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Interactive comment on "Validation of Aeolus winds using radiosonde observations and NWP model equivalents" *by* Anne Martin et al.

Anonymous Referee #2

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General comments:

The manuscript is well structured and addresses an important topic of the new observation system which is of significant importance for the NWP. It is found as an important contribution to the Aeolus special edition and is well in the scope of the scientific journal. The methods applied are well designed. It is appreciated that a reference data from two independent models are provided, which allowes to address the issue of the model related bias as current bias correction methods are still dependent on the model itself. The estimate of the various error sources is explained, however, the section on the representativeness error is not very clear (please see next paragraph for details). Below I list several minor issues that should be resolved. Some suggestions are as well provided.

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Discussion paper

Specific comments:

Abstract is overall well understood. However, I have some questions: The bias correction applied in April 2020 is the M1 temperature correction, however, in the abstract the longitute-latitude related bias correction is described. I found this confusing when reading the abstract and I suggest modifying sentence on line 20 such that it is clear that the operational bias correction at ECMWF is not the one studied in the manuscript.

What does expression "analytical" (Line 49) represent? I don't see it necessary and I suggest removing it.

I believe in methodology section it should be mentioned what is the time span of the validation (i.e. validation period). It is mentioned in terms of baseline but not in terms of date-time, which is important for readers not directly related with the Aeolus mission.

A word on quality control. This is first mentioned in (Line 106). But it is confusing because it is not clear what all is part of quality control? Is it defined just by L2B HLOS error estimate or anything else? There were problems with hot pixels in FM-A period, which has been handled with specific QC (for example). I suggest adding few sentences about this in case more complex QC has been used (in methodology).

The sentence given in lines (145-147) is not clear. What is the meaning of ". . . 10 deg. Latitude x 10 deg. Longitude and limited periods of 7 day"? I am not sure how to interpret this information. Could this be better explained?

In the collocation methodology of radiosondes. What is the reason for choosing the 500 m in vertical (Line 123)? Is this some sort of trade-off to have enough large sample? The HLOS range-bins are thinner near the ground especially for Mie.

For the model description given in Section 2.3 I suggest adding the information on horizontal resolution of both models (like it is provided for COSMO and ICON LES in the text below). I think this is important for the understanding the representativeness error of HLOS winds when compared to various models.

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The methodology on the estimation of representativeness error is not very clear (section 2.4). The same for results give in Section 3.2.1. It is not clear how the estimation of the various representativeness errors is actually performed (for the purpose of reproducibility of data presented in manuscript). How exactly are two high resolution models used to estimate the representative error of HLOS if first L2B HLOS is compared to global model (Eq. 6b) and second to radiosondes (Eq. 6a)? What is a definition of point and line measurement in the scope of estimation of representativeness error (Line 250)? I don't understand how values are computed (Line 254, 255, 264). Values reported in Lines 254,255 are found as sigma_b in Table 2. Please clarify. I suggest providing more detailed explanation of the methodology used (in section 3.2.1) in section 2.4?

In line 183 (section 3.1 in general) and Table 1 I found some confusing information about the term "mean absolute difference" (and mean absolute bias). What exactly is computed here? Is this an average of absolute values of BIAS shown in Figure 1. If so, in Table 1 |BIAS| is confusing?

At the end of Line 195: " . . . of limited areas (10 deg. Latitude . . .". This is related to the comment given before. I don't understand what is meant by this. How are these limited areas used for computation of global statistics? (See please the same comment above).

Line 197. I would not agree for Mie descending. But I would say that the values for global statistics are in the range of values of of all three (radiosonds, ECMWF and DWD) local statistics . Which, on the other hand, does not hold for Rayleigh-clear statistics.

Line 218. Which bias correction update ? I suggest being specific and to mention that this is the one that is validated in the following sections (the lon-lat dependent one).

In Table 2 the sigma_b for Mie on 90 km is about 0.5 m/s but only 0.12 m/s when on 10 km. What is a scientific reason for this? Because no matter the Mie accumulation

the IFS HLOS is always an interpolation to the L2B HLOS center of gravity location. So is this the result of QC used or maybe better L2B classification on clear cloudy for smaller accumulations?

Line 295: Sentence started with "Since the representativeness . . ." is not clear. What does it mean? What is the range of estimated uncertainties?

Line 337: It is confusing how the bias correction is applied (Eq. 7). "i=1 being the current day" suggests that at the day of applying the bias correction the O-B for that same day are as well included. Isn't that the bias correction factor for a particular day is provided from O-B of previous days?

Figure 6: the pattern looks very random. Are these differences statistically significant (especially for ascending orbit)?

How does the computed estimate of the Aeolus instrument error compare with the L2B estimated HLOS instrument error? By the values reported in the manuscript this seems quite well in range, but I miss this comparison. It would be of interest to see how good is the L2B error estimation algorithm. Has this been studied?

In addition, for Conclusions. The bias correction method used is essentially a temporal and spatial smoothing. This is as well a source of bias residuals shown in Figure 4 and 6, as bias correction method is not able to react on fast changes in systematic errors that happens along the Aeolus orbit.

Technical corrections:

A general note on Figures. I suggest to use the same framework on all images. This is by using labels (a,b . . .). At the moment this is not true everywhere and on some images (Right, Left, . . .) is used instead. In addition on some Figure there is no units, this should be corrected.

Line 8: instead of "comparisons" it would be maybe better to use "the validation".

Line 11: If the "independent reference data sets" are the two models, I suggest here to be specific and change this with ". . . between the two model data sets" or similar.

Line 11: I suggest to switch "representativeness" into "representative of Aeolus winds" .

Line 13: Sentence (To achieve . . .) is not well understood. I suggest turning it around "Besides the . . . the Aeolus instrument error is estimated . . ." or similar.

Line 16: The expression "depend on" should probably be changed to "vary with".

Line 25: Better be specific. I suggest to switch "Earth's wind" to "atmospheric wind".

Line 26: The sentence "Within seven days, . . ." is not completely correct. The orbit does not cover the globe as the footprint is in scale of meters and orbits are separated by 1000 km or more. But the repeat cycle of the orbit is about 7 days. I suggest to rewrite this.

Line 27: Could remove the "only one large instrument", it is not necessary.

Line 31: First two sentences could be switched. It reads better.

Line 36: Could remove "on" and "parts"

Line 42: At the end of the sentence ". . . geostrophic balance" I suggest to put some reference. For example https://doi.org/10.1175/BAMS-86-1-73

Line 45,46: I suggest to add few additional valuable references (https://doi.org/10.1256/qj.05.83, https://doi.org/10.1002/qj.43, https://doi.org/10.1002/qj.2430).

Line 67: I suggest to put a new paragraph just before "The text is struct. . ."

Line 71: "representativeness error of comparisons", this is very confusing. Could the expression "comparisons" be removed here?

Line 80: In reference "ECMWF: . . ." the "ECMWF:" should be removed.

Line 86: "The resulting HLOS wind" should be modified by "The resulting HLOS wind observation therefor represents a horizontal average over . . ."

Line 87: The reference "Matic et al" should be changed to "Šavli et al"

Line 87 (end): "the" should be removed.

Line 89: ". . ., to avoid systematic errors. . ." should be changed to " . . . to reduce the HLOS systematic error . . ." (for example). This is because there are other sources of systematic error that exist.

Line 93: I suggest to change the ". . . types" to "... resulting in four wind products (i.e. Rayleigh-clear, Rayleigh-cloudy, Mie-clear and Mie-cloudy)." to be more specific.

Line 95: Again the reference "EMCWF: . . ." should be corrected by removing "ECMWF:"

Line 115 (and 116): I suggest to rewrite a bit into "...is taken into account by splitting data into groups of 15 min."

Line 116 (by the end): Please correct "contains" into "contain".

Line 118: Please correct "the ascent and the ascent" into " the ascent and the descent".

Line 156: I suggest to change the heading title into: "statistical measures", "statistical metrics", "validation metrics", or something similar. "Statistical characteristics" is not valid for description of statistical metrics that have been used.

For Eq. 2 I suggest to add that index "i" represents time.

Eq 3-4 seem incomplete. In results bias is provided for radiosonde, and 2 models. I suggest to explain here that different biases and STD are provided for different reference data. This should be seen by equations defined here. At the moment it seems that Eq 6 for STD is always computed taking BIAS from model (even if STD is computed for radiosondes). I believe this is not what has been used. Correct me please if

I am wrong.

Eq 5 is as well confusing. I suggest to replace this with the definition for MAD (so removing the "scaled"), which is a very basic measure. And in the text it should be mentioned that scaled MAD is used instead which is defined as 1.4826*MAD because it provides a measure similar to STD for normal samples.

Title of heading in section 3 is confusing. It suggest shorten it. Maybe something like "Aeolus HLOS error time series characteristics".

Line 199: Please modify "... wind bias, ..." to "...wind bias and random error, ..."

Line 204: "modes" is probably "mode"?

Line 227: Please correct "bu" to "but"

Line 237: Please correct "differences" to "difference"

Line 253: Please use the uniform Figure labels (i.e. a,b,...)

Figure 2: Please use labels a,b,...

Table 2: In caption "...(Representativeness errors ..." should be corrected to " ...(representativeness errors ...)"

Line 329: "Thus, it is tested ..." should be correct to "Thus, it is first tested ...."

Figure 3: missing units.

Line 401: I think this is not needed as this is already given in the last paragraph of Introduction.

Figure 5: missing labels

Figure 6: missing labels

Line 406 (at the end): Please correct "as" to "as a"

Line 480, 483 and 485: Please check if this kind of referencing is correct.

Line 502: Please correct "Matic. S" to "Šavli. M" and "Zagar. N" to "Žagar. N"

Line 536: Please correct "Zagar. N" to "Žagar. N"

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