Aeolus Level-2B HLOS (horizontal line-of-sight) Wind Product Monthly Quality Report

Period: For the month up to 7 October 2021

By Michael Rennie (ECWMF); a member of the Aeolus DISC team

Introduction

An introduction to the Aeolus Level-2B HLOS wind monitoring statistics is provided on the Aeolus CAL/VAL webpage (under L2B Data Quality Handbook); for those that have access. The ECWMF Technical Memorandum 864 (Section 2.3) provides information about how the Aeolus observation minus background (O-B) departure statistics are calculated. Available here:

https://www.ecmwf.int/en/elibrary/19538-nwp-impact-aeolus-level-2b-winds-ecmwf

ECMWF's daily updated, automatically produced statistics of observation minus background (O-B) and observation minus analysis (O-A) are available from the following website (from which many of the plots used in these reports are obtained):

https://www.ecmwf.int/en/forecasts/charts/obstat/?facets=Data%20type,Aeolus%20HLOS%20Wind

Some Quality Control (QC) is applied to produce the ECMWF automated statistics, which consists of:

- Rejecting observations with Level-2B processor estimated instrument error beyond a thresholds: σ_O > 12 m/s for the Rayleigh and σ_O > 5 m/s for the Mie.
- Rejecting observations when the Level-2B HLOS wind result overall confidence flag is set to invalid.
- A model based "first-guess check" i.e. reject if first-guess departure is deemed to be too large, indicating gross errors i.e. $O - B > 5\sqrt{\sigma_O^2 + \sigma_B^2}$ (a 5-sigma check).

ECMWF also have some daily data coverage plots for Aeolus:
https://www.ecmwf.int/en/forecasts/charts/monitoring/dcover?facets=undefined&obs=Aeolus&Flag=all

Other Aeolus L2B wind monitoring websites

- Météo-France:
  http://www.meteo.fr/special/minisites/monitoring/SATELLITE/LIDAR/lidar.html#
- Met Office:
  https://nwp-saf.eumetsat.int/site/monitoring/winds-quality-evaluation/doppler-wind-lidar/doppler-monthly-monitoring/
  https://nwp-saf.eumetsat.int/site/monitoring/nrt-availability/data-timeliness/

1. L2B Rayleigh-clear O-B and O-A departure statistics

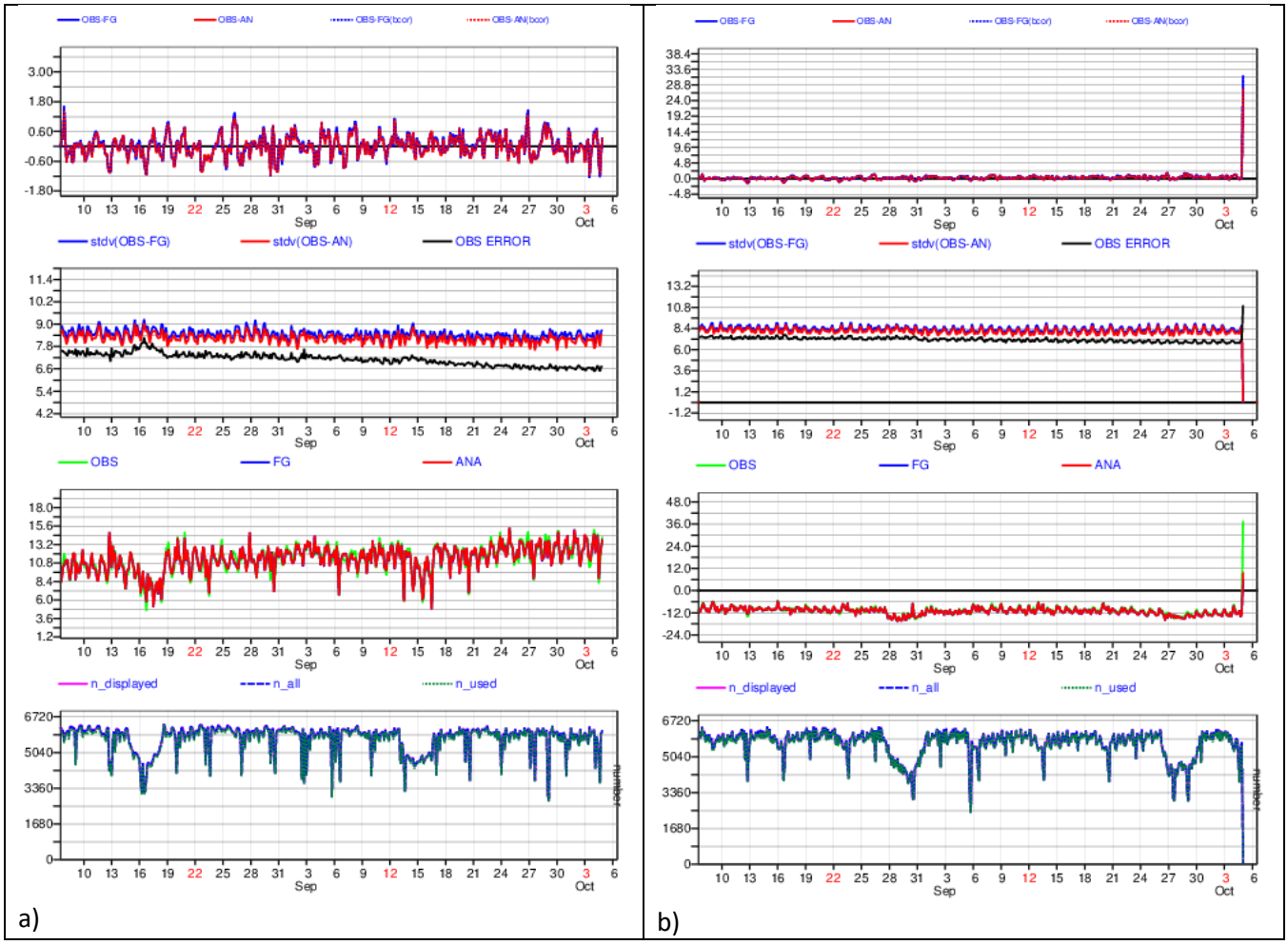


Figure 1. This figure shows changes with time in the O-B and O-A departure statistics of the L2B Rayleigh-clear winds with respect to the ECMWF model. The statistics are calculated every 3 hours for the 0-400 hPa pressure range. Panel a) is for ascending and panel b) is for descending orbit phase. The top plot is the mean of departures i.e. bias; the second plot down is the standard deviation of departures and the assigned observation error in data assimilation (OBS ERROR) i.e. information on random error; the third plot down is the mean observation value and mean model equivalent and the bottom plot is the number of observations per sample.

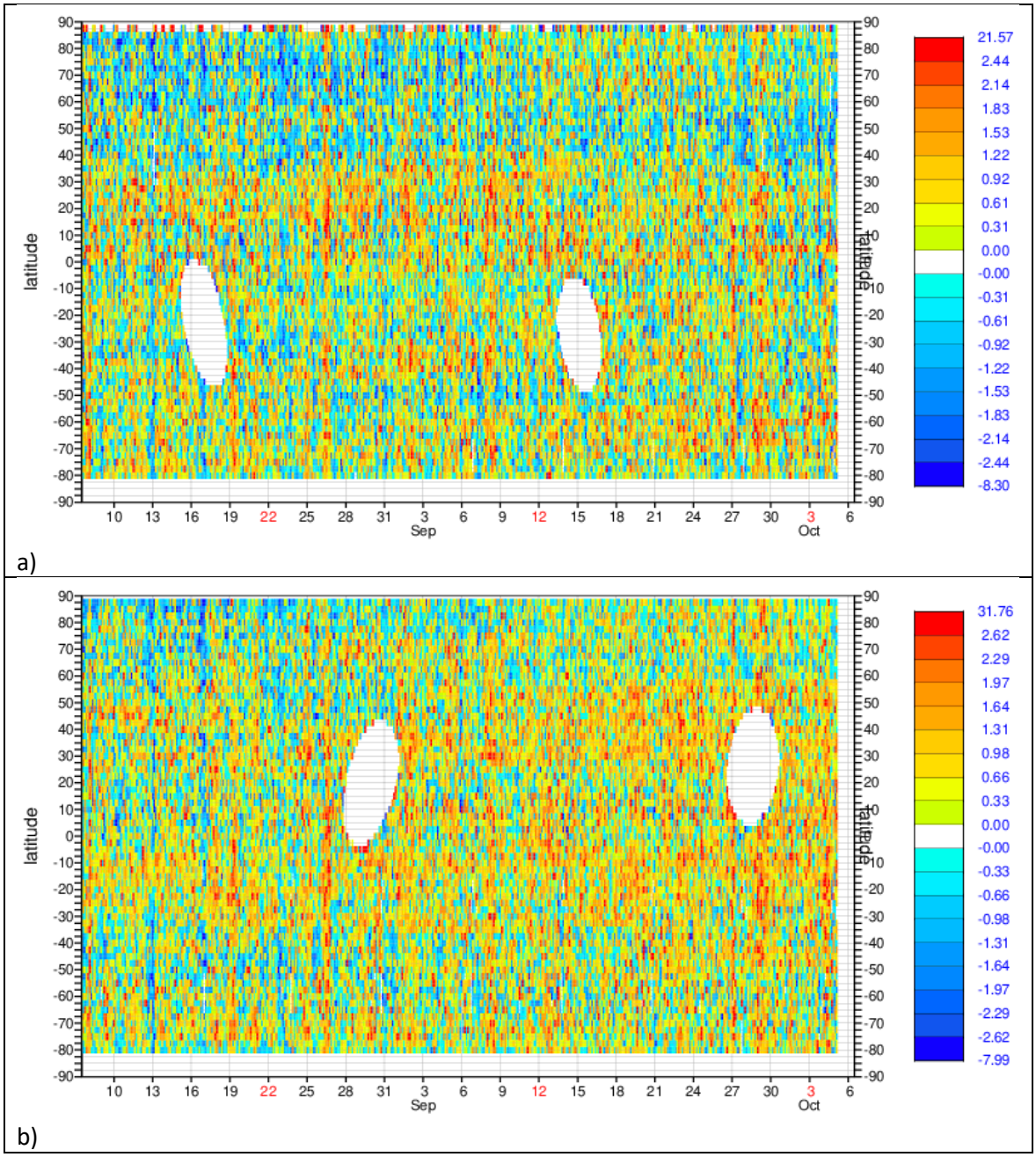


Figure 2. Latitude-time dependence of the mean(O-B) for L2B Rayleigh-clear HLOS winds for the 0-400 hPa pressure range for a) ascending and b) descending orbit phase. Unit: m/s.

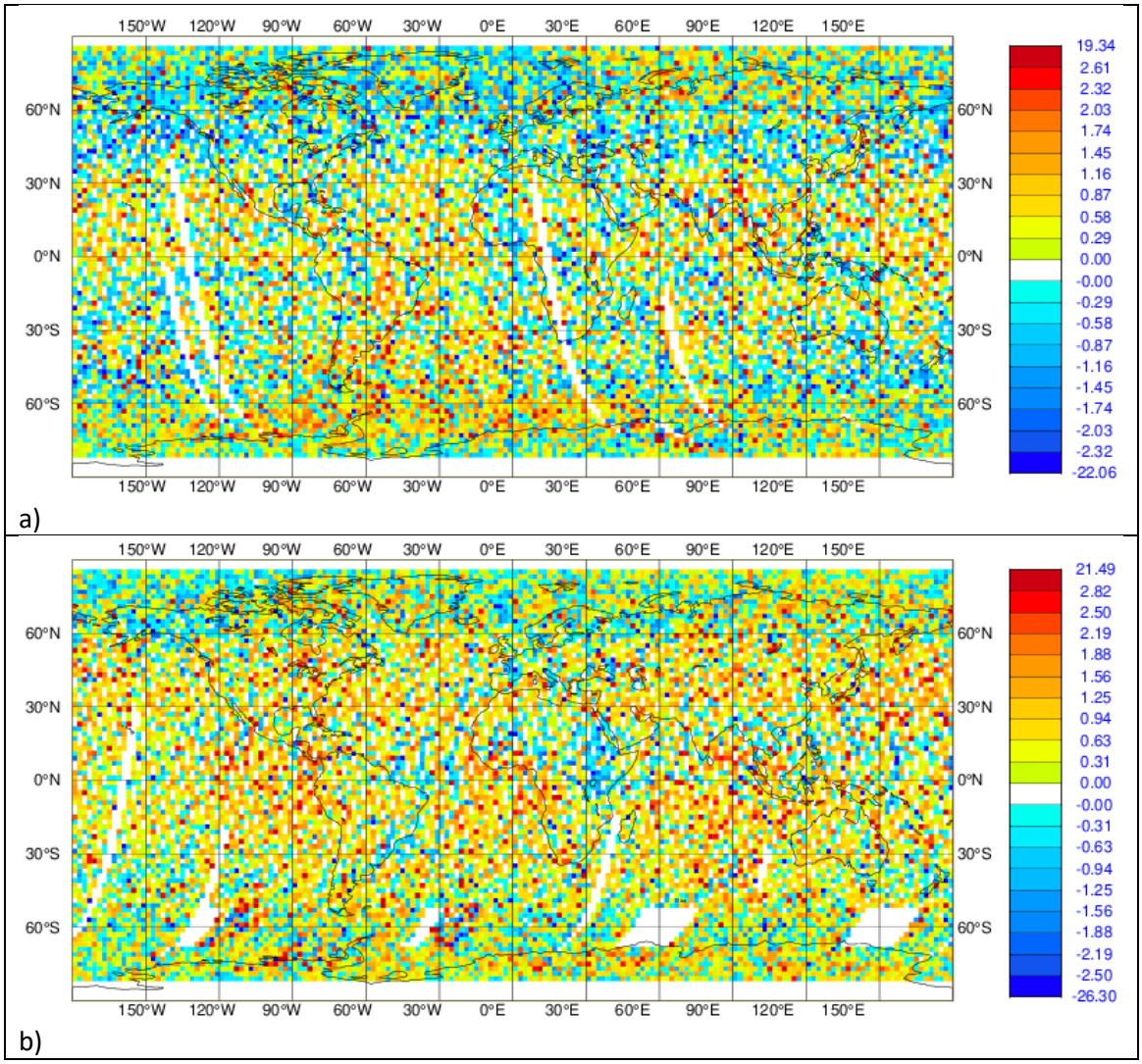


Figure 3. Maps of L2B Rayleigh-clear mean(O-B) for the 0-400 hPa pressure range for a) ascending and b) descending orbit phases. Unit: m/s. For the period: 1 September 2021 to 1 October 2021. These plots are only updated once per week.

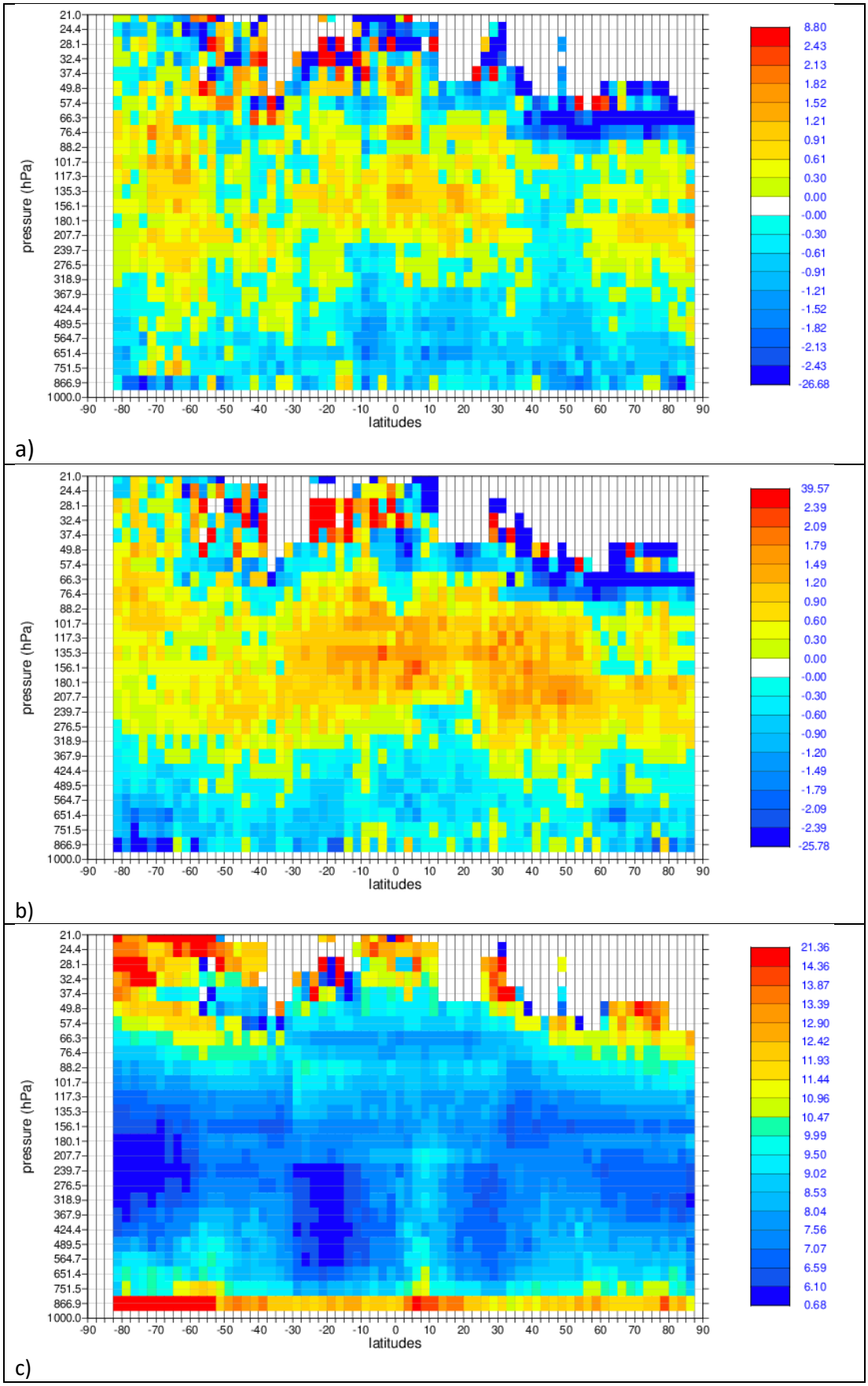


Figure 4. Pressure versus latitude dependence of the L2B Rayleigh-clear mean(O-B) for a) ascending and b) descending orbits. Panel c) is the standard deviation of (O-B) for ascending orbits. Unit: m/s. For the period: 12 September to 2 October 2021.

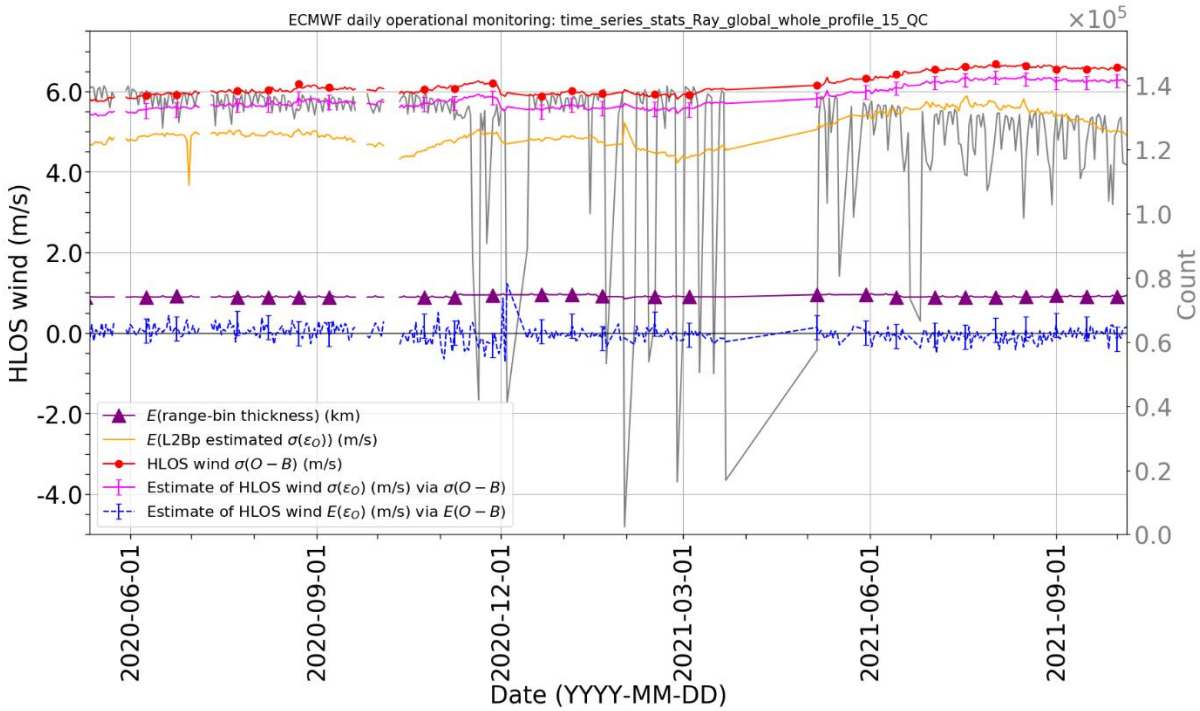


Figure 5. Times-series of daily, global, whole profile L2B Rayleigh-clear HLOS wind related statistics since 12 May 2020 (since L2B data was made public). QC for this type of plot is to reject winds if abs(O-B) > 15 m/s.

Comments and assessment of L2B Rayleigh-clear winds for this period:

- The random errors have remained fairly stable for September 2021 (if not slightly decreased) despite the atmospheric path signal decreasing trend. This is because the solar background noise is approaching its seasonal minimum for Aeolus' orbit. The L2B wind noise is much more sensitive to solar background noise when the useful atmospheric signal is low.
- Some vertical stripes to the bias as a function of latitude and time are evident from Figure 2. These bias jumps have been traced to fluctuations in the dark current levels on existing hot pixels. These fluctuations become relatively more significant as the atmospheric path useful signal decreases with time. To improve knowledge of the dark current fluctuations and hence correct for them better, the number of DUDEs per day was increased from four to seven in September. This helped to some extent, but the problem still occurs.
- The positive bias for descending orbits in the tropics (Figure 4) at ~150 hPa is particularly strong for this period. It is unclear what is causing this i.e. an Aeolus issue or an ECMWF short-range forecast issue.
- Looking at the longer term trends; the number of Rayleigh-clear observations passing QC for assimilation is dropping with time as the signal decreases. Also, the moon-blinding QC is particularly affecting the numbers available in the tropics every 2 weeks on average (elliptical holes in Figure 2).

2. L2B Mie-cloudy O-B and O-A departure statistics

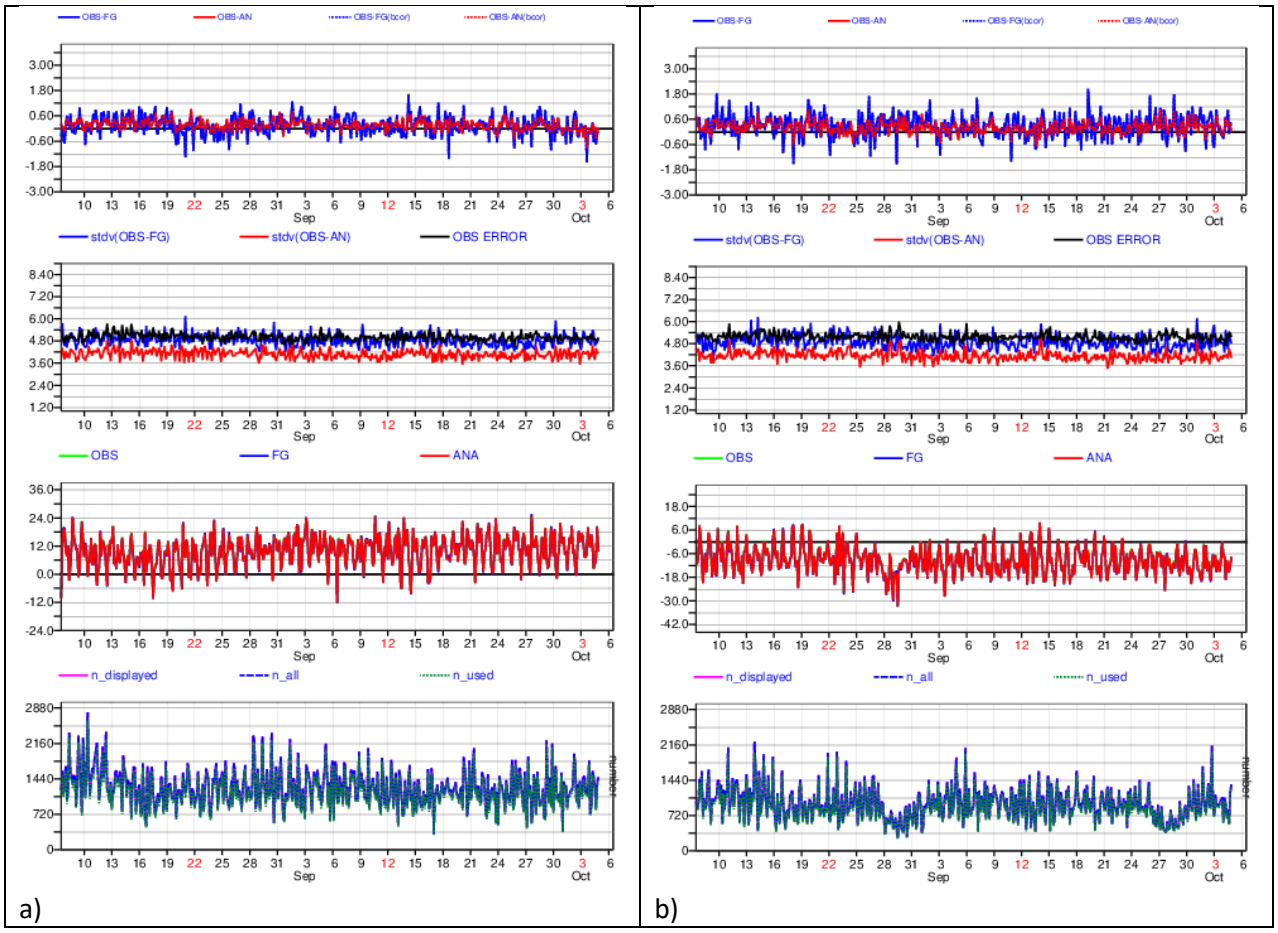


Figure 6. Same type of plots as in Figure 1, but for L2B Mie-cloudy HLOS winds.

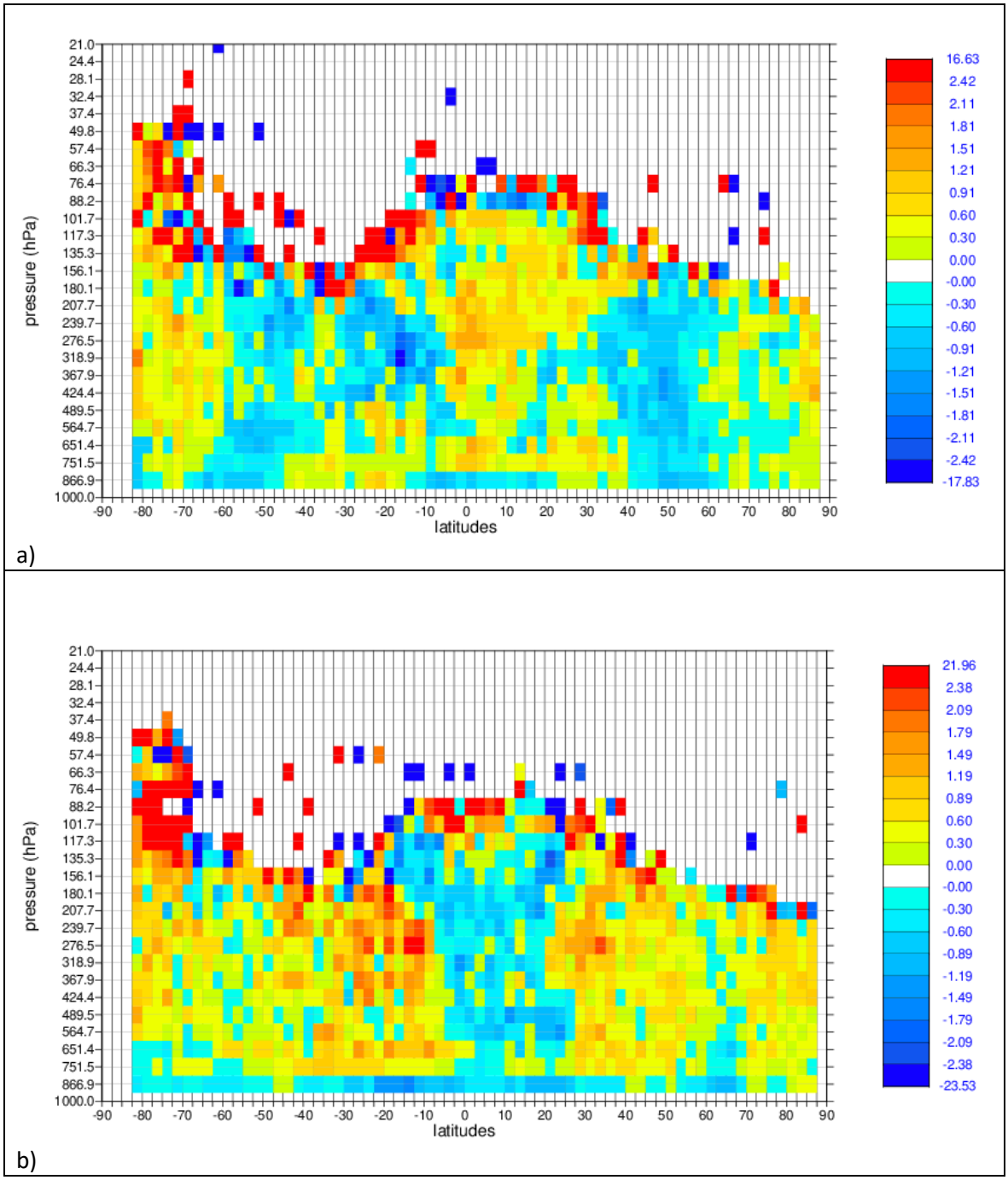
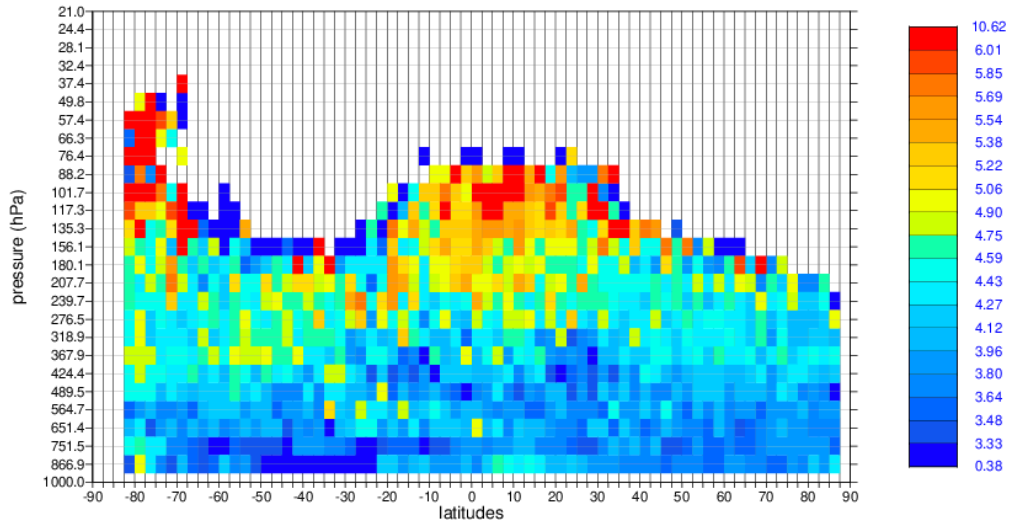
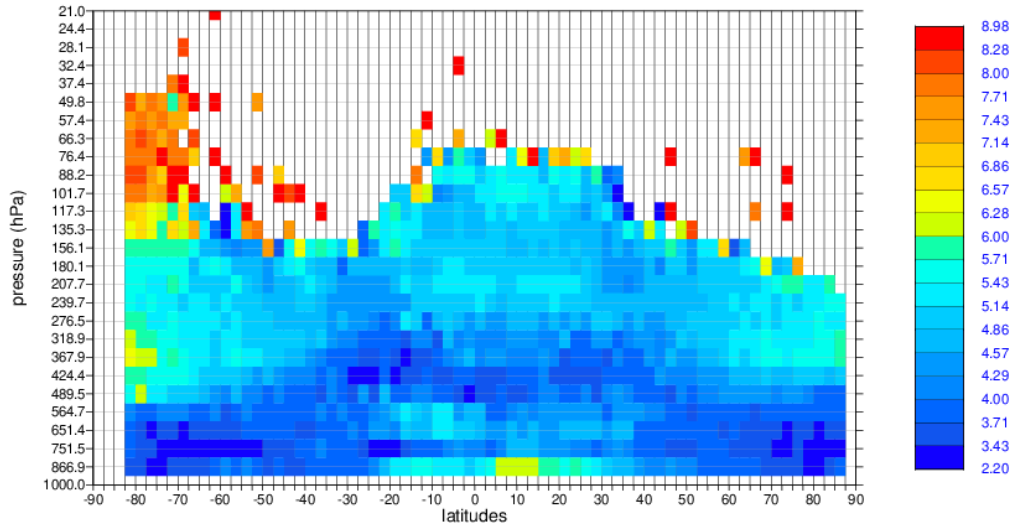


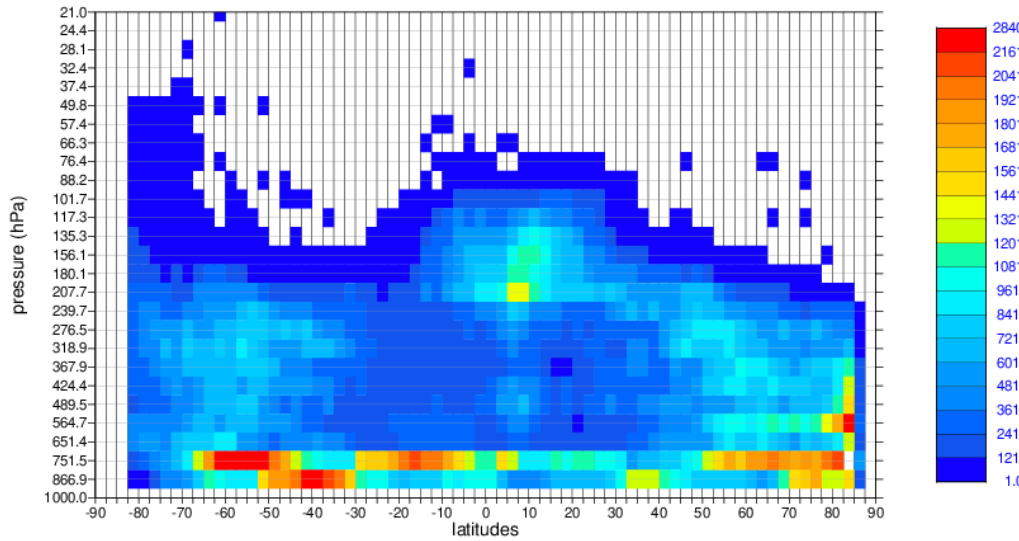
Figure 7. Pressure versus latitude dependence of the L2B Mie-cloudy mean(O-B) for a) ascending and b) descending orbits. Unit: m/s. For the period: 12 September to 2 October 2021.


pressure (hPa)
21.0
24.4
28.1
32.4
37.4
49.8
57.4
66.3
76.4
88.2
101.7
117.3
135.3
156.1
180.1
207.7
239.7
276.5
318.9
367.9
424.4
489.5
564.7
651.4
751.5
866.9
1000.0
-90 -80 -70 -60 -50 -40 -30 -20 -10 0 10 20 30 40 50 60 70 80 90
latitudes
10.62
6.01
5.85
5.69
5.54
5.38
5.22
5.06
4.90
4.75
4.59
4.43
4.27
4.12
3.96
3.80
3.64
3.48
3.33
0.38

a)


pressure (hPa)
21.0
24.4
28.1
32.4
37.4
49.8
57.4
66.3
76.4
88.2
101.7
117.3
135.3
156.1
180.1
207.7
239.7
276.5
318.9
367.9
424.4
489.5
564.7
651.4
751.5
866.9
1000.0
-90 -80 -70 -60 -50 -40 -30 -20 -10 0 10 20 30 40 50 60 70 80 90
latitudes
8.98
8.28
8.00
7.71
7.43
7.14
6.86
6.57
6.28
6.00
5.71
5.43
5.14
4.86
4.57
4.29
4.00
3.71
3.43
2.20

b)


pressure (hPa)
21.0
24.4
28.1
32.4
37.4
49.8
57.4
66.3
76.4
88.2
101.7
117.3
135.3
156.1
180.1
207.7
239.7
276.5
318.9
367.9
424.4
489.5
564.7
651.4
751.5
866.9
1000.0
-90 -80 -70 -60 -50 -40 -30 -20 -10 0 10 20 30 40 50 60 70 80 90
latitudes
2840.00
2161.90
2041.85
1921.80
1801.75
1681.70
1561.65
1441.60
1321.55
1201.50
1081.45
961.40
841.35
721.30
601.25
481.20
361.15
241.10
121.05
1.00

c)

Figure 8. Pressure versus latitude dependence of the L2B Mie-cloudy a) ascending stdev(O-B) m/s, b) corresponding L2Bp estimated observation error m/s (scaled) and c) number of observations. For the period: 12 September to 2 October 2021.

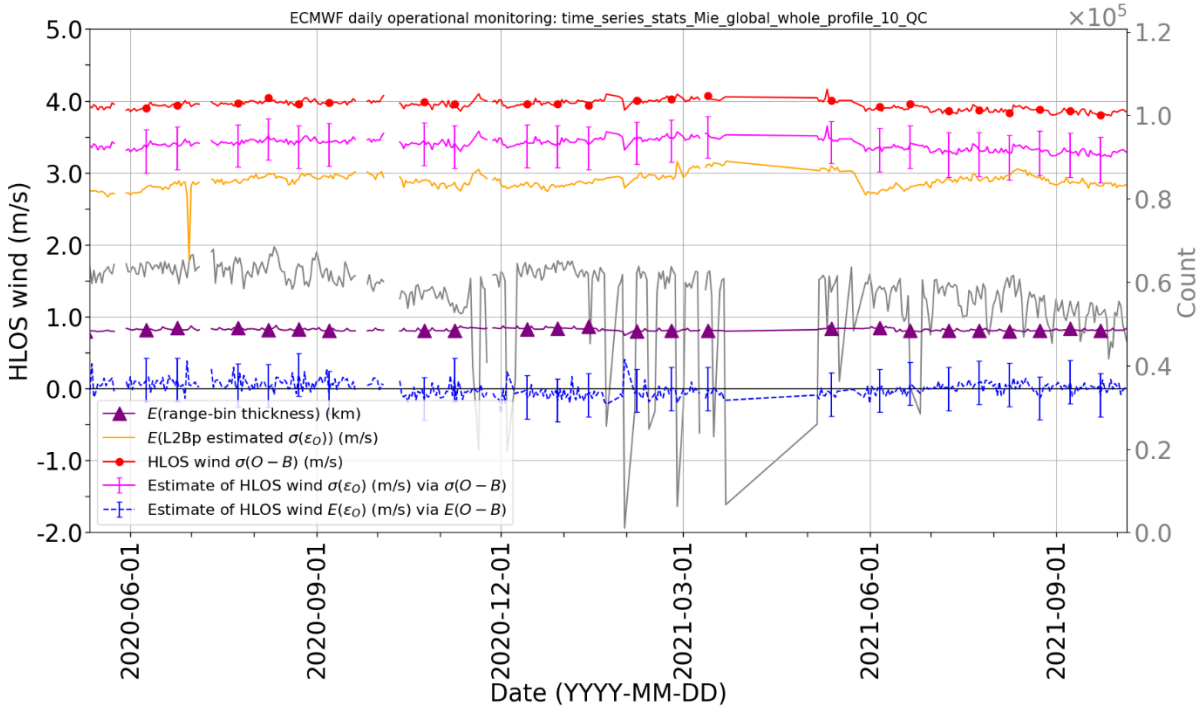


Figure 9. Times-series of daily, global, whole profile L2B Mie-cloudy HLOS wind related statistics since 12 May 2020 (when L2B data was made public). QC for this type of plot is to reject if abs(O-B) > 10 m/s.

Comments and assessment of on L2B Mie-cloudy winds for this period:

- Bias and random errors have remained fairly stable in September 2021.
- The number of Mie winds at low pressures (high altitudes) over the S. Pole because of Polar Stratospheric Clouds has reduced compared to last month.
- The ascending orbit negative bias at 20°S in the zonal average plots is smaller than last month, which might suggest it results from an NWP model issue that varies with the seasons.