

Atmos. Meas. Tech. Discuss., referee comment RC3  
<https://doi.org/10.5194/amt-2021-54-RC3>, 2021  
© Author(s) 2021. This work is distributed under  
the Creative Commons Attribution 4.0 License.

## Comment on amt-2021-54

Anonymous Referee #3

---

Referee comment on "Validation of Aeolus winds using ground-based radars in Antarctica and in northern Sweden" by Evgenia Belova et al., Atmos. Meas. Tech. Discuss.,  
<https://doi.org/10.5194/amt-2021-54-RC3>, 2021

---

On 22 August 2018, ESA launched the first Doppler wind lidar onboard the satellite Aeolus into space. Circling the Earth on a sun-synchronous dawn-dusk orbit at a mean altitude of 320 km, global wind profiles are obtained within 7 days. The dual-channel receiver design allows acquiring Rayleigh wind measurements in aerosol-free regions as well as Mie wind measurements in aerosol or cloud layers. In order to use Aeolus data in NWP models and to improve the data quality in newer processor versions, the systematic and random errors of Aeolus must be understood.

In previous papers and analysis, it was already shown, that the systematic error of Aeolus shows a latitudinal and longitudinal behavior - results which could only be obtained by global validations. Numerical weather prediction models were essential to provide such findings but could be affected by potential model biases. Hence, a validation of Aeolus observations with independent remote sensing or in-situ measurements distributed over the globe are a crucial part of the Aeolus Cal/Val activities.

In this regard, this manuscript provides a useful contribution for the validation of Aeolus wind observations by using collocated measurements from radar wind profilers covering particle-free regions as well as regions with particles in the troposphere and lowermost stratosphere with high temporal resolution. The instruments are located in Arctic Sweden and Antarctica, regions where observational wind data is sparse.

The manuscript is well structured and written, presenting the obtained results with adequate figures. The paper deserves publication after some minor revisions.

### General comments

- In the manuscript the reprocessed data set from 1 July 2019 until 31 December 2019 is validated. First of all, this is an important information which should be mentioned in the abstract. The second point is, did you also analyze the operational data set from this time period in order to estimate the improvements of the new processor versions

especially at the locations near the poles, where this information could be of interest for the processor developers?

- Aeolus wind observations are filtered for an error estimate threshold of 8 m/s for Rayleigh-clear and 4.5 m/s for Mie-cloudy winds. On which facts is this QC-criteria based? Did you try other values and how this affects the number of available data points and the determined random error of Aeolus wind observations?
- As horizontal collocation criteria a radius of 100 km around the radar wind profiler sites was chosen. The location of the two RWP sites close to the poles provide the opportunity to cover many Aeolus orbits at this latitudes where the satellite tracks are closer together. Did you try to increase the radius to a larger value (120 or 130 km) to see if this could improve the statistics by including more data points although the representativeness error would increase?
- How does the inclusion of all Rayleigh-clear observations within the horizontal collocation radius affect the validation instead of using only the closest observations? This would be consistent with the approach which is applied for Mie-cloudy wind measurements and would provide more data points.
- Have the authors included the random errors of the RWP measurements as well as an estimate of the representativeness error in the determination of the Aeolus wind observation error? Otherwise the determined random error of Aeolus would be a combination of the different errors.
- An ERA5 model comparison which was performed in addition was mentioned several times in the manuscript. Did the authors consider to include this analysis in this work also in view of the possible imperfect bias correction of the ESRAD system?

## Specific comments

- P.1 L.20: Please include the data set time period and mention that reprocessed data was used in the analysis.
- P.3 L.65: Please include a short overview of the manuscript structure
- P.3 L.76: "20 laser pulses": Until January 2019, 19 laser pulses were accumulated for one measurement. Afterwards it was only 18 pulses. See Weiler et al. 2020 or Lux et al. 2021 ("ALADIN laser frequency stability...")
- P.3 L.79: Mie winds were horizontally averaged up to 14 km as of March 2019. Also horizontal averaging lengths smaller than 14 km are possible.
- P.4 L.14: How was the ESRAD bias correction done? Is this correction stable over all 6 months and the covered heights? From Belova et al. 2020, it seems not to be a constant offset over all heights.
- P.5 Fig.2: What is plotted here? Are these the locations of the single wind observations in the L2B product? How does the number of Aeolus wind observations which are used in the comparison fit to the numbers (N points) from Table 2 and 3? For me it looks like there were much more Mie winds used than Rayleigh winds which is not represented by the numbers in the tables. Please clarify.
- P.6 L.37: Is the QC-criteria based on an error estimate threshold applied before choosing the closest Rayleigh-clear wind observation or afterwards? Please clarify.
- P.6 L.36: To better understand the statement "24 or 27 km" the authors could mention that the Aeolus range bins are following a digital elevation model (DEM) and within a radius of 100 km around the MARA site a strong change in topography from 0 to around 3000 m is covered.
- P.6 L.40: Between mid October and December there was a so called Strateole range bin setting (RBS) with a maximum height of 17 km (17 km or 19-20 km for the MARA site) and an AMV setting with maximum height of 14 km for 2 weeks in between.

- P.6 L.42: The height resolution is only possible as a multiple of 250m. Please check if 1130 m should be changed to 1000 or 1250 m.
- P.6 L.43: The AMV RBS with 14 km maximum height was in operation for 2 weeks.
- P.6 L.44: See comment P.3 L.79
- P.6 L.44: The Mie wind RBS are not the same as the Rayleigh RBS. For the sake of completeness, the Mie wind RBS could be added.
- P.6 L.49: Why did the authors create a single profile out of all Mie wind observations and did not compare single Mie wind observations with RWP wind measurements? Are the obtained Mie wind profiles free of gaps? Since the Mie wind RBS are not the same as the Rayleigh RBS settings, additional errors could be introduced when averaging Mie winds to the vertical Rayleigh wind resolution.
- Subsection 3.1: Could the authors please comment if blacklisted data was excluded?
- P.6 L.60: As already mentioned in comments above, the Mie and Rayleigh RBS are not the same. Are you also averaging to the Mie wind profiles?
- P.8 L.16: To be consistent with the bias value in table 2 the value here should be changed to -1.9 m/s.
- Fig.4, 5, 10 and 11: Please increase the font size to the same value as used in Fig.2.
- Table 2 and 3: Can the authors please comment on the reason for the big difference in available data points for "Summer" and "Winter"? Are there less valid Aeolus or less valid RWP winds in winter?
- P.10 L.35: -2 m/s -> -1.9 m/s to be consistent with values in table 2
- P.13 Fig.10 b): Do you have any explanation for the strong negative bias for descending tracks at around 9 km altitude? Why is the std difference between ascending and descending orbits that large?
- P.16 L.21: As mentioned above: up to 14 km