Answer to Referee #2

We greatly appreciate the insightful feedback provided by Referee #2, which we received on August 07, 2023. The comments from the referee that have been addressed in the manuscript are indicated in green, and the responses from the authors to the referee are highlighted in red.

This manuscript compares AEOLUS wind measurements with coordinated radiosonde observations, targeting the overpasses of AEOLUS, during a two month tropical field campaign. The comparison allows the AEOLUS observations to be placed within a proper uncertainty contex for future use by modelers and others. The paper is in mostly good shape, but there are a few problems that need to be fixed.

There is one major question unaddressed. The AEOLUS satellite has been in operation since 2018, so into its 5th year of measurements. With such a large data base it seems there should have been a number of near overpasses of the standard radiosonde network in the tropics during those 5 years. Is that not the case? If that is not the case it should be mentioned so the motivation for the dedicated radiosonde campaign is clear. If it is the case then such a study needs to be referenced, or the number of such previous coincidences needs to be mentioned and the reason for excluding them from this study. There is no mention of this in the literature review.

Thank you for your comment. We chose to focus on radiosonde data from the JATAC campaign for four specific reasons:

1. **Tropical Data Scarcity**: Radiosonde network in the tropics, especially the Global Observation System (GOS), has limited and irregular data due to infrequent reporting.
2. **Timing Gaps**: Radiosondes are usually launched at fixed times (12 and 00 UTC), creating observation gaps for the comparison with Aeolus, especially near the Greenwich meridian. Additional measurements at 06 UTC and 18 UTC were needed for comprehensive coverage.
3. **Challenges in Validation**: Changes in Aeolus data quality and product change over the past five years made a broad validation challenging. Focusing on the JATAC period allowed for a more accurate validation.
4. **Comprehensive Comparisons**: Restricting the comparisons to the JATAC period enables meaningful comparisons with other instruments used during the campaign, such as aircraft measurements conducted simultaneously.

To clarify our motivation, we have included the following sentence in line 75: "*Furthermore, our approach involves using radiosonde data exclusively from the JATAC campaign to facilitate more*

comprehensive comparisons with other campaign instruments, considering the scarcity of radiosonde measurements in the tropics, the need for radiosonde launches at local dusk-dawn times to reduce timing gaps and possible variations in Aeolus data quality across different times and locations."

The other major complaints concern the figures. First the choice of symbol/line size, color, and faintness is poor. Data in the figures should not be hard to see at normal zoom levels, and not hard to distinguish between one set of data and another, but presently that is the case. In some figures the lines indicating the data are practically invisible, and the colors chosen are too close to each other. Second there is no need to repeat in the text the figure captions. Leave that in the figure. In the text discuss the figure, the reader will find the figure caption.

Thank you for your feedback. We've addressed this concern and made the necessary adjustments to Figures 1, 2, 7, 8, and 9 based on the specific comments provided below and addressed in subsequent responses. We've also ensured that there's no redundancy between the captions and the main text throughout the manuscript. We believe these modifications have significantly improved the clarity of the figures, thanks to your valuable input.

Further specific comments on these issues and a few others, along with suggested corrections follow here by line number. Text in the manuscript, or corrections to that text, are set off with ellipses. While I am willing to review a second version, that is not necessary assuming the authors make a good faith effort to address these comments.

- General comments
  - 87 … with an angle of …
    - revised accordingly
  - 100 … respectively. The 87 km is required by the lower …
    - revised accordingly
  - 109 It would be helpful to briefly mention what particles are being observed for the Mie-clear observations. Later we find that Mie-clear is not used. Why introduce a classification that is not used for obvious reasons? Mie-clear must have no particles for scattering, so how can it work. Leave it out.
    - Thank you for your input. We have excluded "Mie-clear" from the text.
  - 112 Is this product identified by two numbers, 12 and L2bP 3.50? This is a bit confusing. Are both numbers important for the reader? We find later neither is used further.
    - A single mention of these two numbers is enough to provide precise information to the reader regarding the dataset utilized in this study.

- 113 It is not surprising that the Mie-clear signal is weak, which harkens back to line 109. This should be dealt with all at once. Not piecemeal. In addition there is a problem with this sentence related to the word “should”.
    - revised accordingly
- 125-126 Does (4d-EnVar) have to be defined twice?
    - revised accordingly
- Table 1 – Of what importance is the weekday? More important would be the dates it seems. The times are very tight for Aeolus, usually a span of one minute. But is the orbit of Aeolus that stable that it would always be 50, or 180, or … km away from the sounding location on every profile on a given week day at exactly the same time? This needs explanation. It seems there would be some variability for soundings on different days, and some variability on the coincidence radius.
    - We omit listing all 20 dates, given their weekly recurrence. The weekday is just informative for this purpose. Our choice of a co-location radius is positioned closely along the satellite tracks but large enough to accommodate the orbit variability each week. Start and stop times have been rounded to the nearest minute, and they consistently exhibit similarities week after week.
- 135-136 KIT has already been defined, so use it. If an acronyms is not going to be used, don’t define it. In fact I don’t think KIT is used again.
- 137 Aren’t all weather radiosondes light these days?
    - Yes indeed, “light” can be omitted.
- 141 Similarly, NASA has already been defined.
- 149 Don’t all weather radiosondes provide wind speed, wind direction, temperature, humidity and air pressure?
    - Yes this information is indeed not necessary. We rephrased as following: “*The launches were coordinated by the KIT with local support from the JATAC team, using DFM-09 (GRAW) weather radiosondes.”*
- 171-173 Why is very high/high included for clouds below 7 km? Similarly if very high is for clouds above 16 km, why is it included for clouds between 7 and 16 km? Why are these classifications even mentioned? They are never used again.
    - Kindly refer to our response to the first reviewer.
- 182 …80 km and a time resolution of 6 hours …
- 192 What is meant by the radiosonde total horizontal wind speed? Isn’t the radiosonde wind speed averaged over each Aeolus height bin?
    - When referring to total horizontal wind speed, we are indicating the combined magnitude of both wind components.
- 229 Generally ms-1 means per millisecond, whereas m/s is usually written as m s-1.
    - We changed this throughout the whole text.
- 244 … In contrast, the Mie …
- 247 How does a wind product get a validity flag of 0? Don’t the authors just mean that, … all Aeolus wind products with EE above 8 ms–1 for Rayleigh and 4 ms–1 for

Mie, are omitted. … Why introduce a validity flag which is just a reflection of these criteria. The criteria mean something. The validity flag doesn't and is never mentioned again.

- In this section, we're describing the quality control procedure we implement before using the data for our study. The validity flag is an important part of this process, along with the EE thresholds, to remove observations that are not reliable and have been blacklisted. We don't revisit this aspect later because our primary objective here is to explain the initial data preprocessing steps.

- 267 Note that Mie-clear is not included here, which begs the question of why it was ever mentioned.
  - We have removed all references to Mie-clear in the text.
- 4.1.1 Comparative analysis with the ECMWF model equivalents – Isn't the comparison primarily between AEOLUS and the radiosondes? The ECMWF in the title is a bit confusing. It should be pointed out whether the ECMWF model equivalents have incorporated the sounding data, which was added to the GTS as mentioned earlier.
  - You're right, the title was somewhat misleading. Hence, we modified it to "Comparative analysis with radiosondes and ECMWF model equivalents". Additionally, in section 2.2 "Radiosondes", we already mentioned that "Most of the radiosondes launched at Sal were ingested into the Global Telecommunication System (GTS)". However, this detail isn't crucial to the main conclusion of this section. The key takeaway here is the strong agreement between radiosonde and model equivalents, highlighting the reliability of the co-location parameters used in this study.
- Figure 1. Don't use red and orange for two colors, particularly when the red has an orange tint. Use red and green or black, something that can be clearly distinguished. Make the symbols larger.
  - Thank you for your suggestions. We have replaced the orange color with green and increased the size of the symbols
- 269-274. Don't repeat the figure caption in the text. Let the figure caption do its job.
  - We appreciate your feedback. We have significantly condensed the description of the figure within the text.
- Table 3 In the caption introduce the quantities in the same order as they appear in the Table, as was done in Table 2, for consideration of the reader, not in the reverse order as done here.
  - We have revised the caption for Table 3 to maintain a consistent and logical order in the content description.
- Figure 2 and its caption need work.
- 1) The caption puts so many qualifiers in the first sentence that the reader is unsure what difference is shown. The caption should read something like. Differences between Aeolus (O) and radiosonde (RS) wind observations (dots) for a) Sal and b)

PR/SRCX for descending (blue) and ascending (red) profiles. The solid line and shading are the average differences and their standard deviations. Average differences with ECMWF model equivalents (B) are given as dotted lines. If this is correct, It is presently so confusing it is hard to be sure.

    - We have revised the caption based on your suggestion to make it clearer and more readable. Thank you for your feedback!
- 2) The individual differences (dots) are too faint to be seen clearly.
    - We enhanced the data's visibility by increasing its opacity.
- 3) The dots and the averages and standard deviations are not consistent. The dots show much more spread than indicated by the standard deviations and are not consistent with the averages. For example, consider the descending profile in b) between 5 and 10 km. There are 2-3 blue dots below 0 m/s and 10 or more dots > 0 m/s, with a range of 2-8 m/s, yet the average line is between 0 and 2 m/s. Something is wrong.
    - The issue pointed out by both you and the other reviewer stemmed from one omission in the caption. We originally did not mention that we applied vertical smoothing on the line using a three-value moving average, which led to the confusion. To address this, we have incorporated an extra sentence into the caption.
- 4) It is not clear why the difference has to be multiplied by -1 for descending profiles. That just confuses the comparison, leaving the reader with the need to invert the descending profiles to compare with the ascending profiles. It is also not clear why this difference has to conform with the sign convention of the model coordinate system.
    - We use the model coordinate system for several reasons. Firstly, it offers a more intuitive means to represent the actual bias by displaying the actual wind difference between the two orbits. Furthermore, this choice facilitates comparisons with the study conducted by Borne et al., which documented this bias in West Africa and employed the model coordinate system. This observational validation of the bias serves as a valuable confirmation of the results observed previously in West Africa using model equivalents.
- 324-328 While the text does a somewhat better job than the figure caption there is still no need to repeat a figure caption in the text. Here is where the need to conform to the model convention and how this limits the ability to compare the ascending and descending profiles needs to be explained.
    - Thank you for your feedback. We have indeed shortened the figure caption in the text and included the following sentence to clarify the reason for adhering to the model convention: “*To better understand the variations in wind speed between the orbits and enable easy comparisons with studies like Borne et al. (2023), which has also documented this bias within the model coordinate system, we have adopted to the model sign convention. This involves multiplying the HLOS winds from descending tracks by -1.*”

- 328-329 So, considering the -1 multiplication of the descending differences, isn't this difference from -2.5 to 2.5 m/s? The fact that ascending and descending below 5 km both appear above 0 m/s in a) is a bit misleading? If they agree they should appear on opposite sides of 0 m/s as in b), correct?
    - Indeed, at 8 km altitude, the difference should be 5 m/s, not 2.5 m/s as previously mentioned. We've corrected this in the text. Below 5 kilometers over Sal, the presence of the Saharan Air Layer and dust particles could potentially contribute to the bias, but there is no hard evidence for this.
- Fig. 3 the cloudy colors are so faint as to be very difficult to see against the dominant blue. Use bright colors. If the Rayleigh-cloudy outlier symbols are the same size as the Rayleigh-clear outlier, then there are no such points on the plot. Don't include a legend for points that don't appear.
    - We improved visibility by changing the colors for Rayleigh-cloudy data to green and removed the outlier legend for Rayleigh-cloudy since they are not present in the figure.
- 422, 451, 460 Where are the transparent symbols? Are these the fainter symbols? This criteria is not defined in the figure caption, or in a legend on the figure, but should be. At present the reader does not know which symbols these are. There are already too many colors on the plot to distinguish a transparent symbol. How is transparent brown different than say yellow or orange? Use a different symbol mark: box, open circle, cross.
    - Thank you for your comment. We have updated the symbols for the faded values, replacing them with asterisks (*) to enhance their distinction from the other data points. Additionally, we have included the following sentence in the figure caption: The faint * symbols serve as references for values that did not meet the QC criteria.
- 450 What is a. u.? No panel in Fig. 6 has a scale extending to 5e13.
    - a.u stands for "arbitrary unit" as the useful signal is normalized. Thank you for pointing out the mistake in the exponent; the correct value is indeed 5e15.
- 458 kgkg-1 ?
    - The dust mixing ratio unit is in kg/kg.
- 464 Why show measurements which are artifacts and clearly wrong. Leave them out.
    - We present all measurements in accordance with the applied QC criteria, including those that were rejected (shown in a transparent format). This offers a chance to observe certain artifacts that are evidently incorrect but were not flagged by the QC process. This information is valuable for refining the QC procedure. We have added following sentence in the manuscript line 461: "*This highlights that some artifacts were not flagged correctly by the QC process.*"

- Fig. 7 Make the data visible! Use thicker lines. Use a darker gray so the reader can see all the data. There is a lot of space on the figure, don't make it difficult to see the data.
- Fig. 7e) legend …High semitransparent meanly thick clouds …? Do the authors mean mainly?
    - The name follows the SAF NWC product nomenclature. This cloud type is correctly referred to as "High semitransparent meanly thick clouds". To clarify this, we have added "The cloud names follow the SAF NWC product nomenclature." in the legend of Figure 7.
- 479-480 … it is not surprising … Rayleigh-cloud measurements ... Isn't this obvious? Surely this aspect of the algorithms have been clearly checked for assurance that clear sky conditions are determined.
    - Yes, this is obvious, so we have taken out "Rayleigh-cloudy" and "Mie-cloudy" from the sentence.
- 484 … with to a …?
    - Thank you for pointing out the error. We rectified the sentence by employing "with the".
- 489 In Table 1 the co-location radius was listed as 50 km, now it is 60 km. Recall the earlier comment about Table 1 and how the orbits could be so consistent with the co-location radii listed.
    - Thank you for noticing this mistake. You're right, it's 60 km in both cases. Kindly refer to our previous explanation in response to Table 1, where we elaborated on why we consistently selected these co-location radii.
- 514 … However in panel 9d, we see …
    - Thank you for pointing out the error that we have corrected.
- 532-533 Isn't this a little surprising. At large co-location radii there are going to be differences just due to geophysical variations over such a large distance. The atmosphere is not that homogeneous over distances that large.
    - We would argue that the atmospheric dynamics in the tropical Atlantic at this time of year are mainly driven by large-scale African Easterly Waves, which have a typical wavelength between 2000 and 4000 km. Furthermore, our results support this hypothesis as we don't see any error dependence with respect to the co-location distance.
- 554-556 Isn't this expected almost by definition. The signal is going to be cleaner without clouds so the instrument will perform better. Inherently Rayleigh-cloudy is going to give a weaker signal.
    - Yes, that's what we anticipated. Our aim here is to verify this expectation using the results of the validation study.