoes. Among them, in Josset et al. (2008) the inverse relationship is between wind speed and surface attenuated backscattering. The surface attenuated backscattering is a parameter representing the lidar echo intensity of ocean surface and is totally distinct from atmospheric aerosol optical properties (extinction coefficient, backscatter coefficient, AOD, etc.). Hu et al. (2008), Venkata and Reagan (2016) applied this relationship, conducting the sea surface wind speed estimation from CALIPSO's ocean surface backscatter (Hu et al., 2008) and retrieving aerosol from CALIPSO's ocean surface returns (Venkata and Reagan, 2016), respectively. Though Li et al. (2010) focused on Aeolus and also used this relationship, it mainly cared about the sea surface reflectance for different incidence angles. For the recent works about Aeolus, Labzovskii et al. (2022) analyzed the sensitivity of Aeolus Lidar Surface Returns (LSR) to the types of surface, of which the research objective was exploring the retrieval of AOD using LSR over ocean, while Dionisi et al. (2022) was going to evaluate and document the feasibility of deriving an in-water prototype product from the analysis of the signal acquired Aeolus.

Thanks again for your recommendation. These works definitely broaden our horizons. As these works have little link with the subject of this manuscript (the relationship between marine aerosol optical properties and the corresponding spatiotemporally synchronous wind speed), it is decided that they are not quoted in the manuscript.

3. **Methodology:** This part of the manuscript is a potential pitfall as well. In particular, you have introduced your own framework of marine aerosol domination, cloud screening and wind speed-aerosol optical property analysis. However, nearly every stage of the framework you showed on Figure 1 should be justified because you made numerous debatable assumptions. The assumptions about effective ability to classify marine aerosol using CALIPSO to be applied for Aeolus, assumption about efficiency of cloud screening based on Rayleigh channel information of Aeolus. I will raise the following issues

   - According to 2.1, it looks like you used the wind speed from official Aeolus observational product. However, Figure 2 implies that you used AUX_MET winds from NWP/ECMWF simulations and L2C data. Clarify this aspect in every section please.

AR: We used the wind speed from official Aeolus Level 2C wind vector products, which are the outputs from the assimilation of the Aeolus Level 2B products (observational wind) in the ECMWF numerical weather prediction (NWP) operational model after 9 January 2020. Actually, the "NWP model winds from Level 2C product" means we used model winds from ECMWF provided in the L2C data, which are assimilated with observational wind.

In Section 2.1, we describe the Level 2C product of Aeolus as "It should be emphasized that Level 2C wind vectors are the outputs from the assimilation of the Aeolus Level 2B products in the ECMWF numerical weather prediction (NWP) operational model after 9 January 2020

(Rennie et al., 2021)." And for what data we used in this study, it was stated that "As mentioned above, we use Level 2A and Level 2C products of Aeolus for the study of the relationship between marine aerosol optical properties and wind speeds."

In Section 3, to clarify this aspect, the relevant description has been revised as "As for the wind vector data, Aeolus Level 2C product provides the u component (zonal components of wind vector) and v component (meridional components of wind vector) from the ECMWF model after assimilation of Level 2B observational wind product, at the same data bins of the Level 2A optical properties product."

Reference:

Rennie, M. P., Isaksen, L., Weiler, F., de Kloe, J., Kanitz, T., and Reitebuch, O.: The impact of Aeolus wind retrievals on ECMWF global weather forecasts, Q. J. Roy. Meteor. Soc., 147, 3555–3586, https://doi.org/10.1002/qj.4142, 2021.

- First, you may describe the methodology and only then, introduce Figure 1. In most cases, the description of a figure comes before the figure itself. Moreover, think about a reader, without reading a text, he/she might be easily confused by reading terms and concepts that you not introduced, nor described yet.

AR: Thanks for the advice, revised.

- You do not need to repeatedly use the term 'aerosol optical depth' as the acronym AOD is quite common. For instance, you keep using the term 'aerosol optical depth' without acronym even in Figure 1.

AR: Thanks for the advice. Besides the term "aerosol optical depth" in Figure 1, we have checked the whole manuscript and replaced the unnecessary "aerosol optical depth" with "AOD".

- Once you state that SCA product is more robust than other algorithms, either mention these algorithms directly or just state that SCA product is robust.

AR: Thanks for the advice. The sentence has been revised as "Extinction coefficient at 355 nm and backscatter coefficient at 355 nm retrieved by the standard correction algorithm (SCA) from Aeolus Level 2A product are used in this study, as the SCA processing is capable to produce more stable extinction coefficient and backscatter coefficient than the Mie channel algorithm (Flament et al., 2021)."

Reference:

Flament, T., Trapon, D., Lacour, A., Dabas, A., Ehlers, F., and Huber, D.: Aeolus L2A aerosol optical properties product: standard correct algorithm and Mie correct algorithm, Atmos. Meas. Tech., 14, 7851–7871, https://doi.org/10.5194/amt-14-7851-2021, 2021.

- Cloud screening. The presence of undetected clouds can severely plague your clear sky assumptions. How did you ensure that this screening strategy worked well? I did not notice any evaluation or statistical analysis of "cloud-free" and "cloud-containing" layers in your paper. Thus, the efficacy of this approach is questioned. Moreover, why one needs to use molecular optical depth and not Mie backscattering or extinction product (fundamentally more sensitive to thin clouds or liquid water clouds than Rayleigh product) directly to detect clouds at various heights? Let alone, you said that the SCA product is stable and you can confidently rely on these products.

AR: Sorry for that the vague sentence "The relative humidity (RH) and molecular backscatter coefficient of each data bin from the NWP model of ECMWF are provided in the Level 2A product and are utilized to screen the cloud layers." misled you. This sentence has been revised as "Aeolus measured particulate β, combined with relative humidity (RH) and molecular β from the ECMWF NWP model provided in the Level 2A product are utilized to screen the cloud layers." in the revised manuscript.

Actually, we used backscatter ratio (BR), which is the ratio of total β and molecular β, as the criteria to conduct cloud screening. Specifically, when the BR is larger than 2.5, the data bin is considered cloud contaminated and is eliminated. This approach was proposed in the Aeolus Level -2A Algorithm Theoretical Basis Document, i.e., Flament et al. (2021). It is indeed principally based on the Mie backscattering (particulate β), as Mie backscattering is fundamentally more sensitive to thin clouds or liquid water clouds while molecular β depending on temperature and pressure at various heights is relatively stable. Therefore, the approach is regarded available for cloud screening.

Moreover, as you advised, we supplemented the statistical analysis of "cloud-free" and "cloud-containing" layers in the revised manuscript as "With this cloud screening approach, in this study, 9%, 35%, 40% data in the altitude range of 0-2 km was eliminated for the NP area, the SP area and the SI area, respectively." to support the feasibility of this approach.

Reference:

Flament, T., Trapon, D., Lacour, A., Dabas, A., Ehlers, F., and Huber, D.: Aeolus L2A aerosol optical properties product: standard correct algorithm and Mie correct algorithm, Atmos. Meas. Tech., 14, 7851–7871, https://doi.org/10.5194/amt-14-7851-2021, 2021.

- Eliminating outliers. Okay, you referenced the paper from 1986 to justify statistical filtering of outliers. However, how did you ensure that in the particular case of Aeolus data, you have not filtered useful data using this particular statistical filter? I mean statistical filtering is helpful for sure, but only when you can understand when to apply this statistical filtering from physical point of view. Thus, please justify physical aspect of this choice here. The same is applied to outlier removal step introduced in Lines 368 – 375.

AR: This approach of eliminating outliers referred from Hoaglin et al. (1986) is the same as one used for boxplot. It is a widely used approach in data analysis, especially in the statistical analysis.

It can identify outliers from the dataset which are meaningless and will affect the statistical analysis results. For this study, though the valid aerosol extinction coefficients and backscatter coefficients from Aeolus were selected with the quality control flags, there will still be outliers that are unreasonable values. Before the elimination, the outliers of extinction coefficients and backscatter coefficients can catch up to 1000 $\mathrm{Mm^{-1}}$ and 30 $\mathrm{Mm^{-1} \cdot sr^{-1}}$ while generally the particulate extinction coefficients and backscatter coefficients are within 300 $\mathrm{Mm^{-1}}$ and 10 $\mathrm{Mm^{-1} \cdot sr^{-1}}$. Therefore, it is considered essential to eliminate these unreasonable values by the Tukey's test method.

Reference:

Hoaglin, D. C., Iglewicz, B., and Tukey, J. W.: Performance of some resistant rules for outlier labelling, Journal of the American Statistical Association, 81(396), 991-999, https://doi.org/10.1080/01621459.1986.10478363, 1986.

- Why the title of 2.1 is "ALADIN/Aeolus" with right slash? Give more comprehensible name to the section please. Same applies for 2.2.

AR: The titles of Section 2.1 and Section 2.2 have been revised as "ALADIN" and "CALIOP".

- (1) You introduce a depolarization correction of backscattering based on the assumption that CALIPSO can ideally detect marine aerosol, but this is not the case. What if you just introduced positive bias in many cases of your analysis by assuming their marine nature, while their depolarization was not typical for marine aerosol cases?

AR: Actually, for the defined "marine aerosol dominates areas" in this manuscript, there are a few terrestrial aerosols like dust, polluted dust, polluted continental and smoke, with the total proportion of no more than 10%, while among them the depolarization ratios at 355 nm of dust and polluted dust are 0.22-0.24 and 0.16 respectively, much larger than $\delta_{mar,355nm}$. Consequently, regarding all the aerosols as marine aerosol and correcting β_{mar} by formula (1) leads to the obvious underestimation of the β for dust and polluted dust. Nevertheless, in view of the small proportions of dust (no more than 3.15%) and polluted dust (no more than 0.79%) above the study areas and thanks to the statistical analyses of data for a long term, the assumption that regarding all the aerosols as marine aerosol will have little impact on the statistical analyses between β_{mar} and wind speed and is considered acceptable. The comments of this issue have been supplemented in Section 3 of the revised manuscript, as presented below: "It should be illustrated that all the aerosol β s from Aeolus identified as $\beta_{mar,Aeolus-co}$ s and then utilized to calculate β_{mar} s by formula (1) is under the ideal assumption that marine aerosol is the only aerosol type in the study areas. Though the study areas are all located in the remote ocean far away from land and are evaluated as "marine aerosol dominate" by CALIOP, there are a few terrestrial aerosols like dust, polluted dust, polluted continental and smoke, with the total proportion of no more than 10% (see Section 4.1 for the detail). For the part of terrestrial aerosols, the depolarization ratios at 355 nm of them are 0.22-0.24 for dust, 0.16 for polluted dust, 0.01 for polluted continental and 0.03 for smoke, among which the dust's and the polluted dust's are much larger than $\delta_{mar,355nm}$ (Floutsi et al., 2023). Consequently, regarding all the aerosols as marine aerosol and correcting β_{mar} by formula (1) leads to the obvious underestimation of the β for dust and polluted dust. Nevertheless, in view of the small proportions of dust (no more than 3.15%) and polluted dust (no more than 0.79%) above the study areas and thanks to the statistical analyses of data for a long term, the assumption that regarding all the aerosols as marine aerosol is considered not to critically impact the β_{mar} - wind speed relationship, while it should be noticed that the actual β is a little bit larger than the β_{mar}."

Reference:

Floutsi, A. A., Baars, H., Engelmann, R., Althausen, D., Ansmann, A., Bohlmann, S., Heese, B., Hofer, J., Kanitz, T., Haarig, M., Ohneiser, K., Radenz, M., Seifert, P., Skupin, A., Yin, Z., Abdullaev, S. F., Komppula, M., Filioglou, M., Giannakaki, E., Stachlewska, I. S., Janicka, L., Bortoli, D., Marinou, E., Amiridis, V., Gialitaki, A., Mamouri, R.-E., Barja, B., and Wandinger, U.: DeLiAn – a growing collection of depolarization ratio, lidar ratio and Ångström exponent for different aerosol types and mixtures from ground-based lidar observations, Atmos. Meas. Tech., 16, 2353–2379, https://doi.org/10.5194/amt-16-2353-2023, 2023.

- Potential inaccuracies due to assumptions (not calculations or objective information) about MABL of ~1 km are not discussed.

AR: Thank you for your comment. In the revised manuscript, besides the MABL height of around 1 km summarized from several references, the mean MABL height values of 787.47 ± 231.77 m at the NP area, 939.39 ± 360.20 m at the SP area and 1005.29 ± 366.60 m at the SI area are calculated from ECMWF provided boundary layer height as extra argument to support the MABL height. The MABL heights are variable and thus set as 1 km will lead to the potential inaccuracies. However, restricted by the relatively low height resolution of Aeolus (0.25 km below 0.5 km, 0.5 km in the range of 0.5 km to 2 km), utilizing more precise height boundaries won't make more sense. Therefore, it is considered that the statistical results of the 0-1 km layers and the 1-2 km layers are capable to generally represent the atmospheric conditions within the MABL and above the MABL.

The discussion about MABL heights are revised in the manuscript as:

"Referring the results of Luo et al. (2014), Luo et al. (2016) and Alexander et al. (2019), the MABL height of the remote ocean is summarized as around 1 km. Moreover, calculated with ECMWF provided boundary layer heights at the three study areas for the time period of 20 April 2020 to 26 May 2021, the mean values and the standard deviations are 787.47 ± 231.77 m at the NP area, 939.39 ± 360.20 m at the SP area and 1005.29 ± 366.60 m at the SI area. Hence, the boundary height of the two vertical layers is set as 1 km, approximately corresponding to the mean MABL height of remote ocean. Though the MABL heights are variable and thus set as 1 km will lead to the potential inaccuracies, restricted by the relatively low height resolution of Aeolus (0.25 km below 0.5 km, 0.5 km in the range of 0.5 km to 2 km), utilizing more precise height boundaries won't make more sense. It is considered that the statistical results of the 0-1 km layers and the 1-2 km layers are capable to generally represent the atmospheric conditions within the MABL and above the MABL."

Reference:

Alexander, S. P. and Protat, A.: Vertical profiling of aerosols with a combined Raman-elastic backscatter lidar in the remote Southern Ocean marine boundary layer (43–66°S, 132–150°E), J. Geophys. Res.-Atmos., 124, 12107–12125, https://doi.org/10.1029/2019JD030628, 2019.

Luo, T., Yuan, R., and Wang, Z.: Lidar-based remote sensing of atmospheric boundary layer height over land and ocean, Atmos. Meas. Tech., 7, 173–182, https://doi.org/10.5194/amt-7-173-2014, 2014.

Luo, T., Wang, Z., Zhang, D., and Chen, B.: Marine boundary layer structure as observed by A-train satellites, Atmos. Chem. Phys., 16, 5891–5903, https://doi.org/10.5194/acp-16-5891-2016, 2016.

- LayerL and LayerH are counterintuitive terms. At least, LayerL could be referred as $\text{Layer}_{\text{MABL}}$ for clarity throughout the text. Explain if I am wrong here and missing some intuitive links with L and H letters.

AR: The letter L of Layer_{L} represents "lower", indicating it is the lower layer, of which the altitude range is 0-1 km. Likewise, the letter H of Layer_{H} represents "higher", indicating it is the higher layer, of which the altitude range is 1-2 km. To clarify this issue, the relevant description in the manuscript has been revised as "The lower layer with the altitude range of 0 km to 1 km is called Layer_{L} in this paper and the higher layer with the altitude range of 1 km to 2 km is called Layer_{H}."

4. **Results:**

- Some information you placed into the Results obviously fits the methodological description in more logical way (see the lines from the start of Results 4 to Line 260). Lines 368 – 370 as well, where you talk about elimination of statistical outliers; this should be explained in the methodology not in the middle of the results section.

AR: Thanks for the suggestion. The study areas selection part has been moved to the second paragraph of the methodology section. And the wind direction analysis part was removed according to the third comment of results. The detailed explanation can be found in the response there. Likewise, the average calculation part including the outlier elimination part was moved to the last paragraph of the methodology section.

- Some terminological problems are visible. For instance, you say "it is considered that the Aeolus retrieved extinction and backscattering area reasonable". First, considered by whom? Second, what is "reasonable" from physical point of view? (Line 305 and above). This aspect is better clarified in Line 315.

AR: We compare Aeolus retrieved α_{mar} and β_{mar} with converted typical α_{mar} and β_{mar} ranges at 355 nm, calculated from the typical marine aerosol optical properties' ranges at 532 nm reported by Prijith et al. (2014), Kiliyanpilakkil and Meskhidze (2011) and the typical conversion coefficients, i.e., Ångström exponents reported by Floutsi et al. (2023). The data sources for the comparison are published and recognized, thus compared to the typical ranges, it is considered that the Aeolus retrieved extinction and backscattering area reasonable. The sentence has been revised, and we think it is clear if one combines this sentence with several previous sentences, which are shown as below:

"It is reported that the typical ranges of α_{mar} and β_{mar} at 532 nm over remote ocean areas are around 60 Mm^{-1} to 80 Mm^{-1} and around 1 $Mm^{-1} \cdot sr^{-1}$ to 5 $Mm^{-1} \cdot sr^{-1}$, respectively, observed and retrieved by CALIOP (Prijith et al., 2014; Kiliyanpilakkil and Meskhidze, 2011). Applying the typical α_{mar} Ångström exponent from 532 nm to 355 nm of 0.7 ± 1.3 and the typical β_{mar} Ångström exponent from 532 nm to 355 nm of 0.8 ± 0.1 (Floutsi et al., 2023), the converted typical ranges of α_{mar} and β_{mar} at 355 nm can be calculated, which are around 47 Mm^{-1} to 180 Mm^{-1} and around 1.3 $Mm^{-1} \cdot sr^{-1}$ to 7.2 $Mm^{-1} \cdot sr^{-1}$. Compared with the typical ranges of α_{mar} and β_{mar} at 355 nm, calculated from CALIOP retrieved typical ranges of marine aerosol optical properties and the typical conversion coefficients, it is considered that the Aeolus retrieved α_{mar} and β_{mar} are reasonable."

Reference:

Floutsi, A. A., Baars, H., Engelmann, R., Althausen, D., Ansmann, A., Bohlmann, S., Heese, B., Hofer, J., Kanitz, T., Haarig, M., Ohneiser, K., Radenz, M., Seifert, P., Skupin, A., Yin, Z., Abdullaev, S. F., Komppula, M., Filioglou, M., Giannakaki, E., Stachlewska, I. S., Janicka, L., Bortoli, D., Marinou, E., Amiridis, V., Gialitaki, A., Mamouri, R.-E., Barja, B., and Wandinger, U.: DeLiAn – a growing collection of depolarization ratio, lidar ratio and Ångström exponent for different aerosol types and mixtures from ground-based lidar observations, Atmos. Meas. Tech., 16, 2353–2379, https://doi.org/10.5194/amt-16-2353-2023, 2023.

Kiliyanpilakkil, V. P. and Meskhidze, N.: Deriving the effect of wind speed on clean marine aerosol optical properties using the A-Train satellites, Atmos. Chem. Phys., 11, 11401–11413, https://doi.org/10.5194/acp-11-11401-2011, 2011.

Prijith, S. S., Aloysius, M., and Mohan, M.: Relationship between wind speed and sea salt aerosol production: A new approach, Journal of Atmospheric and Solar-Terrestrial Physics, 108, 34-40, https://10.1016/j.jastp.2013.12.009, 2014.

- You dedicate considerable efforts to prove that your aerosol in ocean zones has marine/ocean origin. For instance, you speculate about winds in MABL and above. Why CALIPSO classification is not enough as methodological choice to determine once and for good that you have marine aerosol? You are eroding your research scope by devoting too much efforts to prove this point in the results, not in the methodology.

AR: Thanks for the advice. CALIPSO classification was considered enough as methodological choice to prove the "marine aerosol dominates areas". The original thought was that the wind directions were regarded as the assist evidences for the "marine aerosol dominates areas". But after discussion, we thought this part was an indirect and weak clue to the objective, and as you mentioned, this part eroded the research scope. Therefore, we decided to remove the wind direction part to maintain the concentration of the research scope.

- The style of reporting lacks references to certain figures, which hampers review process. You added three figures together in a row (4 – 6) and each consists of multiple panels. In this case, it is not helpful to refer to figures like "From Figures 4 – 6 you can see…" (line in the case of Line 316).

AR: Thanks for the suggestion. This sentence has been revised as "Figure 4, Fig. 5, and Fig. 6 presents the parameters distributions at two layers above the NP area, the SP area and the SI area".

- Line 316. I do not see this similarity qualitatively. Please try to use quantitative terms or more explicit qualitative description of similarity.

AR: The description that "have several similar features" is considered unspecific for the three figures including 24 panels totally. It is thought meaningless and was removed in the revised manuscript.

- Line 325 Numerical reference to what is "evident high wind speed region" is missing. Use numbers or direct references to figures here and elsewhere.

AR: Thanks for the suggestion. To clarify the description of "evident high wind speed region", the sentences have been revised as "Referring to $\mathrm{Layer_H}$, shown in the upper four panels of Fig. 4, Fig. 5 and Fig. 6, it can be found that the spatial variation trends of ws, α_{mar}, β_{mar} in the three areas are alike with those at $\mathrm{Layer_L}$. The evident high wind speed regions, where the wind speeds are up to around 8-10 $\mathrm{m \cdot s^{-1}}$ in 5°N to 20°N of the NP area, 15-18 $\mathrm{m \cdot s^{-1}}$ in 40°S to 60°S of the SP area and 13-19 $\mathrm{m \cdot s^{-1}}$ in 35°S to 60° of the SI area, also exist at $\mathrm{Layer_H}$ while α_{mar} and β_{mar} are slightly enhanced in these regions, which indicates that the wind speed may still have weak positive influence on the marine aerosol optical properties at the higher atmosphere layer above the MABL."

- Section 4.3 Use quantitative metrics while talking about such phenomena as increasing tendency. When I am looking at Figures 8 and 9, what we need here are rather: statistical agreement metrics (correlation or anything similar), metrics of statistical significance if this agreement exists, trend metrics. From first glance, I do not see any correlation for panels a, b, c. Perhaps, some correlation at panel d, but you did not articulate it.

AR: Actually, the previous thoughts of Fig. 8, 9 and 10 were to only present the data value distributions of marine aerosol optical properties and wind speed with 2-D histogram. That's why we only discussed about the data value ranges in the first paragraph of Section 4.3. It was considered that the 2-D histograms were not intuitive enough for the trend analyses. Consequently, there were no statistical agreement metrics, metrics of statistical significance and trend metrics in this part. The statistical agreement metrics and trend metrics are analyzed adequately in Fig. 11, 12 and 13, which also provide the wind speed data count distributions by the histogram. To conclude, in the aspect of trend metric, Fig. 8, 9 and 10 were not that intuitive as Fig. 11, 12 and 13; in the aspect of data value distribution, Fig. 11, 12 and 13 can also provide sufficient information. Therefore, it is considered that the information carried by Fig. 8, 9 and 10 is limited, while retaining these figures are redundant and repetitive. In the revised manuscript, we decided to remove Fig. 8, 9, 10 and the relevant description, then the previous Fig. 11-Fig. 16 were updated to Fig. 8-Fig. 13 consequently.

- Lines 403 – 405. You present an unsupported hypothesis here where it is not possible to establish whether you are facing the lack of wind data of > 15 m/s, some other physical phenomena such as response of ocean surface backscatter to stronger winds, which affects AOD in the end or even something else. Such unsupported surmises are not advisable for journals, focused on atmospheric physical phenomena.

AR: Thanks for your reminding. We did the gradient analyses of marine aerosol extinction and backscatter with wind speed. The results were added in the revised Fig. 11 (new Fig. 8) shown as below. We think with the gradients as prove, the surmise that there might be two distinct variation trends of α_{mar} and β_{mar} above or below the wind speed of 10 $\mathrm{m \cdot s^{-1}}$ can be guessed. The argument and the statement have been revised as "Referring to the panel (c) and (d) of Fig. 11, within the same wind speed interval, the gradient at $\mathrm{Layer_L}$ is larger than that at $\mathrm{Layer_H}$, i.e., the optical properties at $\mathrm{Layer_L}$ will increase more rapidly with wind speed. It is worth to notice that for the case that the wind speed is above 10 $\mathrm{m \cdot s^{-1}}$, the gradients of α_{mar} and β_{mar} seem to show decreasing tendencies, whereas under the condition when the wind speed is lower than 10 $\mathrm{m \cdot s^{-1}}$, the values of the optical properties' gradients present increasing tendencies, indicating the better fitting by power law functions at lower wind speed. This phenomenon may imply that there might be two distinct variation trends of α_{mar} and β_{mar} above or below the wind speed of 10 $\mathrm{m \cdot s^{-1}}$."

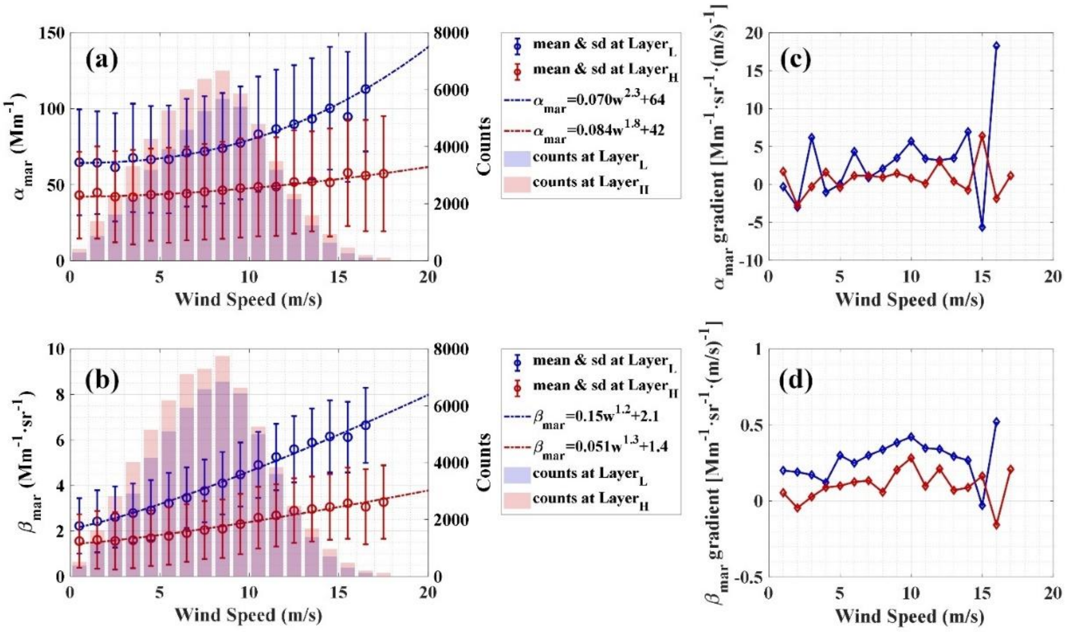

Figure 11: Relationship between marine aerosol optical properties ((a) for α_{mar}, (b) for β_{mar}) and wind speed above the NP area. The blue circles and error bars represent the means and standard deviations of the optical properties along wind speed grids at $Layer_L$ **, while the reds represent the same items at** $Layer_H$ **. The blue and red dotted-dashed lines are the optical property averages regression curves fitted along the wind speed grid at** $Layer_L$ **and** $Layer_H$ **, respectively. The blue and red histograms indicate the data counts of every wind speed grid at** $Layer_L$ **and** $Layer_H$ **, respectively. (c) and (d) represent the gradients of** α_{mar} **and** β_{mar} **with wind speed.**

- Lines 411 – 429 In this paragraph, you quantify only wind speed values, not optical properties of aerosols. I do not see any value in these speculations of optical properties of aerosols becoming “larger” or “smaller” at certain wind speed intervals without (1) strong quantitative arguments about relationship of these optical properties to wind speeds, (2) consistent, centered narration around the pattern you identified. Moreover, it is unclear why you analyzed both extinction and backscattering, it does not seem that you make any difference between these parameters. Neither in the way treating them, nor in making conclusions, you just report that they change in some way with wind. Without quantitative arguments of relationship with wind, without explicit references to figures, where you noticed these patterns, why would it matter after all?

AR: Thanks for your comments. We have rephrased this section with more strong quantitative arguments and modified with consistent, centered narration in the revised manuscript. We have supplemented the gradients of extinction and backscattering in the panel (c) and (d) of Fig. 8, Fig. 9 and Fig. 10 to describe the variation tendencies quantitatively. Extinction and backscattering are two most typical optical properties measured by lidar, which represents the attenuation property on light and the scattering property on light of aerosol, respectively. The objective of analyzing both of them is to try to establish extinction-wind speed and backscattering-wind speed relationship as inputs of the radiation transfer model.

- Line 468. Once again, Josset et al. [2008] have examined relationship between WS (AMSR-E from A-Train) and aerosol optical properties from collocated CALIPSO observations. Only over ocean. Please consider this point while writing your elaborations on WS-AOD_mar interplay here.

AR: The interplay of wind speed and AOD_mar intended to explore in this study is mainly based on the physical principle that the marine aerosol is produced and developed by the drive of wind. The specific relationships are between marine aerosol optical properties (extinction, backscatter, AOD and lidar ratio) and wind speed. The marine aerosol optical properties are calculated based on the atmospheric backscatter lights of lidar beams, independent of wind speed. Nevertheless, the relationship mentioned in Josset et al. (2008) was a method to calculate AOD using wind speed as an input parameter. Specifically, the relationship was established between the normalized surface reflectance and wind stress (Cox and Munk, 1954), and then, as an input, the normalized surface reflectance can be conducted into the calculation of AOD. This AOD is retrieved using wind speed as an input parameter. Consequently, the research objective in Josset et al. (2008) was distinct with ours. We decided not to discuss their work.

- Line 508 Unsupported surmise about the presence of clouds. Arguments are needed here.

AR: Thanks. Regarding to the AOD comparison between Aeolus retrieved and CALIOP retrieved presented in Fig. 14 (Fig. 11 in the revised manuscript), the lower CALIOP AOD at low wind speed has been discussed for the reason that using fixed lidar ratio leads to the possible underestimation. Besides, the strict cloud screening strategy was conducted to avoid cloud contamination as introduced in Section 3. Therefore, the surmise that high Aeolus AOD results from the possible cloud contaminations are considered unsupported and unnecessary. We decided to remove the sentence "The slightly high Aeolus retrieved AOD_{mar} may result from the possible cloud contaminations of the marine aerosol data bins." in the revised manuscript.

- Line 510 Quite late to introduce lidar ratio as you already spoke about it before. Please address the consistency of terminology and your acronyms here and elsewhere

AR: Thanks for the suggestion. The marine aerosol lidar ratio has been introduced in Section 3 so we decided to remove the first sentence of Section 4.4.2. Besides, the terminology "marine aerosol lidar ratio" was checked and replaced by " LR_{mar} " throughout the manuscript besides the first appearance.

- Figure 15. The deviations of LR from Aeolus are around 50%? For many types of data, such deviations make the quantification nearly meaningless. Your lidar ratio can jump from the values of 10 to >40.

AR:

According to the lidar observations, the pure marine aerosol LR at 355 nm can vary from 10 sr to 40 sr, while the simulated results showed that the pure marine aerosol LR can vary from 10 sr to 90 sr (Groß et al., 2013; Groß et al., 2015; Bohlmann et al., 2018; Floutsi et al., 2023; Masonis et al., 2003). Though the deviations of LR from Aeolus are large and the LR can jump from the values of 10 to >40, they are considered in the reasonable range physically. The large LR standard deviations at each wind speeds may result from the fluctuations of marine aerosol LR. From Fig. 12 (Fig. 15 of the old version, shown as below), it can be found that the not only ALADIN, but the CALIOP retrieved LRs reported by Dawson et al. (2015) are also have large deviations. However, focusing the mean values of LRs, the tendencies are comparable and similar.

Moreover, some errorbars and even data points are omitted (see intersection of 40 LR and wind speed of 1 m/s).

Figure 12 (Fig. 15 of the old version) has been modified as below:

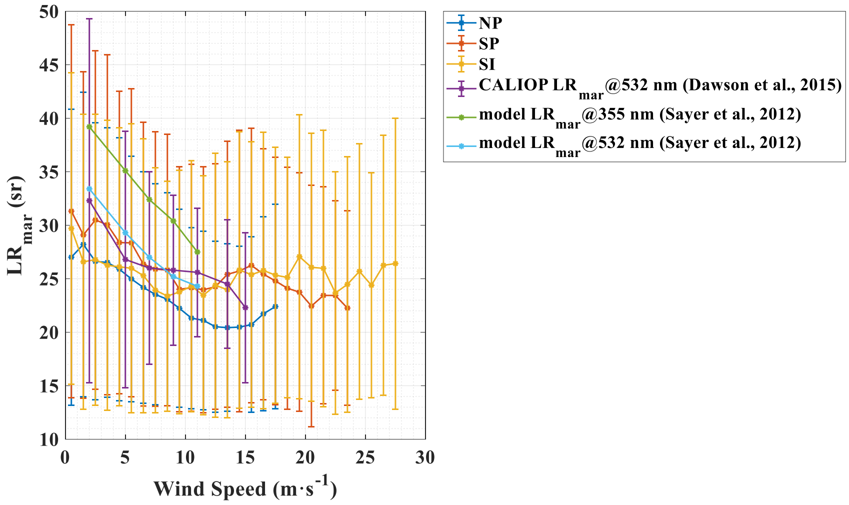

Figure 12: LR_{mar} versus the wind speed. The dark blue curve, red curve, yellow curve and the corresponding error bars represent the averaged LR_{mar} and their standard deviations above the NP area, the SP area and the SI area, respectively. The purple curve and the corresponding error bars represent the CALIOP-retrieved LR_{mar} at 532 nm (Dawson et al., 2015). The green curve and the light blue curve represent the modelled LR_{mar} at 355 nm and at 532 nm, respectively (Sayer et al., 2012).

Reference:

Bohlmann, S., Baars, H., Radenz, M., Engelmann, R., and Macke, A.: Ship-borne aerosol profiling with lidar over the Atlantic Ocean: from pure marine conditions to complex dust–smoke mixtures, Atmos. Chem. Phys., 18, 9661–9679, https://doi.org/10.5194/acp-18-9661-2018, 2018.

Dawson, K. W., Meskhidze, N., Josset, D., and Gassó, S.: Spaceborne observations of the lidar ratio of marine aerosols, Atmos. Chem. Phys., 15, 3241–3255, https://doi.org/10.5194/acp-15-3241-2015, 2015.

Floutsi, A. A., Baars, H., Engelmann, R., Althausen, D., Ansmann, A., Bohlmann, S., Heese, B., Hofer, J., Kanitz, T., Haarig, M., Ohneiser, K., Radenz, M., Seifert, P., Skupin, A., Yin, Z., Abdullaev, S. F., Komppula, M., Filioglou, M., Giannakaki, E., Stachlewska, I. S., Janicka, L., Bortoli, D., Marinou, E., Amiridis, V., Gialitaki, A., Mamouri, R.-E., Barja, B., and Wandinger, U.: DeLiAn – a growing collection of depolarization ratio, lidar ratio and Ångström exponent for different aerosol types and mixtures from ground-based lidar observations, Atmos. Meas. Tech., 16, 2353–2379, https://doi.org/10.5194/amt-16-2353-2023, 2023.

Groß, S., Esselborn, M., Weinzierl, B., Wirth, M., Fix, A., and Petzold, A.: Aerosol classification by airborne high spectral resolution lidar observations, Atmos. Chem. Phys., 13, 2487–2505, https://doi.org/10.5194/acp-13-2487-2013, 2013.
Groß, S., Freudenthaler, V., Wirth, M., and Weinzierl, B.: Towards an aerosol classification scheme for future EarthCARE lidar observations and implications for research needs, Atmos. Sci. Lett., 16: 77-82, https://doi.org/10.1002/asl2.524, 2015.
Masonis, S. J., Anderson, T. L., Covert, D. S., Kapustin, V., Clarke, A. D., Howell, S., and Moore, K.: A study of the extinction-to-backscatter ratio of marine aerosol during the Shoreline Environment Aerosol Study, J. Atmos. Ocean. Tech., 20, 1388–1402, https://10.1175/1520-0426(2003)020<1388:ASOTER>2.0.CO;2, 2003.
Sayer, A. M., Smirnov, A., Hsu, N. C., and Holben, B. N.: A pure marine aerosol model, for use in remote sensing applications, J. Geophys. Res., https://10.1029/2011JD016689, 2012.

- Line 529. You cannot say that similar results have been shown in previous studies. Rather, your study being chronologically newer, reports similar results, not the other way round. Moreover, specify the study you meant here directly.

AR: Thanks for the suggestion. The sentence has been revised as "The results reported in this paper are similar to those in the previous studies, of which Dawson et al. (2015) and Sayer et al. (2012) investigated the relationship between LR_{mar} and wind speed utilizing measured LR_{mar} and modelled LR_{mar} respectively."

Reference:

Dawson, K. W., Meskhidze, N., Josset, D., and Gassó, S.: Spaceborne observations of the lidar ratio of marine aerosols, Atmos. Chem. Phys., 15, 3241–3255, https://doi.org/10.5194/acp-15-3241-2015, 2015.

Sayer, A. M., Smirnov, A., Hsu, N. C., and Holben, B. N.: A pure marine aerosol model, for use in remote sensing applications, J. Geophys. Res., https://10.1029/2011JD016689, 2012.

- Line 531 You already used term AMSR-E, but explain it here once again.

AR: Thanks, revised.

- Minor comments on this section you do not need to respond to, just consider this criticism while rewriting your results

AR: Thanks for the comments. We considered all of them while rewriting the results.

1. Avoid ambiguous terms like "explicit relationship"; stick to statistical, mathematical or physical terminology in such cases.

AR: Thanks. We have deleted the word "explicit".

2. Line 375 As mentioned in the comment about introduction, some previous studies have reported negative relationship between wind speed and aerosol optical properties given wind speed-AOD-surface backscattering fundamental relationship once we are dealing with water surface. The discussion on this aspect with the link to previous studies is missing in both introduction and results sections.

AR: As explained in the response to the comment about introduction, the marine aerosol optical properties – wind speed relationships are based on the physical principle that the production and the development of marine aerosol are driven by wind. The marine aerosol optical properties were retrieved from the atmospheric backscatter lights of lidar beams. The surface bins were eliminated to avoid ocean surface return signals. Nevertheless, the negative relationship between wind speed and aerosol optical properties in some previous studies was exactly using surface return signal to calculate AOD, while the ocean surface return signal is negative with wind speed. Therefore, the research objective of our study is distinct with theirs.

- Line 418 Growth rates become smaller is a dubious formulation. Did you mean growth rates slowed down? The same applies to "change points". What are "change points" in line 420? Same for "wind speed distribution ranges are larger" (Line 413).

AR: These formulations have been removed as we almost rewrote this section.

The first sentence of this paragraph has been revised as "For the SP area and the SI area, the maximal wind speed can reach up to 28 $m \cdot s^{-1}$, while the variations of the optical properties along with wind speed are more complicated.".

1. Line 423 24 – 28 m/s is not quite strong wind, it's basically storm

AR: This formulation has been removed as we almost rewrote this section.

2. Line 424 You basically said that extinction will sharply increase under the condition of increased extinction, right? Re-read the sentence please or explain what I understood wrongly here.

AR: This sentence has been removed as we almost rewrote this section.

3. Line 425 Statistical significance should be supported by arguments here

AR: This statement has been removed.

- Line 440 Gradient change points? Where we can see that, which figure? Numbers are not mentioned here also to judge. Please update the entire paragraph with exact references to figures or numbers.

AR: Thanks. The sentence has been revised as "The gradient change point of α_{mar} (15 $\mathrm{m \cdot s^{-1}}$) is greater than that of β_{mar} (10 $\mathrm{m \cdot s^{-1}}$), and above them the enhancement rate becomes lower." This paragraph has been entirely revised.

- Line 444 There is no section starting here. Please update this paragraph using the same guidelines as I gave above (more quantitative analysis).

AR: Thanks for the suggestion. This paragraph has been removed and the statements in this paragraph has been integrated to other parts.

1. Line 459. The language of this section has been visibly deteriorated compared to previous sections. Please revise it as well to make it more readable: the effort (line 461)?, grid? (465, maybe grid cell?)

AR: Thanks. "The effort" has been revised as "the attempt". The "wind speed grid" has been revised as "wind speed interval".

2. Line 478 "Quite similar" is unscientific. Quantitative arguments please

AR: "Quite similar" here refers to the AOD data source, the study areas and the wind speed range of this study is similar to Kiliyanpilakkil and Meskhidze (2011). The specific arguments were presented in the front of this sentence as "As described above, the $\mathrm{AOD_{mar}}$ data source (from spaceborne lidar observation), the study areas (remote ocean regions globally), and the wind speed range (0 $\mathrm{m \cdot s^{-1}}$ - 29 $\mathrm{m \cdot s^{-1}}$) of the $\mathrm{AOD_{mar}}$ - ws relationship exploration in Kiliyanpilakkil and Meskhidze (2011) match well with those of this study."

3. Line 505 So how did you avoid enormously high errors due to wrongly fixed lidar ratios or at least quantified it?

AR: These errors belong to CALIOP retrieved AOD. Using CALIOP retrieved AOD can not avoid these errors while using Aeolus retrieved AOD can deal with this problem because Aeolus AOD retrieval is without the assumption of marine aerosol lidar ratios. This part is to illustrate the strength of Aeolus in the study of marine aerosol optical properties – wind speed relationship. To clarify this issue, the sentence has been revised as "Besides, as discussed in Section 4.4.2 of this paper, the particle size and the LR of the marine aerosol will vary with wind speed, so using the CALIOP $\mathrm{AOD_{mar}}$ retrieved with the fixed $\mathrm{LR_{mar}}$ may generate additional error in the exploration of the relationship between the $\mathrm{AOD_{mar}}$ and the wind speed."

1. **Conclusions:** Conclusions should be meticulously revisited after the revision. Most importantly, you missed the opportunity to give a holistic summary on what your analysis revealed in terms of physical behavior of aerosol. Did we learn something new about marine aerosols from physical standpoint? According to your conclusions – unlikely. Alternatively, you could fill up

this summary by speculating on the value of your findings with regards to Aeolus capabilities (low signal-to-noise ratio, low resolution, presence of clouds, complex relationship between ocean properties, AOD and wind speed). In the current form, you just plainly repeated the results and methodological choices in briefer form. Other, more concrete problems are here:

- You hinted that you identified marine aerosol in the results, but it is rather implied that you introduced some methodological tool to assume marine aerosol. Once again, it is unclear why CALIPSO classification was not enough for this purpose (Line 568)

AR: We identified marine aerosol with CALIPSO classification and cloud screening method and did not use any other methodological tool to assume marine aerosol. It is considered CALIPSO classification is enough for this purpose. To reduce ambiguity, this paragraph has been rephrased as "Three study areas located in remote ocean were selected, which were named the North Pacific (NP) area, the South Pacific (SP) area and the South Indian (SI) area, respectively. Then we examined the domination of marine aerosol with the aerosol classification data provided by CALIOP VFM products. The proportions of marine aerosol in these three areas are all larger than 79% respectively while the percentage sums of marine aerosol and dusty marine aerosol are all above 90%. After quality control, cloud screening was conducted with the criteria (relative humidity and backscatter ratio), and 9%, 35%, 40% data was identified cloud contaminated in the altitude range of 0-2 km then was eliminated for the NP area, the SP area and the SI area, respectively. Finally, backscatter correction is applied to the Aeolus L2A products. These procedures allow us to obtain reliable, cloud-free marine aerosol optical properties and the corresponding wind speed."

- Sensitivity analysis on distinguishing clouds from aerosols has not been shown, so I have doubts that you actually separated them quantitatively (Line 568). This statement definitely does not report your actual findings and therefore does not fit the conclusive tone it takes.

AR: The statistical analysis of cloud contaminated data has been conducted and the result was added in Section 3 and this part. The description in this part is "After quality control, cloud screening was conducted with the criteria (relative humidity and backscatter ratio), and 9%, 35%, 40% data was identified cloud contaminated in the altitude range of 0-2 km then was eliminated for the NP area, the SP area and the SI area, respectively." We think it can be the argument to the statement that "These procedures allow us to obtain reliable, cloud-free marine aerosol optical properties and the corresponding wind speed." in this paragraph.

- Vague methodological descriptions are redundant and uninformative for readers in the conclusions (Lines 568 – 570 about defining the areas of the study for example)

AR: Thanks. The methodological description part has been shorten and revised as "Three study areas located in remote ocean were selected, which were named the North Pacific (NP) area, the South Pacific (SP) area and the South Indian (SI) area, respectively. Then we examined the domination of marine aerosol with the aerosol classification data provided by CALIOP VFM products. The proportions of marine aerosol in these three areas are all larger than 79% respectively while the percentage sums of marine aerosol and dusty marine aerosol are all above

90%. After quality control, cloud screening was conducted with the criteria (relative humidity and backscatter ratio), and 9%, 35%, 40% data was identified cloud contaminated in the altitude range of 0-2 km then was eliminated for the NP area, the SP area and the SI area, respectively. Finally, backscatter correction is applied to the Aeolus L2A products. These procedures allow us to obtain reliable, cloud-free marine aerosol optical properties and the corresponding wind speed."

- Repetitive formulations, partly reflecting your research aim/objectives are spotted (Line 574)

AR: Thank, we have revised the repetitive formulations.

- The information preceding the line 583 is redundant for conclusions from my point of view and should be either shortened or be more concrete in terms of reporting.

AR: Thanks. This paragraph has been removed. The statements were integrated into the next paragraph.

- Line 600 – repetitive, you said it three times in the conclusions. Report conclusion directly without repeating research aim/question.

AR: Thanks. The sentence has been revised as "The α_{mar} - ws , β_{mar} - ws models within and above MABL at remote ocean areas were established with Aeolus provided data."

- As mentioned, you do not shed the light on the difference between backscattering coefficient and extinction coefficient; they were treated identically and discussed as statistical parameters, not physical properties of aerosols.

AR: Extinction and backscattering are distinct, the two most typical optical properties measured by lidar, which represents the attenuation property on light and the scattering property on light of aerosol, respectively. They are defined as extensive optical properties, dependent on the aerosol concentration. The objective of analyzing both of them is to try to establish extinction-wind speed and backscattering-wind speed relationship as inputs of the radiation transfer model.

- Lines 595 – 599 You cannot judge about the size of the particle without either deriving microphysical properties of aerosols or at least by using Angstrom exponent. Lidar ratio does not fit such purpose, it just shows the ratio between light being extinct and light being scattered.

AR: Thanks for your comments. As you mentioned, it is better to use Ångström exponent to indicate the particle size of aerosol. However, with the only work wavelength of 355 nm, Aeolus can not provide Ångström exponent. Generally, aerosol lidar ratio shows the ratio between light being extinct and light being scattered. However, it was reported that the marine aerosol lidar ratio and its particle size have negative relationship (Masonis et al., 2003). The relationship between lidar ratio and marine aerosol particle size was introduced in Section 4.4.2 as:

"It is reported that the LR_{mar} depends on the particle size, and specifically, with the reduction of the coarse mode, the total LR turns out to increase (Masonis et al., 2003). The possible reason for this phenomenon is that as the particles become smaller, the extinction is enhanced by the increasing sideward scattering and the backscatter gets weaker due to the decrease of the scattering cross section (Haarig et al., 2017)."

Therefore, it is considered that we can use marine aerosol lidar ratio implying its particle size. The statement in the conclusion section has been revised as "The LR_{mar} and marine aerosol particle size have negative relationship (Masonis et al., 2003). From the relationship between the LR_{mar} and the wind speed, it indicates that as the wind speed is increasing, the particle size of marine aerosol obviously becomes larger at relative low wind speed range, then could be broken up into smaller by wind at higher wind speed, and ultimately turns out a larger state again at very high wind speed."

- Line 603 You have not analyzed turbulence in your study.

AR: Thanks. We have deleted this sentence.

- Line 604 Wind speed bin is not scientific term known by a general reader.

AR: Thanks. We have deleted this sentence.

- Line 605 The statement about 'not total similarity' of aerosol variation tendencies does not bring any new knowledge and is, therefore, not useful for conclusions.

AR: The statement has been revised as "Nevertheless, the regression curves of α_{mar} - ws and β_{mar} - ws above three study areas (the NP area, located in the Pacific Ocean, the low latitudes of the Northern Hemisphere; the SP area, located in the Pacific Ocean, the middle latitudes of the Southern Hemisphere; the SI area, located in the Indian Ocean, the middle latitudes of the Southern Hemisphere) are not totally consistent, while the meteorological and environmental conditions apart from wind are also distinct at different regions."

- Lines 605 – 607 On the development of aerosols over ocean due to complex factors – you have not shown this in your study. As a suggestion, it is trivial because the complex relationship between aerosol evolution over ocean and processes on the ocean-atmosphere interface, as well as in the atmosphere; this relationship is obvious. Bring numbers and facts if you'd like to add some new value to this common knowledge.

AR: Thanks for the comments. We have tried to make this paragraph logic. The argument and the corresponding statement were revised as:

"Nevertheless, the regression curves of α_{mar} - ws and β_{mar} - ws above three study areas (the NP area, located in the Pacific Ocean, the low latitudes of the Northern Hemisphere; the SP area, located in the Pacific Ocean, the middle latitudes of the Southern Hemisphere; the SI area, located in the Indian Ocean, the middle latitudes of the Southern Hemisphere) are not totally consistent, while the meteorological and environmental conditions apart from wind are also distinct at different regions. It implies that in order to obtain more precise α_{mar} and β_{mar} models, besides wind speed, other meteorological and environmental factors, e.g., atmospheric stability, sea and air temperature, RH, etc. should participate in the establishment of the models, because the production, entrainment, transport and removal of the marine aerosol above the ocean are not only dominated by the wind, but also be impacted by these factors (Lewis and Schwartz, 2004). If future study is capable to obtain more other meteorological parameters above ocean, jointly analysing the aerosol optical properties and the wind together with them, more detailed information of marine aerosol production, entrainment, transport and removal will be acquired."

2. **Language and Format:** Language should be revised either by seeking assistance of colleagues, more familiar with the standard of academic English or automated software for language check at minimum. Multiple stylistic (PDF-oriented font format is spotted at line 48 as example), and more critically, grammar errors are found ('significate' at line 45 for instance). Formatting caveats also include redundant spacing (line 131), double bracketing, inconsistent introduction of acronyms, etc. Please eliminate all these drawbacks, which currently emphasize the raw condition of your draft.

   AR: Thanks for your comments. We have carefully reviewed and revised the manuscript throughout to avoid grammar errors and formatting caveats.

Mentioned references:

1. Dionisi et al., (https://meetingorganizer.copernicus.org/EGU23/EGU23-16196.html)
2. Hu, Y., Stamnes, K., Vaughan, M., Pelon, J., Weimer, C., Wu, D., Cisewski, M., Sun, W., Yang, P., Lin, B., Omar, A., Flittner, D., Hostetler, C., Trepte, C., Winker, D., Gibson, G., Santa-Maria, M., 2008. Sea surface wind speed estimation from space-based lidar measurements. Atmos. Chem. Phys. 10.
3. Josset, D., Pelon, J., Hu, Y., 2010 Multi-Instrument Calibration Method Based on a Multiwavelength Ocean Surface Model. IEEE Geosci. Remote Sensing Lett. 7, 195–199. https://doi.org/10.1109/LGRS.2009.2030906
4. Josset, D., Pelon, J., Pascal, N., Hu, Y., Hou, W., 2018. On the Use of CALIPSO Land Surface Returns to Retrieve Aerosol and Cloud Optical Depths. IEEE Trans. Geosci. Remote Sensing 56, 3256–3264. https://doi.org/10.1109/TGRS.2018.2796850

5. Josset, D., Pelon, J., Protat, A., Flamant, C., 2008. New approach to determine aerosol optical depth from combined CALIPSO and CloudSat ocean surface echoes: New approach to determine AOD. Geophys. Res. Lett. 35. https://doi.org/10.1029/2008GL033442
6. Labzovskii L., van Zadelhoff G-J, Donovan D, De Kloe J., Josset D., 2022. How sensitive are Aeolus Lidar Surface Returns (LSR) to the types of surface? Insights for LSR-based retrieval of AOD over ocean by using Aeolus; https://doi.org/10.5194/egusphere-egu22-12079
7. Li, Z., Lemmerz, C., Paffrath, U., Reitebuch, O., Witschas, B., 2010. Airborne Doppler Lidar Investigation of Sea Surface Reflectance at a 355-nm Ultraviolet Wavelength. Journal of Atmospheric and Oceanic Technology 27, 693–704. https://doi.org/10.1175/2009JTECHA1302.1
8. Venkata, S., Reagan, J., 2016. Aerosol Retrievals from CALIPSO Lidar Ocean Surface Returns. MDPI Remote Sensing 8, 1006. https://doi.org/10.3390/rs8121006

Responses to RC3:

This manuscript combines Aeolus and CALIPSO data along with ECMWF wind products that assimilate Aeolus to understand the relationship between wind speed and marine aerosol optical properties in 3 remote oceanic basins. The manuscript is well written and results are clearly presented. I recommend publication with minor revision:

1) The authors have a hard cut-off at 1 km to mark the MABL top throughough the manuscript. I would suspect this would vary somewhat with region. Can the authors comment on any ramifications of this? Would using ECMWF MABL help?

AR:

a. That the MABL height of the remote ocean areas is around 1 km was summarized from several references (Luo et al., 2014; Luo et al., 2016; Alexander et al., 2019).

b. Thank you for your advice, and we have calculated the mean values of ECMWF provided boundary layer heights at the three study areas for the time period of 20 April 2020 to 26 May 2021, which are 787.47 ± 231.77 m at the NP area, 939.39 ± 360.20 m at the SP area and 1005.29 ± 366.60 m at the SI area.

c. Moreover, the height resolution (0.25 km below 0.5 km, 0.5 km in the range of 0.5 km to 2 km) of Aeolus is relatively low. Using 1 km as the boundary to split Aeolus data vertically is feasible while more precise MABL height won't make more sense. Therefore, it is considered that the consequent lower layer (0-1 km) is capable to generally represent the MABL.

As you advised, the discussion about MABL heights are revised in the manuscript as:

"Referring the results of Luo et al. (2014), Luo et al. (2016) and Alexander et al. (2019), the MABL height of the remote ocean is summarized as around 1 km. Moreover, calculated with ECMWF provided boundary layer heights at the three study areas for the time period of 20 April 2020 to 26 May 2021, the mean values and the standard deviations are 787.47 ± 231.77 m at the NP area, 939.39 ± 360.20 m at the SP area and 1005.29 ± 366.60 m at the SI area. Hence, the boundary height of the two vertical layers is set as 1 km, approximately corresponding to the mean MABL height of remote ocean. Though the MABL heights are variable and thus set as 1 km will lead to the potential inaccuracies, restricted by the relatively low height resolution of Aeolus (0.25 km below 0.5 km, 0.5 km in the range of 0.5 km to 2 km), utilizing more precise height boundaries won't make more sense. It is considered that the statistical results of the 0-1 km layers and the 1-2 km layers are capable to generally represent the atmospheric conditions within the MABL and above the MABL."

Reference:

Alexander, S. P. and Protat, A.: Vertical profiling of aerosols with a combined Raman-elastic backscatter lidar in the remote Southern Ocean marine boundary layer (43–66°S, 132–150°E), J. Geophys. Res.-Atmos., 124, 12107–12125, https://doi.org/10.1029/2019JD030628, 2019.

Luo, T., Yuan, R., and Wang, Z.: Lidar-based remote sensing of atmospheric boundary layer height over land and ocean, Atmos. Meas. Tech., 7, 173–182, https://doi.org/10.5194/amt-7-173-2014, 2014.

Luo, T., Wang, Z., Zhang, D., and Chen, B.: Marine boundary layer structure as observed by A-train satellites, Atmos. Chem. Phys., 16, 5891–5903, https://doi.org/10.5194/acp-16-5891-2016, 2016.

2) Line 41. Please specify - by area, by mass.

AR: The first sentence of Section 1 has been revised as "According to the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report, the total emission of marine aerosol (including marine primary organic aerosol) produced from ocean is 1400 to 6800 $\mathrm{Tg \cdot yr^{-1}}$, which is considered the largest natural aerosol input to the atmosphere globally (Boucher et al., 2013)." to make it more logical.

Reference:

Boucher, O., D. Randall, P. Artaxo, C. Bretherton, G. Feingold, P. Forster, V.-M. Kerminen, Y. Kondo, H. Liao, U. Lohmann, P. Rasch, S.K. Satheesh, S. Sherwood, B. Stevens and X.Y. Zhang, 2013: Clouds and Aerosols. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin,

G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

3) Line 95. Change from "is" to "was" as ALADIN stopped science operations at the end of April 2023.

AR: Thanks, revised.

4) Line 174. Why was version 3.41 used for January 2022- July 2022? Was version 4 data not available? This has implications for continuity of the VFM algorithm.

AR: Only version 3.41 of CALIOP VFM product is available for January 2022- July 2022, while version 4 data was not available in this period.

Figure 1 shows the Fig. 1 from Kim et al. (2018), which is the flowchart of the CALIPSO aerosol subtype selection scheme for tropospheric aerosols. In this flowchart, the blue-shaded region and blue-dotted arrows are used in V3 but removed in V4 while the red-shaded region and solid red arrows are newly added in V4. It can be learnt from the flowchart that the main framework of the aerosol subtype discrimination algorithm is the same between V3 and V4. Nevertheless, considering that the new-added procedure of version 4 in the red-shaded region identifies part of "polluted dust" aerosol subtype as "dusty marine", partly using version 3 VFM data will lead to the underestimate of "dusty marine" aerosol and the "marine" subtype discrimination will not be influenced. As describe above, using the version 3.41 of the CALIOP VFM data for January 2022- July 2022 in this study led to the underestimate of total marine aerosol portion, which means the real total marine aerosol percentage is larger than the statistic. To conclude, though there are several upgrades between version 4 and version 3, the statistical results of aerosol subtype are acceptable and the "marine aerosol dominating areas" conclusion is not affected.

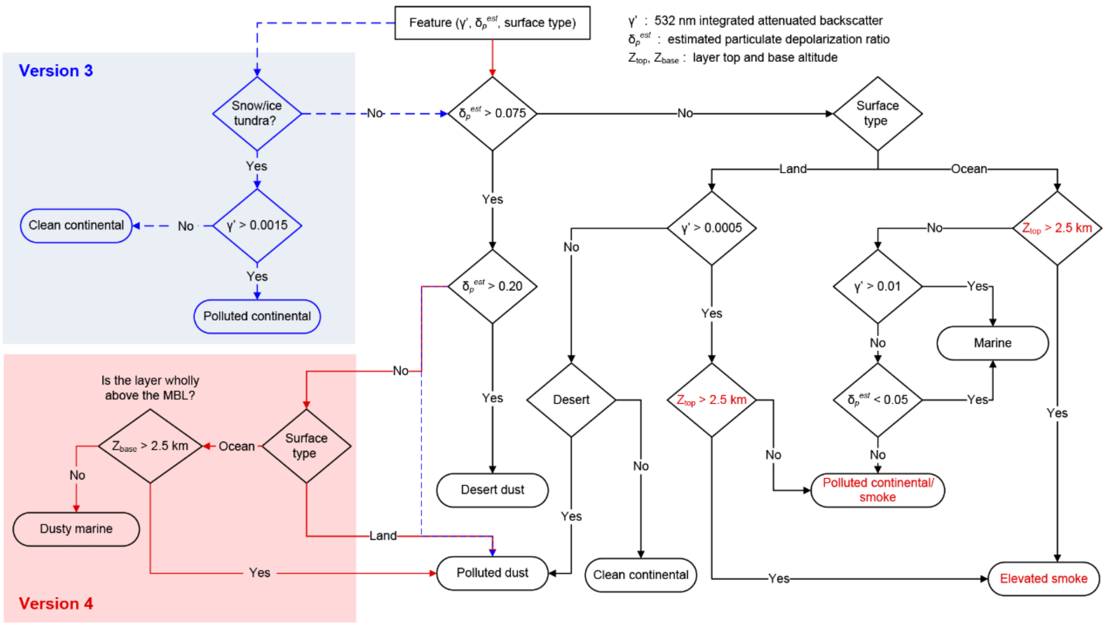

Figure 1: Flowchart of the CALIPSO aerosol subtype selection scheme for tropospheric aerosols (Fig. 1 from Kim et al. (2018)).

To briefly clarify this fact, the relevant description has been added to the Section 4.1 as "It should be illustrated that "dusty marine" was a new aerosol subtype raised for the first time in the version 4.10 of the CALIOP VFM product and was absent in the version 3.41, which was identified from part of version 3.41's "polluted dust" with the criteria of "surface type" and "layer base altitude". Using the version 3.41 of the CALIOP VFM data for the period of 19 January 2022 to 4 July 2022 led to the underestimate of "dusty marine" portion and the total marine aerosol portion. Even though under the condition of underestimate, the percentage of total marine aerosol are larger than 90%, which means the real proportion of total marine aerosol is higher, and hence the conclusion that the marine aerosol dominates in the altitude range of 0-2 km above these three areas is still valid."

Reference:

Kim, M.-H., Omar, A. H., Tackett, J. L., Vaughan, M. A., Winker, D. M., Trepte, C. R., Hu, Y., Liu, Z., Poole, L. R., Pitts, M. C., Kar, J., and Magill, B. E.: The CALIPSO version 4 automated aerosol classification and lidar ratio selection algorithm, Atmos. Meas. Tech., 11, 6107–6135, https://doi.org/10.5194/amt-11-6107-2018, 2018.

5) The authors have not discussed the implication for the time offset of CALIPSO and Aeolus. While I don't think this is a major impact, the aerosol typing by CALIPSO will be after Aeolus observed winds and would be seeing the aftermath. Please consider discussing this point in the manuscript.

AR:

a. Generally, as for the closest orbits of Aeolus and CALIPSO, CALIPSO scanning tracks are about 4 h ahead of Aeolus (Dai et al., 2022). The lifetime of marine aerosol is usually with in the range of 1 day to 1 week, depending on its size (Boucher et al., 2013). Compared to the lifetime of marine aerosol, the 4 h time offset between CALIPSO and Aeolus observations is much shorter, and hence the same marine aerosol layer will be observed by two spaceborne lidars with very high probability.

b. The aerosol type analyses is a statistical result using more than two years CALIPSO aerosol typing data, which represent the background aerosol type conditions in the 0-2 km height atmospheric layers of the three study areas, and is considered to be independent of wind speed.

To conclude, the implication for the time offset of CALIPSO and Aeolus is intended to be ignored resulting from the much shorter time offset compared to the marine aerosol lifetime and the long-term statistical analyses of CALIPSO aerosol typing data.

Reference:

Boucher, O., D. Randall, P. Artaxo, C. Bretherton, G. Feingold, P. Forster, V.-M. Kerminen, Y. Kondo, H. Liao, U. Lohmann, P. Rasch, S.K. Satheesh, S. Sherwood, B. Stevens and X.Y. Zhang, 2013: Clouds and Aerosols. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA

Dai, G., Sun, K., Wang, X., Wu, S., E, X., Liu, Q., and Liu, B.: Dust transport and advection measurement with spaceborne lidars ALADIN and CALIOP and model reanalysis data, Atmos. Chem. Phys., 22, 7975–7993, https://doi.org/10.5194/acp-22-7975-2022, 2022.

6) Equation 1. Consider labeling Bmar, Aeolus as Bmar, Aeolus co or Bmar, Aeolus II to indicate it is the co polarized return.

AR: Thanks for the advice. Equation 1 has been revised as $\beta_{mar} = (1+\delta_{mar,355nm}) \cdot \beta_{mar,Aeolus-co}$.

7) Line 555. The "upward" trend in the middle of the plot seems very faint.(DIFF) Is it statistically significant?

AR: The revised Fig. 13 (Fig. 16 in the old version), shown as below, presents the $\mathrm{LR}_{\mathrm{mar}}$ variation with wind speed at $\mathrm{Layer}_{\mathrm{L}}$ and $\mathrm{Layer}_{\mathrm{H}}$, in (a) the NP area, (b) the SP area and (c) the SI area, respectively.

From this figure, the upward trends can be found at the middle wind speed range, 13 $\mathrm{m \cdot s^{-1}}$-17 $\mathrm{m \cdot s^{-1}}$ of the NP area, 9 $\mathrm{m \cdot s^{-1}}$-16 $\mathrm{m \cdot s^{-1}}$ of the SP area, 10 $\mathrm{m \cdot s^{-1}}$-20 $\mathrm{m \cdot s^{-1}}$ of the SI area, which are especially significant for $\mathrm{Layer}_{\mathrm{H}}$. Therefore, it is considered statistically significant.

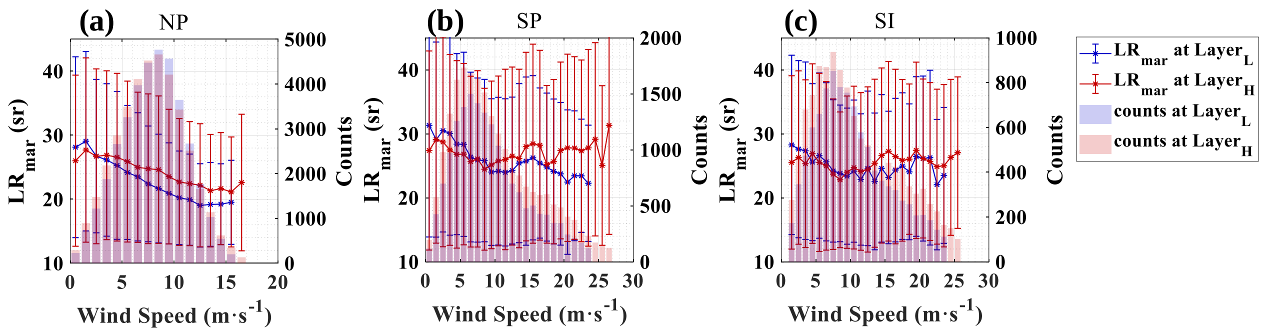

Figure 13: Averaged $\mathrm{LR}_{\mathrm{mar}}$ versus wind speed at $\mathrm{Layer}_{\mathrm{L}}$ and $\mathrm{Layer}_{\mathrm{H}}$, in (a) the NP area, (b) the SP area and (c) the SI area, respectively.