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Comment on amt-2022-223

Anonymous Referee #3

Referee comment on "Quality control and error assessment of the Aeolus L2B wind results from the Joint Aeolus Tropical Atlantic Campaign" by Oliver Lux et al., Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2022-223-RC3, 2022

Review of Lux et al., 2022 "Quality control and error assessment of the Aeolus L2B wind results from the Joint Aeolus Tropical Atlantic Campaign"

The main objective of the Aeolus mission is the improvement of Numerical Weather Prediction (NWP) models by filling an observational gap in the global wind data coverage, especially over the oceans, the poles and in the tropics.

Two components are very important to help achieve that objective: i) providing wind estimates with proper Quality Control (QC) of the retrieved winds; ii) providing accurate estimation of the uncertainty of these retrievals to help with the Data Assimilation (DA) into the models.

The paper addresses the impact of different QC schemes on the results from validation against other sources of truth – airborne observations or collocated model fields.

Random Wind Error is defined as the standard deviation of a Gaussian error distribution around a truth value. And so, the procedure for removal of outliers is a critical component. Most QC schemes relay on the validity flags and on the Estimated Error (EE), both being part of the L2B data. However, the maximum EE thresholds above which data are excluded are determined mostly subjectively and are not consistent among the different studies.

Furthermore, the Rayleigh EE is mostly determined by the Signal-to-Noise Ratio (SNR) of the atmospheric return signal, which has been varying over the course of the mission. The Rayleigh-clear EE also depends on the geographical location, as it considers the noise caused by the solar background radiation, which varies over the orbit. Importantly, other noise sources are not considered. The evolution of the Mie-cloudy EE is less affected by the signal trend and rather driven by the data processing algorithms and relating setting which were modified several times during the mission.

All these make the results obtained from different validation studies and campaigns difficult to compare, thus necessitating a more detailed treatments of the QC schemes and how they affect the statistical results (the estimation of the uncertainty). This detailed treatment of the QC is, indeed, the goal of this paper.

The paper provides careful analyses of Quality Control schemes and their impact on statistical results from the evaluation of ALADIN winds, based on different campaigns and comparisons to models.

The authors developed a two-step QC based on the EE and on a modified Z-score for each observation. This Z-score uses scaled median absolute deviation (MAD) which is more resilient to outliers and so a more robust measure of the wind error variability than the standard deviation.

Employing the two-step process resulted in error distribution with high degree of normality while retaining a large portion of the original dataset. This resulted in significant improvement, especially in the Mie winds, decreasing the systematic error for both Rayleigh and Mie channels to 0.3 m/s. Random errors were evaluated against two sources of truth ECMWF and airborne Doppler wind observations taken by the DWL onboard the Falcon during the JATAC which took place in September 21 in Cabo Verde. (Mie vs. model: 5.3 mâ□□s-1, Mie vs. DWL: 4.1 mâ□□s-1; Rayleigh vs. model: 7.8 mâ□□s-1; Rayleigh vs. DWL: 8.2 mâ□□s-1).

The value of the paper is in developing an improved QC scheme which results in the rejection of only the worst outliers. Maybe even more importantly, the new QC scheme allows the development of better error characterization of the retrieved winds. Both of these (rejection of outliers and improved error characterization) would have a very important impact on the outcome of future data assimilation into operational models.

The paper is written very well, the presentation is clear and the figures are well designed and contribute significantly to the understanding.

General comments:

I agree with the comment of RC-2 regarding the mostly missing discussion on the implications of the improved QC. While, in my mind, the paper presents results with high scientific value (understanding the instrument characteristics, improving the outcomes of validation and the outcomes of DA efforts), the importance of the improved QC are not strongly highlighted either in terms of motivation, or in terms of impact on the scientific or applications efforts (e.g. operational DA).

Specific comment:

- When using the ECMWF winds as the truth against which the Aeolus winds are compared, up to a 12-hour ECMWF forecast is used so that the model data are independent from the Aeolus winds (they have not been assimilated yet). However, Aeolus data have been assimilated in the previous model runs (cycles). What is the possible impact of the fact that the previous cycles have already assimilated the Aeolus winds?
- The text on P. 23 that describes Fig. 10 has several inconsistencies with the figure - e.g. Figure 10 does not have orange bars; it is said that the 1-step QC statistics are given in a black inset while it is gray.