Review of Khaykini et al. (2019), AMTD

Doppler lidar at Observatoire de Haute Provence for wind profiling up to 75 km altitude: performance evaluation and observations

Summary

After the pioneering work by the OHP group (Chanin et al. 1989), this manuscript is certainly an important contribution to the development, validation and application of wind sensing using molecular backscattering in recent years. Thus it is of high relevance for the AMT audience, and I recommend publication after revision. The manuscript is clearly structured and written, and contains recent wind measurement examples from 2019 up to 75 km including one of the first validation results for the space-borne wind-lidar on Aeolus.

General comments

1) The manuscript lacks some details on the upgrade and development of the lidar and retrieval algorithms (including calibration) during the recent years since 2012 (after the last publications from this group by Souprayen et al. 1999). E.g. please state clearly, which part of the instrument design in ch. 2.2. is new and also provide more details of the upgrade. Please be more specific on instrument details (see also my specific comments) to this part, e.g. in ch. 3.1 it is stated that FPI plates were reconditioned, but not further explained.

I would also recommend providing more details on the calibration (L79-L83), as this is essential for wind retrieval and wind bias. E.g. is the spectral tuning of the FPI only used for monitoring, or is it used during the wind retrieval (as mentioned in L125). If yes how are these functions used (measured, fitted), and used for wind retrieval from the actual measurements of the same day. Also a short description on how calibration constant C in equation (1) is obtained is missing.

2) I have two comments to the statistical comparison approach. I am wondering about a justification of using weighted distances for deriving bias and standard deviation in Ch. 3. I would like to see a clear justification of this approach, because I consider this as unusual for instrument inter-comparisons, and provide a short description (e.g. equation), how this was implemented. But overall I would recommend deriving these statistical numbers on bias/std. with and without this weighted approach.

My second comment here is related to a missing statistical comparison of the horizontal wind speed (from u and v-components, and possibly wind direction). I would propose to add this quantity to chapter 3, and specifically provide a scatterplot (as Fig. 4d) and statistical numbers (as part of Table 1). I would also propose to add the statistics of all radiosonde comparisons to Table 1 as an additional row, and discuss these numbers in the text.

Specific comments

I have listed a number of specific and minor comments below.

Line	Comment
12, 523	Provide numbers for vertical and temporal resolution; “high resolution” is different for several application areas
29	Provide a reference for deriving wind speed on regular bases from space-borne temperature measurements using geostrophic assumptions.
38	I would propose to add some more references in the introduction of wind lidars using molecular backscattering, especially here also mention ALADIN and its airborne demonstrator.
58	Add 1-2 references for Aeolus here.
70	Parameters of the FPI are introduced here, while the operating wavelength is not stated (at this place of the manuscript).
91, eq 2	The introduction of parameter P(z, 40°) is missing in the text.
95-99	The vertical pointing beam is used to compensate for laser frequency drifts, with a value, which is constant for each altitude (average over 15-25 km). Please discuss, if there are or not altitude dependent effects in the calibration, which need to be compensated.
100ff	Please provide more instrumental details, as laser frequency stability (shot-to-shot), laser divergence (at output of beam expander) and laser linewidth. Also FOV of telescope should be provided, as well as diameter of multimode fiber. The method of mode scrambling should be shortly introduced. Also the “reconditioning” of the FPI plates (as mentioned in ch. 3.1) should be explained here (new coating? New polishing?)
150	Is this equation of the error in units of m/s? Is C the same constant as introduced in eq. (1)?
200	Figure 3: black circles are hardly visible, e.g. use different colour.
220	Do you provide numbers for correlation coefficient as r or r^2. Please state explicitly in the text and in Table 1.
212	Please explain the rationale to compute the comparison statistics, by “weighting” the difference with the horizontal offset between the measurements. I think this is very unusual. I would propose to provide statistics without weighting, or at least show both the non-weighted or weighted results. The weighting should be shortly explained (e.g. via an equation).
240	Figure 4: y-intercept also in units of m/s
314-316	Please explain, how a possible Mie-induced bias would be recognized in the profiles, e.g. too high or too low values? Do you correct for the Mie-induced bias in the wind retrieval (or any QC), or is it only compensated by the FPI spectral configuration (spacing, FWHM)?
505	Fig caption 10; provide date of comparison and mean distance of Aeolus observations to OHP; it would be also good to include Aeolus track in Fig. 3
515	Please provide distance for altitudes below 5 km of OHP and Aeolus track for spatial variability. Causes could be also related to preliminary nature of Aeolus observations. Have you checked error estimates within Aeolus data products, and

	potentially exclude data with too high errors (e.g. 8-10 m/s)? Have you checked presence of aerosol or cloud layers, which might influence Aeolus Rayleigh wind retrieval?
526	Please state that this number of 6 m/s refers to random error.
553	Could you be more specific, how this finding should be considered for spatial and temporal collocation requirement for performing comparisons for space-borne wind lidars as Aeolus.
527	Please specify which optics could be replaced to improve performance.
533	The std of 2.2. m/s refers only to 1 component and not the horizontal wind speed. This should be clarified. I would also propose to add statistics for the horizontal wind speed in the conclusion (see my general comment 2).
605, Table 1	Please add in Table caption if you use R or R=r2 as correlation coefficient; I would also propose to add at least columns for mean difference and standard deviation for horizontal wind speed (squared sum of u,v; and possibly wind direction) and also another row with mean quantities over all days of comparison.

References:

I would propose to add a few more references related to Aeolus (ESA 2008, Stoffelen et al. 2005) and its actual performance (Kanitz et al. 2019, Reitebuch et al. 2019).

ESA (2008): ADM-Aeolus Science Report. ESA SP-1311, ISBN 978-92-9221-404-3, 121 pages.

T. Kanitz, J. Lochard, J. Marshall, P. McGoldrick, O. Lecrenier, P. Bravetti, O. Reitebuch, M. Rennie, D. Wernham, and A. Elfving, "Aeolus First Light – First Glimpse," Proceedings of SPIE 11180, 111801R (2019).

Reitebuch, O., Lemmerz, C., Lux, O., Marksteiner, U., Rahm, S., Weiler, F., Witschas, B., Meringer, M., Schmidt, K., Huber, D., Nikolaus, I., Geiss, A., Dabas, A., Flament, T., Stieglitz, H., Isaksen, L., Rennie, M., de Kloe, J., Marseille, G.-J., Stoffelen, A., Wernham, D., Kanitz, T., Straume, A. G., Fehr, T., von Bismarck, J., Floberghagen, R., and Parrinello, T.: Initial Assessment of the Performance of the First Wind Lidar in Space on Aeolus, Proc. 29th International Laser-Radar Conference, Hefei, China, June 24-28, 2019.

Stoffelen, A., J. Pailleux, E. Källén, J. M. Vaughan, L. Isaksen, P. Flamant, W. Wergen, E. Andersson, H. Schyberg, A. Culoma, R. Meynart, M. Endemann, P. Ingmann (2005): The Atmospheric Dynamics Mission for Global Wind Field Measurements. Bull. Am. Meteor. Soc. 86, 73-87.

Editorials

I have recognized the following limited number of editorial

Line	Comment
43	acronyms LiWind and LiOvent should be introduced
70	40° is stated here, while L91 and eq. 2 say 41°
73	FPI instead of FMI
81	“30 °C”
218	“For both wind components”
122	“1-minute”
250	“The 1:1 line is shown”
304	acronym LTA
356	acronym LiO3S
485	“Aeolus Level 2B”
479	“dusk/dawn”
669	format of reference