

Aeolus Level-2B HLOS wind product quality report

Period: For the month up to 5 October 2020

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Introduction

Some introductory text on the Aeolus Level-2B 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 on how the Aeolus O-B departure statistics are calculated:

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

Daily updated, automatically produced statistics of observation minus background (O-B) and observation minus analysis (O-A) are available from this website (from which many of the plots used in this report have been taken):

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

Quality Control is applied for these automated statistics, which consists of:

- Rejecting observations with Level-2B processor estimated instrument error beyond a threshold. $\sigma_O > 12$ m/s for the Rayleigh and $\sigma_O > 5$ m/s for the Mie.
- Rejecting observations when the Level-2B HLOS wind result overall confidence flag is 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. $O - B > 5 \sqrt{\sigma_O^2 + \sigma_B^2}$

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

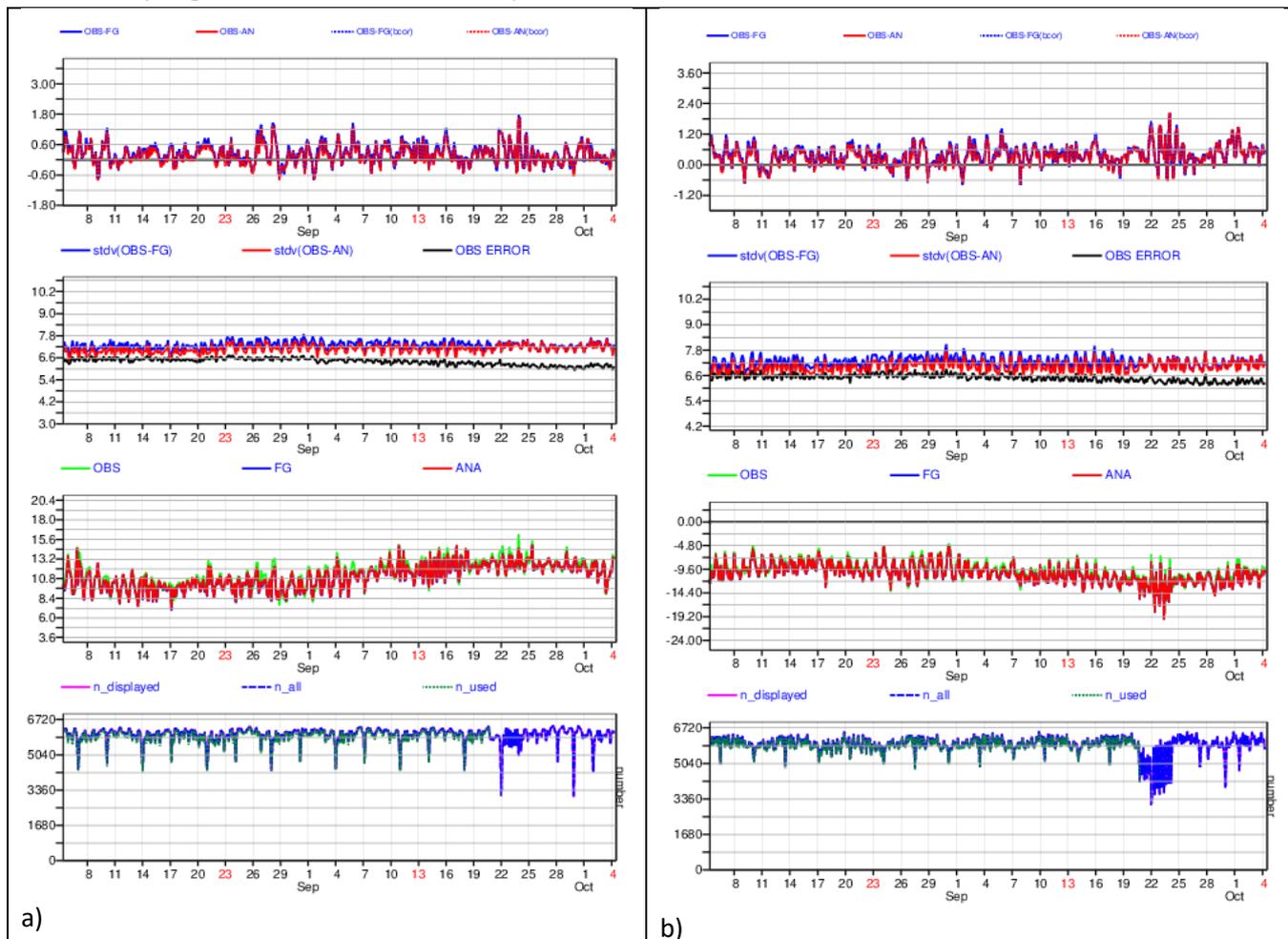


Figure 1. This figure shows changes with time in the O-B and O-A departure statistics of the L2B Rayleigh-clear winds with respect to the ECMWF model. The statistics are calculated every 3 hours for the 0-400 hPa pressure range. Panel a) is for ascending and panel b) is for descending orbit phase. The 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.

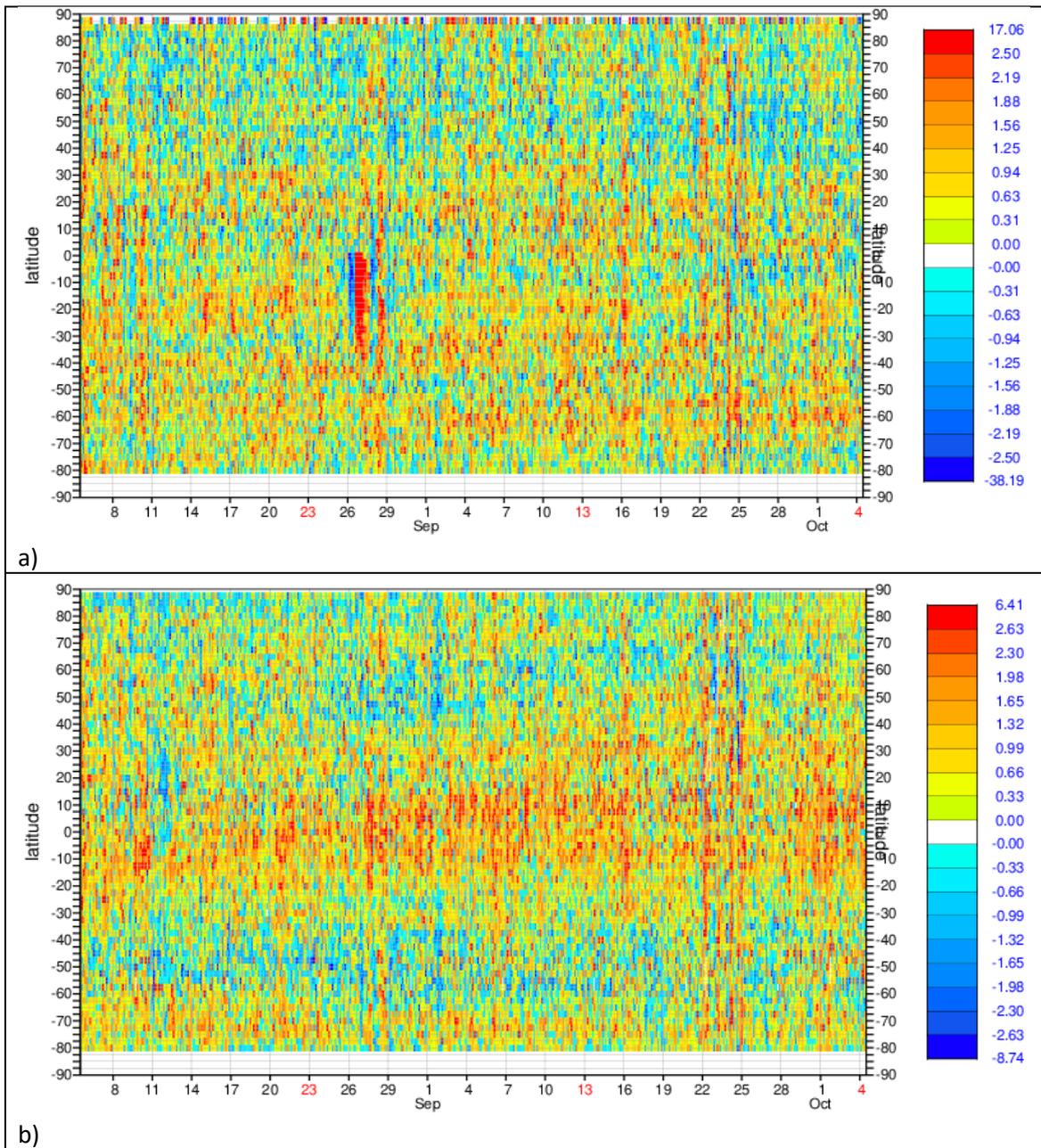


Figure 2. Latitude-time dependence of the mean(O-B) for L2B Rayleigh-clear HLOS winds for the 0-400 hPa pressure range for a) ascending and b) descending orbit phase. Unit: m/s.

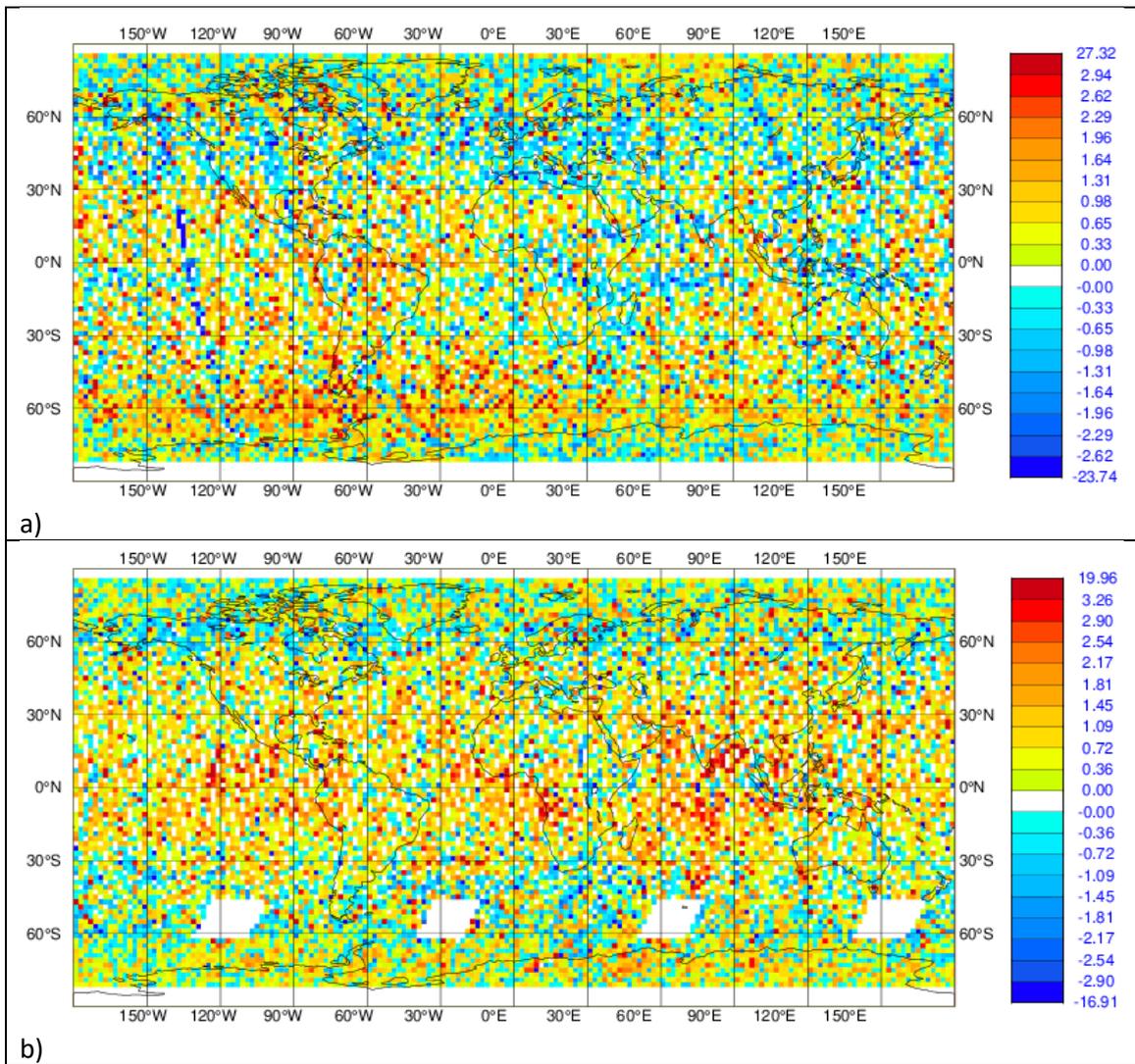
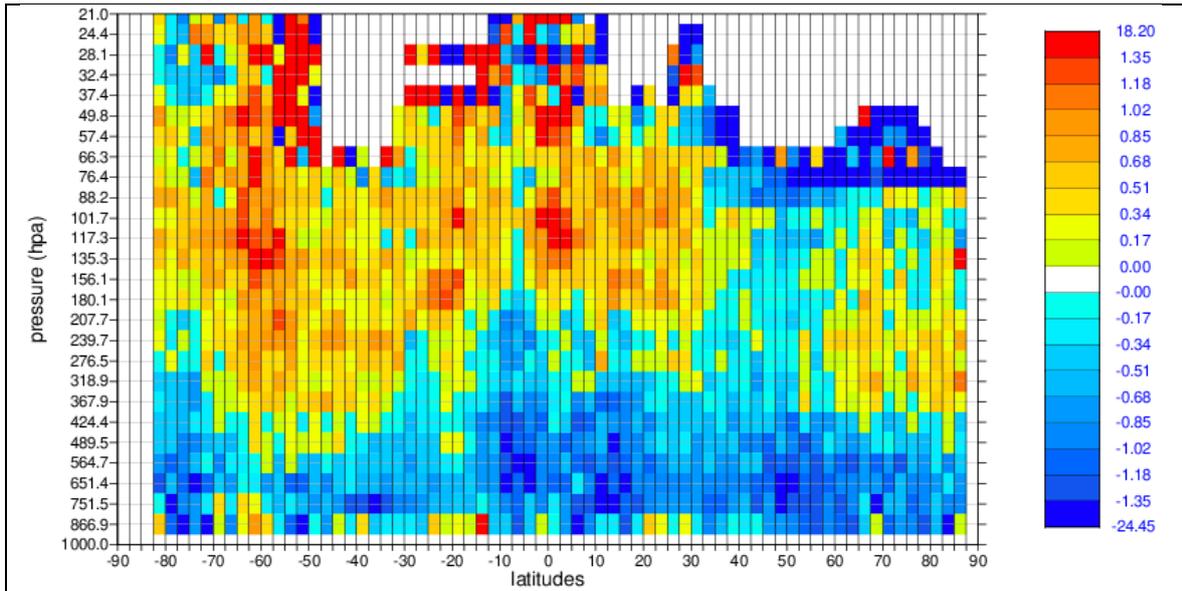
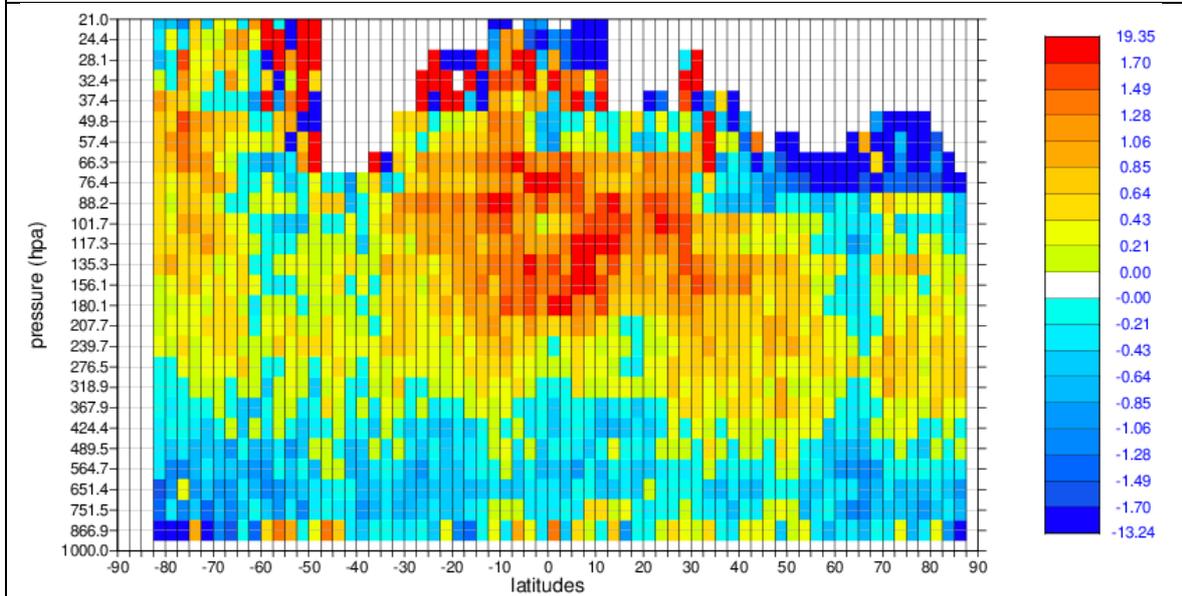


Figure 3. Maps of L2B Rayleigh-clear mean(O-B) for the 0-400 hPa pressure range for a) ascending and b) descending orbit phases. Unit: m/s. For the period: 6 September 2020 to 2 October 2020.



a)



b)

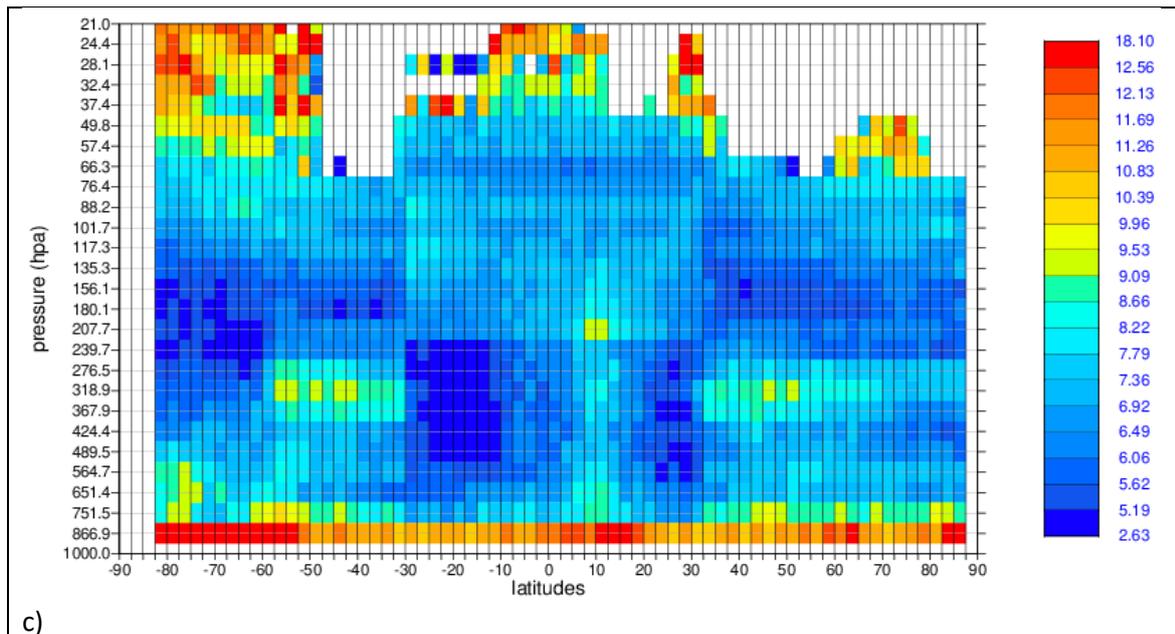


Figure 4. Pressure versus latitude dependence of the L2B Rayleigh-clear mean(O-B) for a) ascending and b) descending orbits. Panel c) is the standard deviation of (O-B) for ascending orbits. Unit: m/s. For the period: 13 September 2020 to 3 October 2020.

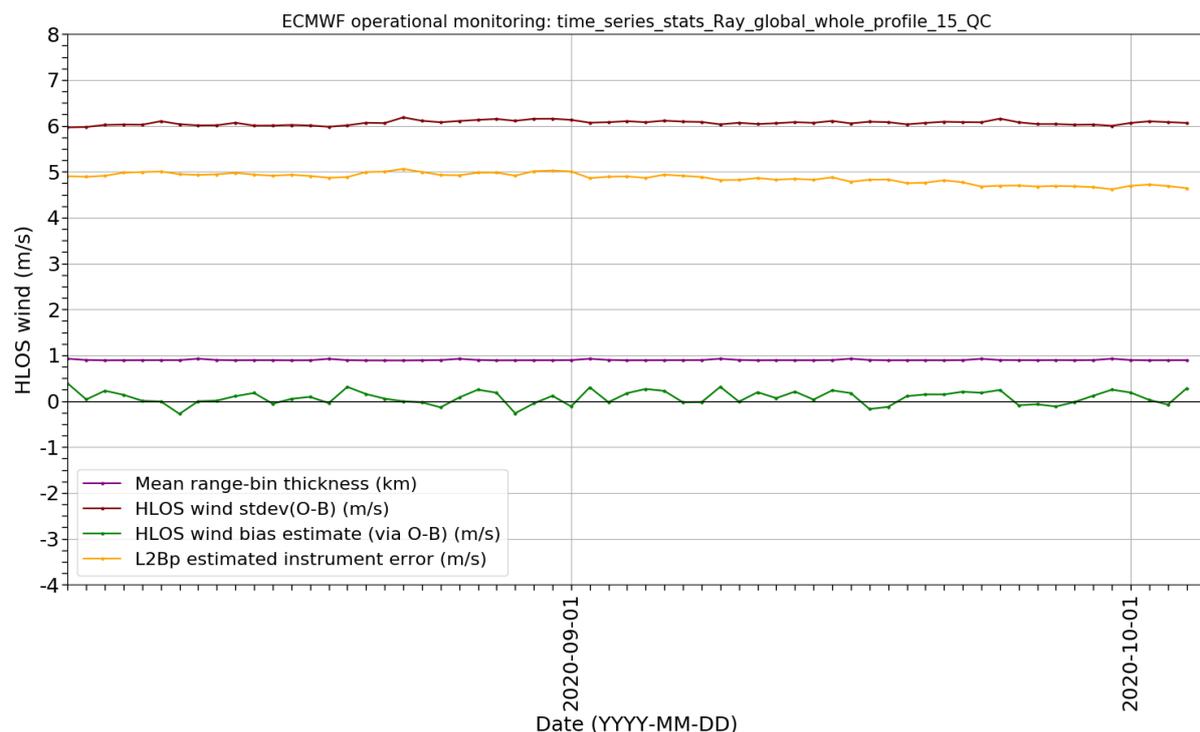


Figure 5. Times-series of daily global, whole profile L2B Rayleigh-clear HLOS wind related statistics for the recent period. QC for this plot is reject if $abs(O-B) > 15$ m/s.

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

- Sequence 1 of the ALADIN laser sensitivity test took place from 21-24 September 2020. This led to some fluctuations in the bias, which is most clearly seen in the Hovmöller type bias plots. L2B winds are rejected from ECMWF operational data assimilation since 21 September

due to the potential for laser sensitivity tests (planned to assimilate again from 10 October). A late decision by ESA meant that calendar week 40 (from 28 September) had nominal settings and in hindsight therefore the data could have been assimilated.

- The global stdev(O-B) and mean(O-B) has looked steady in the past month, although the L2Bp estimated instrument noise has reduced. The flat stdev(O-B) is due to reducing solar background noise along the orbit (seasonal effect of the terminator relative to the Aeolus orbit) and because the actual atmospheric path signal reduction rate has decreased lately (DLR communication with DISC).
- Positive bias persists in the tropical upper troposphere for descending orbits. It is unclear what is causing this. It may be an ECMWF model issue e.g. errors associated with convection.
- Overall, the zonal average bias shows some similarities for ascending and descending orbits, with a generally negative bias at lower levels and more positive bias higher up, except for the Northern high latitudes for which there is strong negative bias around 80 hPa. There are indications in offline testing that the negative bias at lower altitudes may be related to inappropriate Rayleigh response curves for warmer atmospheric temperatures.
- The best quality (lowest random error) Rayleigh winds are over Southern Hemispheric subtropical oceans, due to the lack of cloud cover (until stratocumulus decks).

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

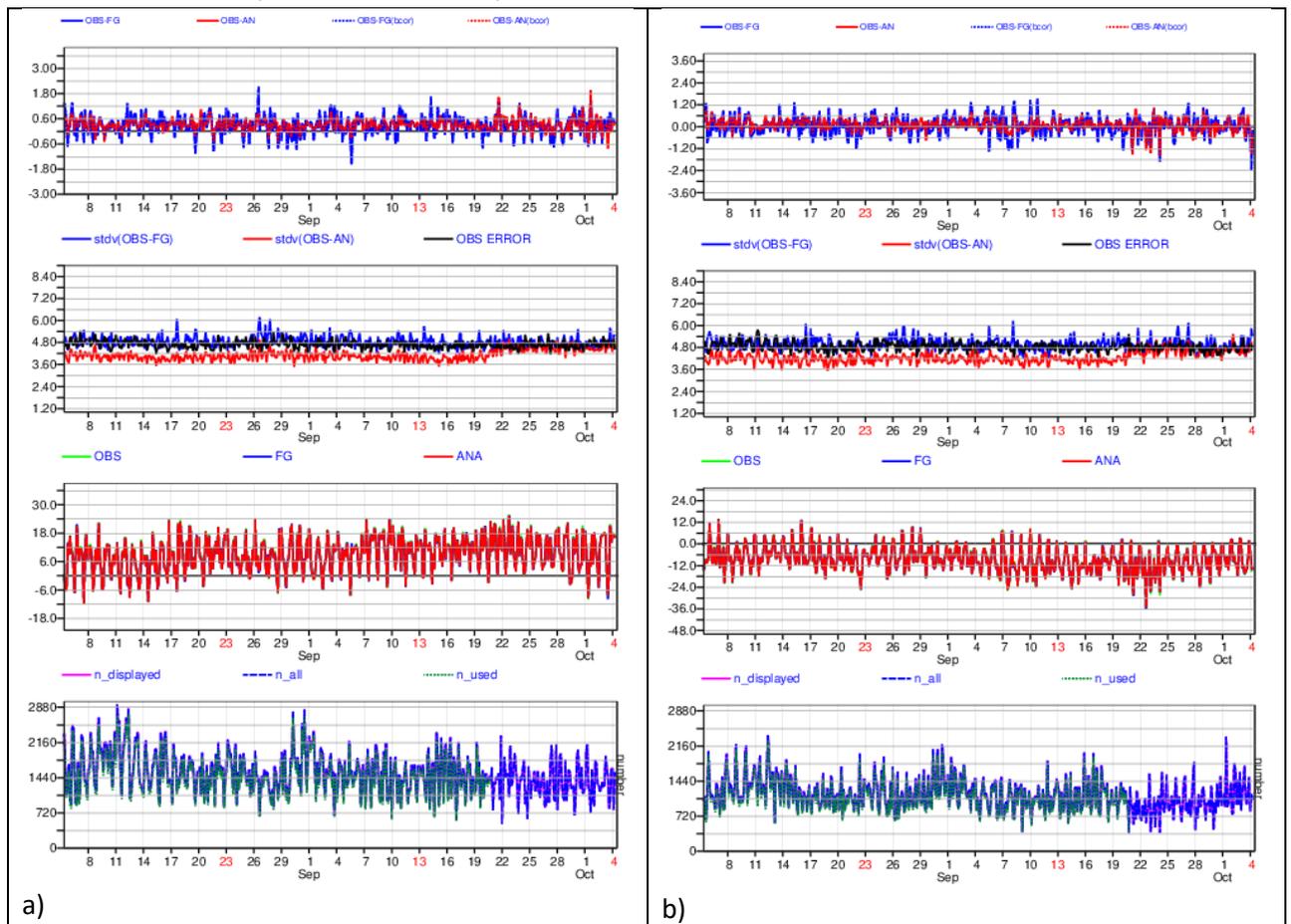


Figure 6. Same type of plots as in Figure 1, but for L2B Mie-cloudy HLOS winds.

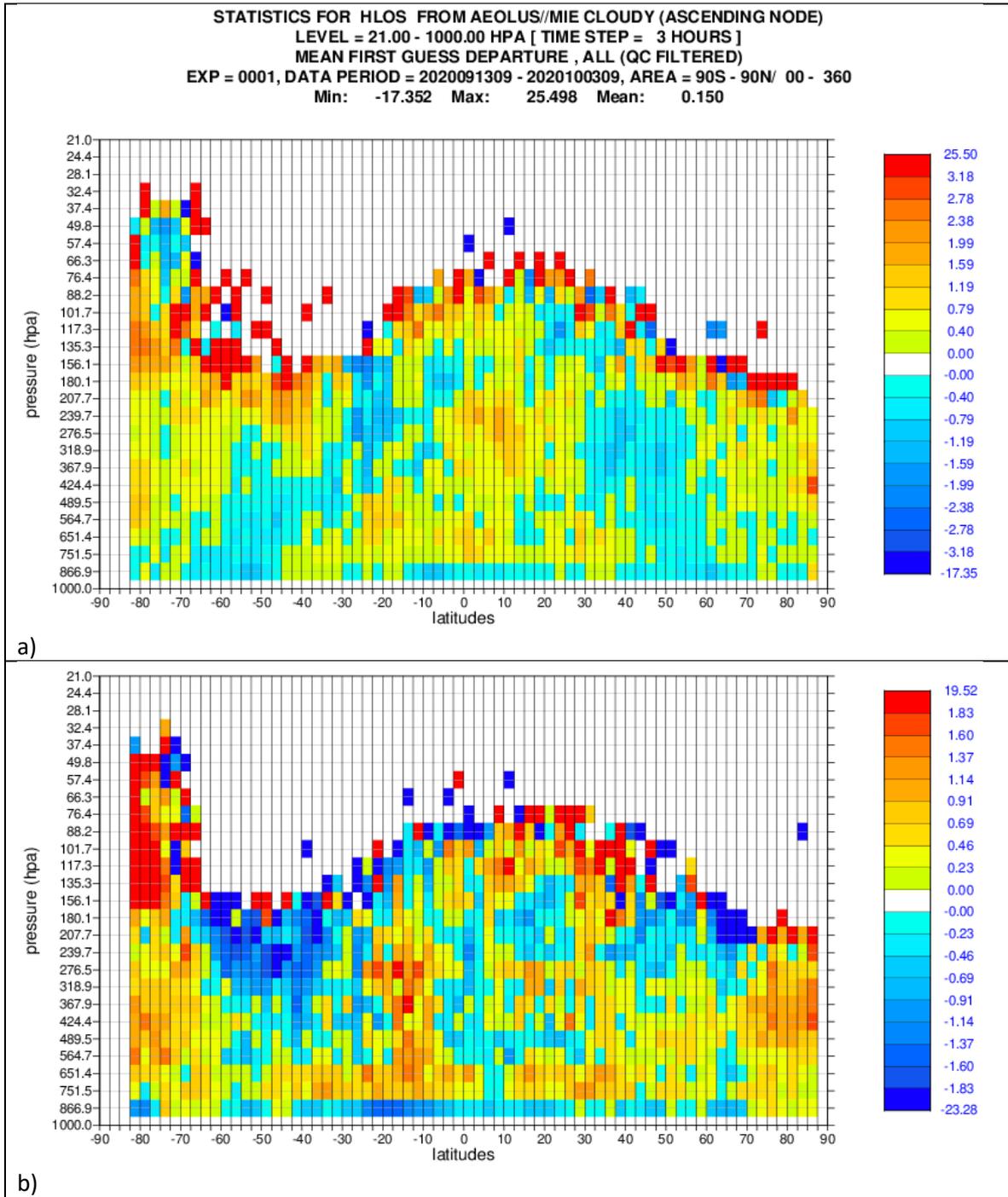
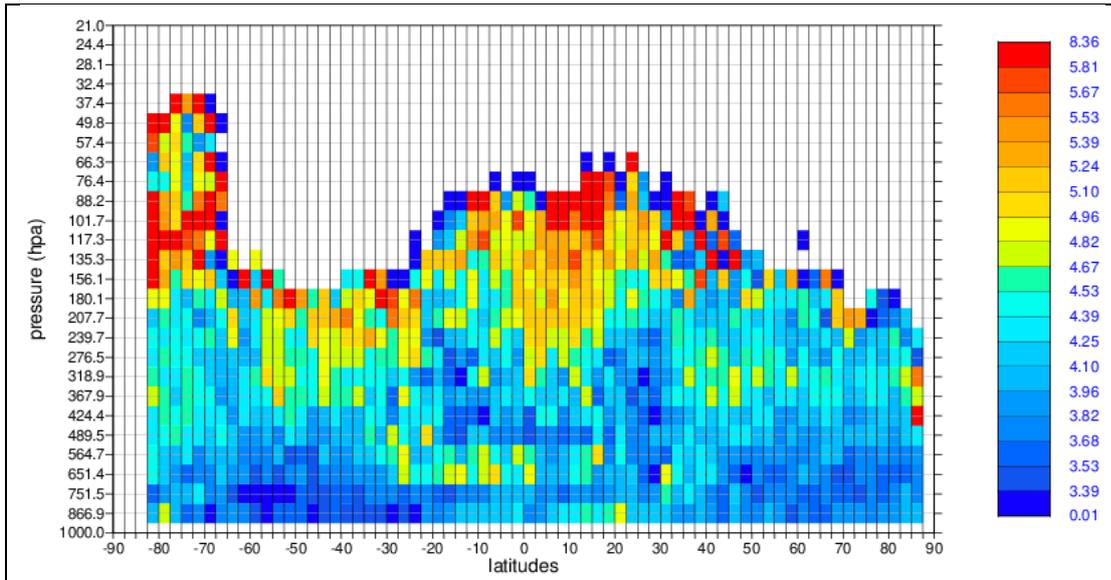
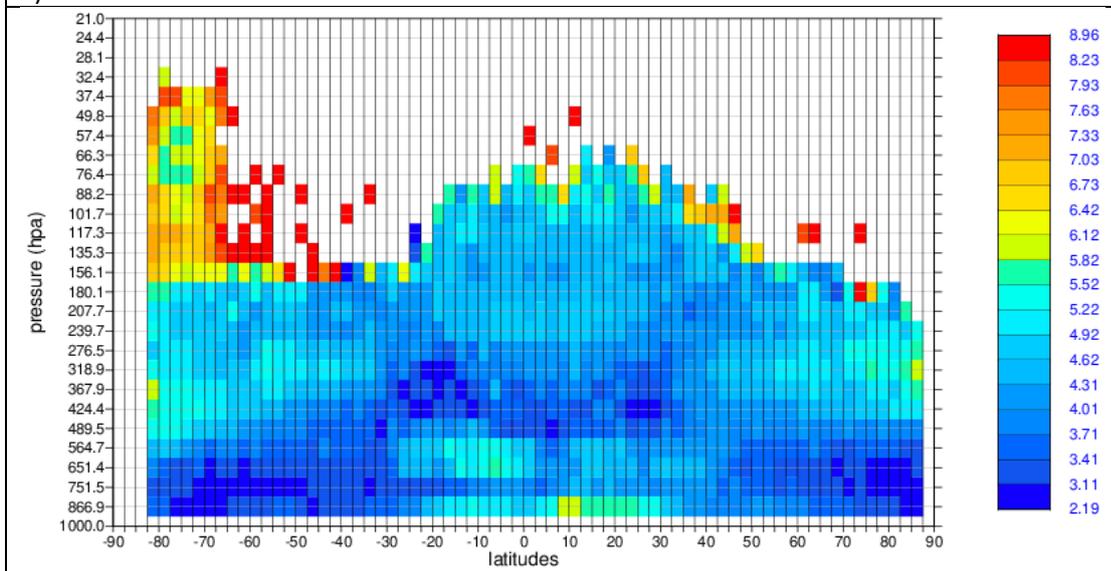


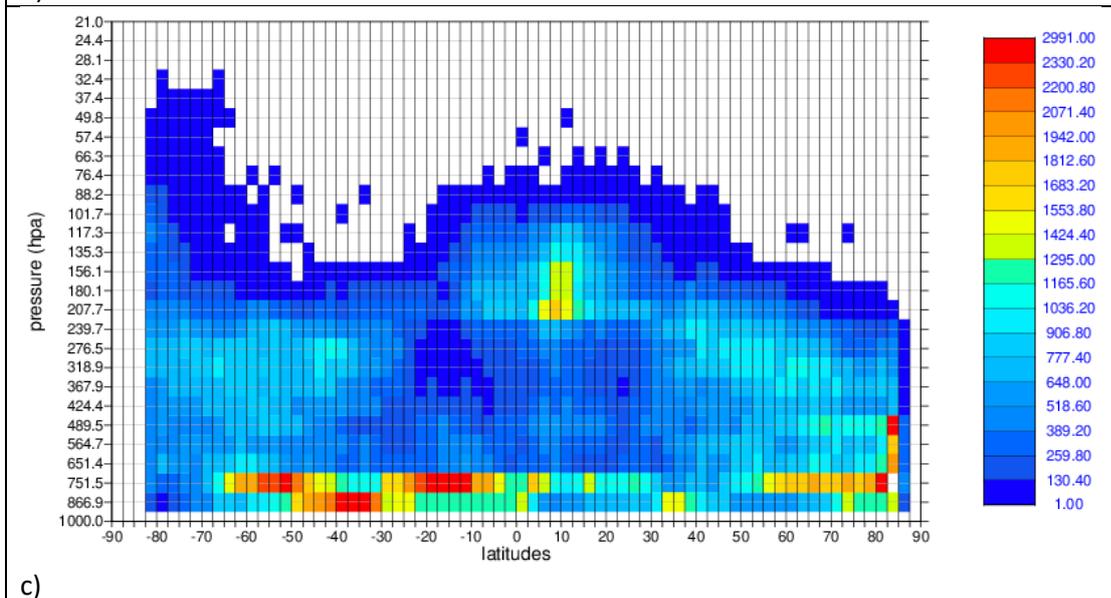
Figure 7. Pressure versus latitude dependence of the L2B Mie-cloudy mean(O-B) for a) ascending and b) descending orbits. Unit: m/s. For the period: 13 September 2020 to 3 October 2020.



a)



b)



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: 13 September 2020 to 3 October 2020.

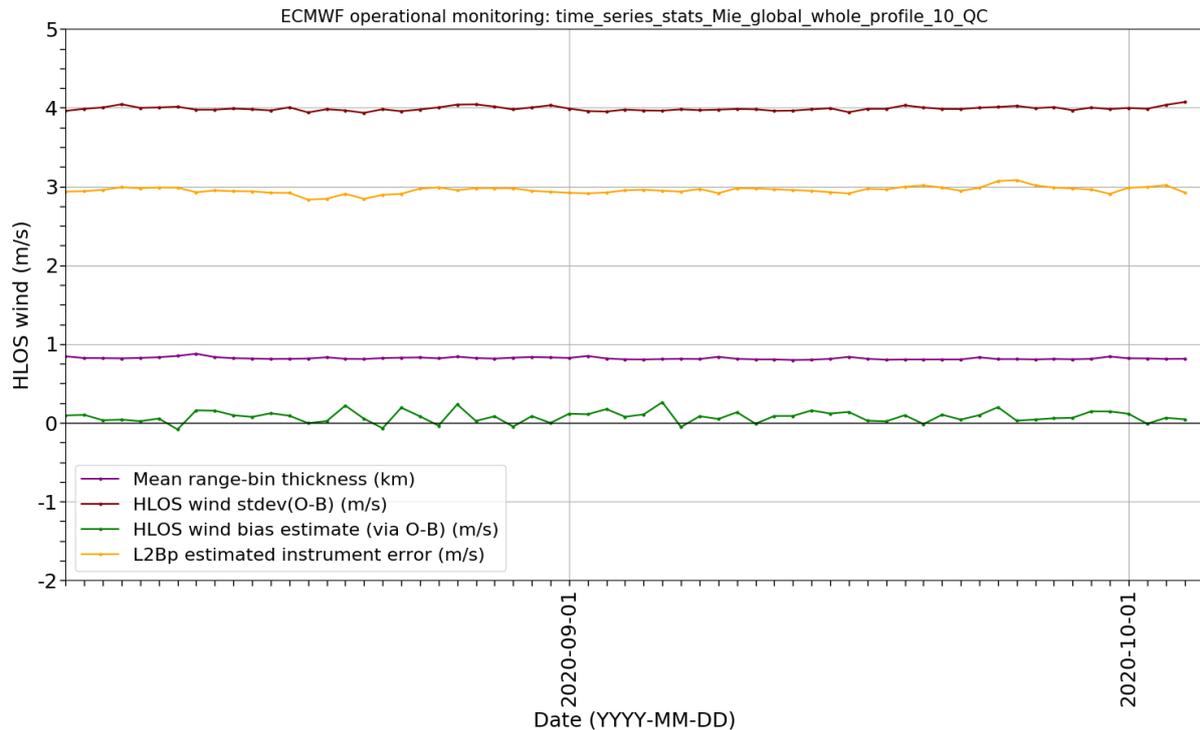


Figure 9. Times-series of daily, global, whole profile L2B Mie-cloudy HLOS wind related statistics for the recent period. QC for this plot is reject if $abs(O-B) > 10$ m/s.

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

- Sequence 1 of the ALADIN laser sensitivity test took place from 21-24 September 2020. L2B winds are rejected from ECMWF operational data assimilation since 21 September due to the potential for laser sensitivity tests (planned to assimilate again from 10 October). A late decision by ESA meant that calendar week 40 (from 28 September) had nominal settings and in hindsight therefore the data could have been assimilated
- Global average random error looks reasonably steady in past month.
- The zonal average biases have a complex pattern and change between ascending and descending orbits (although the magnitude is not huge i.e. ± 2 m/s). It is unclear if these are Aeolus or model wind biases (probably a mix of both). Similar pattern in previous monthly report.
- There remains a good sample of Mie winds at the South Pole between 20-120 hPa due to polar stratospheric clouds. The quality of this data is reasonable for such a high altitude and remote location. This justifies the much higher top range-bin settings for < -60 degrees latitude.
- The highest standard deviation of O-B departures is in the tropical and S. Hemisphere extratropical upper troposphere - which is thought to be an ECMWF model error feature.