

## **Response to Referee Comment (RC1) on**

Validation of Aeolus winds using radiosonde observations and NWP model equivalents

<https://doi.org/10.5194/amt-2020-404>

We appreciate the referee's thoughtful and valuable review. The responses to the individual comments and the corresponding changes in the manuscript are presented in the following.

### **General Comment:**

*The manuscript "Validation of Aeolus winds using radiosonde observations and NWP model equivalents" by Martin et al. provides a good examination of the Aeolus data, mainly for northern midlatitudes but also globally. The validation results cover Aeolus data from its launch to the end of December 2019. Thus, it provides a useful analysis for users of the data. Additionally, it is demonstrated how the bias in Aeolus data can be reduced bringing the data quality towards the mission requirements. The manuscript is well written, concise and has appropriate figures. Only one minor comment is listed below. The reviewer recommends publication after a minor revision.*

### **Minor Comment:**

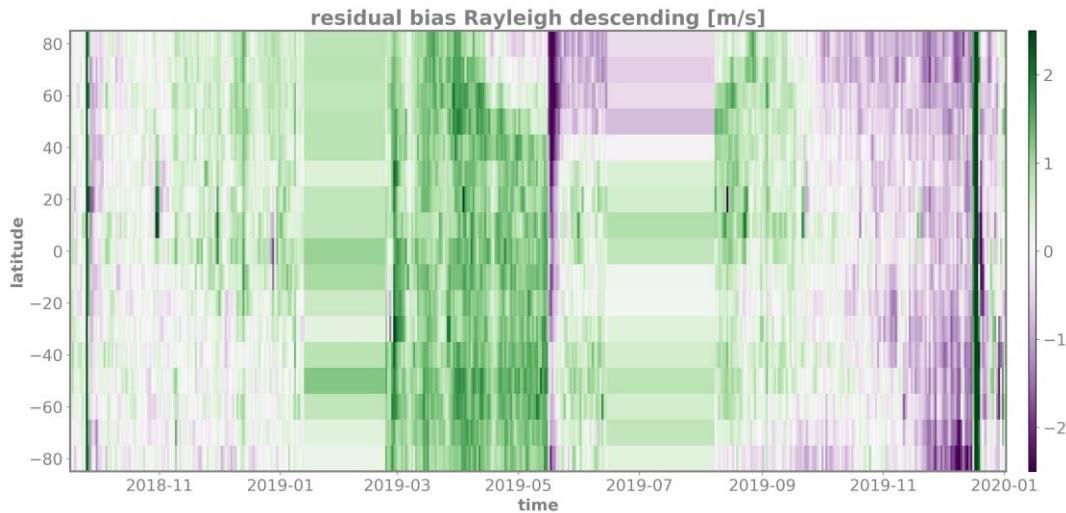
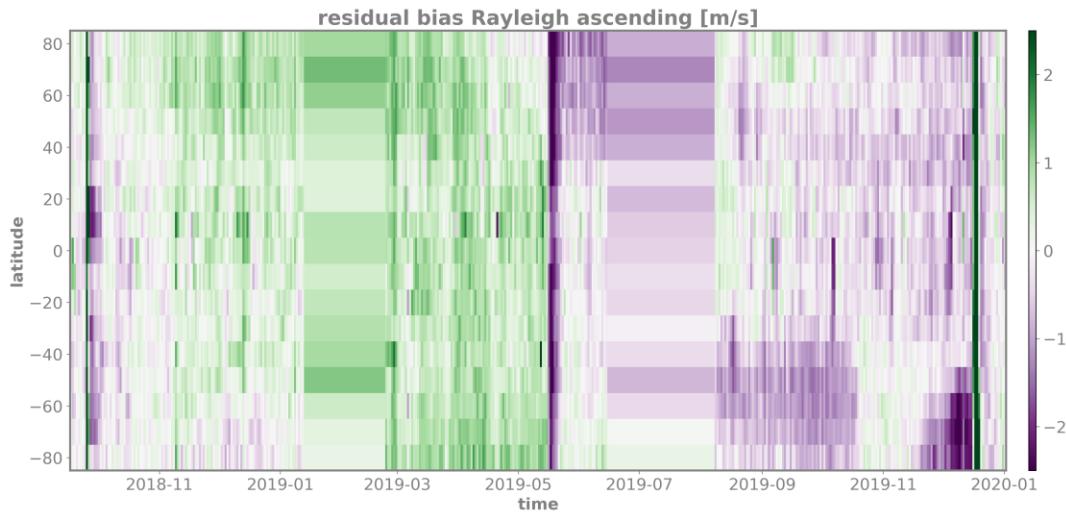
*paragraph 4.1.1: In Figure 4, the global average is shown. It would be of interest to see the latitudinal behavior. This could be done as a shaded plot with time and latitude on the axis for only one correction per model. The three different choices shown only as average numbers over the time series in table 3 is sufficient, but needs a significance test for the difference between methods.*

#### **Response to the Minor Comment:**

As requested, we performed a significance test and added, in that respect, the following sentence:

**Overall, the bias correction approaches show a statistically significant reduction in bias. However, no significant differences between the individual methods were found (following a Student's t-distribution), which again indicates that model biases do not have a dominant effect on the bias assessment.**

The plots below show the latitude dependence of the residual bias after the correction with preceding departure information, as suggested by the reviewer. However, we are not convinced that these plots really add significant information for the reader and we think that the interpretation of features on this plot would be largely speculative given a range of potential causes for a residual bias (various known and unknown fluctuations in the instrument performance; variations of model biases both in the preceding training data as well as in the verification data set; fluctuations of thermal emission from the earth based on the synoptic situation that may affect the instrument). We therefore prefer not to show this additional figure. The main intention was to show that the correction successfully reduces the bias, but does not eliminate it. This is already shown clearly by the average values.



### **Further modification:**

The following reference has been added to the introduction part as example for already published Aeolus wind validation studies:

**Baars, H., Herzog, A., Heese, B., Ohneiser, K., Hanbuch, K., Hofer, J., Yin, Z., Engelmann, R., and Wandinger, U.: Validation of Aeolus wind products above the Atlantic Ocean, Atmospheric Measurement Techniques Discussions, 2020, 1–27, <https://doi.org/10.5194/amt-2020-198>, 2020.**

### **Technical stuff**

*line 118: Consider to rephrase "during the ascent and the ascent time"*

- > changed accordingly: “Due to the radiosonde drift during the sounding and the ascent time, additional errors arise.“

*line 185: typo "differs"*

- > changed accordingly: differ --> “differs”

*line 188: Does the lower representativeness error of the radiosondes mean better agreement with Aeolus? Please clarify - line 189: Higher resolution of radiosondes? Consider*

- > changed accordingly: “This can be explained by the larger representativeness errors associated with radiosondes, which can be regarded as in situ point measurements. Besides the higher spatial resolution of a radiosonde observation compared to the resolution of a global NWP model, ...”

*line 197: Please rephrase the sentence: "For the Mie winds, the global..."*

- > changed accordingly: “For the Mie winds, the global statistic shows values in the range of the results of the three local validation statistics around the radiosonde collocations.”

*line 201: Incompatible to what? Consider to remove term "incompatible"*

- > no changes, as we think the current wording is appropriate. The Aeolus L2B data of different time periods are incompatible, due to different processor baselines (different physical principles) and calibration file updates.

*line 206: "mean differences" = bias? Please keep consistent names. Also, in in the rest of the paragraph.*

- > See explanation of notions in Section 2.5.: Given that the model bias for long validation periods and large scales is usually small in comparison to that of Aeolus observations, the mean difference between the Aeolus observations and the reference data can be referred to as bias. --> no changes

*line 225: "random difference" = random error, standard deviation, sigma? Same as previous comment.*

- > For the comparisons only the expression ‘random differences’ is used. To quantify the random differences, the standard deviation as well as the scaled MAD is used (explanation in Section 2.5.). For the estimation of the Aeolus instrumental error, the total variance of the differences between radiosonde observations and Aeolus HLOS winds  $\sigma^2_{val}$  is described by the scaled MAD (see first part of Section 3.2), because it is more resilient to single outliers (see Section 2.5.). These terms are consistent in the paper. --> no changes

*line 230: consider "signal does not only depend on"*

- > changed accordingly: "... signal does not only depend on..."

*line 232: For the comparison of the standard deviation and MAD, you could show a histogram. This could also be used to justify the thresholds for the gross errors in line 106 and 107.*

- > changed accordingly: we interpretate this comment to be basically related to the estimated error thresholds. Ongoing investigations show that the L2Bp estimated error has to be treated carefully due to a bug until the baseline change in April 2020. This issue is not fully understood yet and a specific justification of the used threshold would deserve a separate study. However, to point out how many data pass the quality monitoring used in this study, the following information is added to Section 2.1.:

**Based on a compromise between the quality of the data set and the number of observations that pass the quality control, Rayleigh winds with an estimated error greater than  $6 \text{ m s}^{-1}$  and Mie winds with an estimated error greater than  $4 \text{ m s}^{-1}$  are excluded. Thus, on average over the validation period about 70 % of the Rayleigh and 76 % of the Mie winds are available for the analysis.**

*line 435f: Consider to rephrase the sentence "Since a one-dimensional...". It is difficult to understand*

- > changed accordingly: "A one-dimensional latitude dependent correction approach, based on the previous seven days, is able to reduce the bias, but still, a temporal trend of remaining bias values of 0.37 - 0.59 m s<sup>-1</sup> occur.

*line 444: typo "onboard" - references: Correct also names from first point*

- > changed accordingly: on board --> "on-board"

*Check spelling for the references: Källén, Zagar (with the accent over the Z), and Savli (with accent over S, first name is Matic)*

- > changed accordingly: "Källén", "Šavli", "Žagar"

*line 142: typo "operationally" - generally: Terms like "the Rayleigh winds mean absolute bias" seem unusually to me. Consider just "the Rayleigh wind mean absolute bias". And equivalently for Mie and random errors*

- > changed accordingly: operational --> "operationally"
- > generally, terms like 'Rayleigh/Mie winds mean absolute bias' are changed accordingly: "the Rayleigh/Mie wind mean absolute bias"

*line 202: typo "positively"*

- > changed accordingly: positive --> "positively"

*line 227: typo "shows" and "but"*

- > changed accordingly: show --> "shows", bu --> "but"

*line 304: typo "estimate"*

- > changed accordingly: estimates --> "estimate"

*line 359: typo "do not"*

- > changed accordingly: don't --> "do not"

*line 398: typo "is not" - Figure 5: Please add the month name into the panels of the figure*

- > no changes, as we think it is sufficient that the month names are mentioned in the caption of the Figure

*line 414: typo "state"*

- > changed accordingly: states --> "state"