Summary of Quality of Aeolus Data Products from 1st Reprocessing Campaign covering June to December 2019

Status 8 October 2020, V 1.0

Aeolus data products were reprocessed for the period from June 24 to December 31, 2019 covering the early operation period of the second Flight Model laser (FM-B). The first reprocessing is using the processor versions deployed in April 2020 (L1bP 7.08.2, L2AP 3.10.1, L2BP 3.30.1), used for near-real time (NRT) generation of baseline (09[1] and) 10 data products. The reprocessing covered L1A, L1B, L2A and L2B data products as well as the respective auxiliary files and provides a homogenous data product quality for the whole period. The next reprocessing campaign will cover the FM-B period from June 2019 to October 2020 with the October 2020 version of the processors (baseline B11).

What is the main improvement with respect to the original processing baseline?

- correction of wind bias in L2B product using daily updates of the correlation between ECMWF O-B (observation-background) statistics and temperatures from the telescope primary mirror M1, in contrast to large wind biases for the NRT product for this period; This correction is applied to Rayleigh and Mie L2B winds and covers also the correction of constant drifts in bias. The correction for day d was applied with correlations from day d (which is even more accurate than the d-1 correlations used for B10 NRT products), which should slightly improve the bias as well.
- use of orbital means for radiometric calibration (K_{ray}, K_{mie}) of the L2A products and improved quality control, in contrast to constant radiometric calibration derived from nadir-pointing mode; provision of the additional parameter attenuated backscatter

What are further improvements with respect to NRT data products?

- correction of hot pixels per orbit in time periods between dark signal measurements (DUDE) for the L1B product, in contrast to updating the hot-pixel correction only 4 times per day after DUDE for the NRT data products; improvement of the hot-pixel correction for the uppermost Rayleigh range bin for some DUDE calibrations of the NRT product up to October 21, 2019

What is the quality of the data products?

- better quality of signal levels (Rayleigh, Mie) in the L1B product wrt. hot-pixel dark current levels, which also improves L2A and L2B products, as L1B signal level is used as input
- the radiometric calibration of the L2A products is improved and reflects the observed signal loss in the atmospheric path of the instrument over time; this leads to lower systematic errors for the backscatter and extinction profiles, with slightly lower values than the NRT products; this results in a lower number of unrealistic, negative values for the backscatter and extinction coefficient
- the Rayleigh (clear) wind bias wrt. to the ECMWF model shows global averages of around 0 m/s; also, most of the orbit phase dependent wind bias has been removed, resulting in a bias within ±0.4 m/s for most orbits except for the October 2019 period (see below); this is a large improvement wrt. NRT products, which showed temporal variations of the Rayleigh bias between +1 to -4 m/s during this period

[1] B09 is equivalent to B10, -the switch was performed due to configurational reasons

- the Mie (cloudy) wind bias wr.t to the ECMWF model shows global averages around -0.15 m/s (underestimation), with most orbits showing a bias within ±0.4 m/s; this is a slight improvement wrt. NRT products, which showed temporal variations of the Mie bias between +0.6 to 0 m/s during this period
- the Rayleigh and Mie wind random errors show a similar level and evolution as for the NRT products, with a period of 2 weeks (2019/10/28 – 2019/11/10) with enhanced values due to a special range-bin setting (250-500 m bins globally) for the purpose of comparison to Atmospheric Motion Vectors AMVs
- the scaled median absolute deviation MAD (1.4826*MAD) as a measure of the random error shows values of around 3.5 m/s (Mie) and an increasing value of 4.3 m/s to 5.3 m/s (Rayleigh) from July to December 2019
- the Mie random error shows a linear increase with altitude, while the Rayleigh random error shows a C-shape with lowest values (scaled MAD of 4 m/s) in middle part of the altitude range and values up to 7 m/s in the lowest and highest altitudes

What are the known limitations of the data products?

- due to laser instrument sensitivity tests, the data products should be only used from June 28, 2019 onwards, no other periods until December 31 need to be excluded; within the period there are small gaps in data coverage due to satellite downlink problems or orbital manoeuvres. Data exclusion periods and data unavailability periods are available at https://earth.esa.int/eogateway/instruments/aladin/quality-control-reports
- as the hot-pixel corrections is applied only for the following orbit file, the temporal behaviour is not corrected within one orbit product; also, 4 Rayleigh hot pixels within the Rayleigh spots can only be corrected with the period of DUDE measurements (4 times per day)
- as the radiometric calibration for L2A products is applied as an orbital average, the variation of the radiometric calibration coefficients within 1 orbit is not corrected. This will be performed for the next re-processing and slightly improve the quality of the L2A product
- the L2B Mie cloudy winds show a constant bias of -0.15 m/s (underestimation). This is a known issue in the M1 telescope bias correction procedure and will be improved for the next reprocessing
- the L2B Rayleigh clear winds show an altitude dependent bias of about 1 m/s over 20 km with an underestimation at lower altitudes and overestimation at higher altitudes; the Mie winds show a slight increase of bias with altitude
- as the L2B bias correction is based on global O-B statistics, there could be higher regional biases; a small difference in bias is observed for ascending and descending paths, with the ascending paths showing a lower bias
- both the L2B Mie and Rayleigh winds show an increase for the bias starting end September 2019 until begin November 2019 with a maximum in mid-October 2019 for the ascending and descending paths; maximum values in mid-October are about 0.4 m/s to -0.6 m/s (Rayleigh) and 0.1 m/s to -0.4 m/s (Mie); the cause of this behaviour is under investigation
- L2B winds show higher random error during the period with AMV range-bin settings from October 28 to November 10, 2019; during that period also the L2A product shows limitations: the Mie Core Algorithm (MCA) can be used, but the standard correction algorithm (SCA) cannot be exploited
- L2B Rayleigh cloudy winds still show significant bias (0.5 m/s to 2 m/s) and significant higher random error than Rayleigh clear winds (6.5 m/s to 7.1 m/s)