

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

Period: For the month up to 6 January 2022

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Introduction

Information on Aeolus Level-2B HLOS wind monitoring statistics is available on the CAL/VAL webpage (under L2B Data Quality Handbook); for those that have access. Section 2.3 of the ECMWF's [Technical Memorandum](#) explains how Aeolus observation minus background (O-B) departure statistics are calculated.

ECMWF's daily updated, automatically produced statistics of L2B HLOS wind observation minus background (O-B) and observation minus analysis (O-A) are available [here](#).

The statistics focus on Rayleigh-clear and Mie-cloudy (not Rayleigh-cloudy and Mie-clear). An expert interpretation of these statistics for the past month is provided in this report, including insights into relevant data events.

Quality Control (QC) is applied in the production of the ECMWF statistics:

- Rejecting observations with Level-2B processor estimated instrument error (1- σ) beyond a threshold: $\sigma_o > 12$ m/s for the Rayleigh-clear and $\sigma_o > 5$ m/s for the Mie-cloudy to remove outliers which spoil non-robust metrics.
- Rejecting observations if the Level-2B HLOS wind result overall confidence flag is set to invalid.
- Rejecting observations which fail the ECMWF model "first-guess check" i.e. reject if $O - B > 5\sqrt{\sigma_o^2 + \sigma_B^2}$ (a 5-sigma check)

Daily data coverage plots for Aeolus are also available [here](#).

Other Aeolus L2B wind monitoring websites

- [Météo-France](#)
- Met Office:
 - [O-B statistics](#)
 - [Data timeliness](#)

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

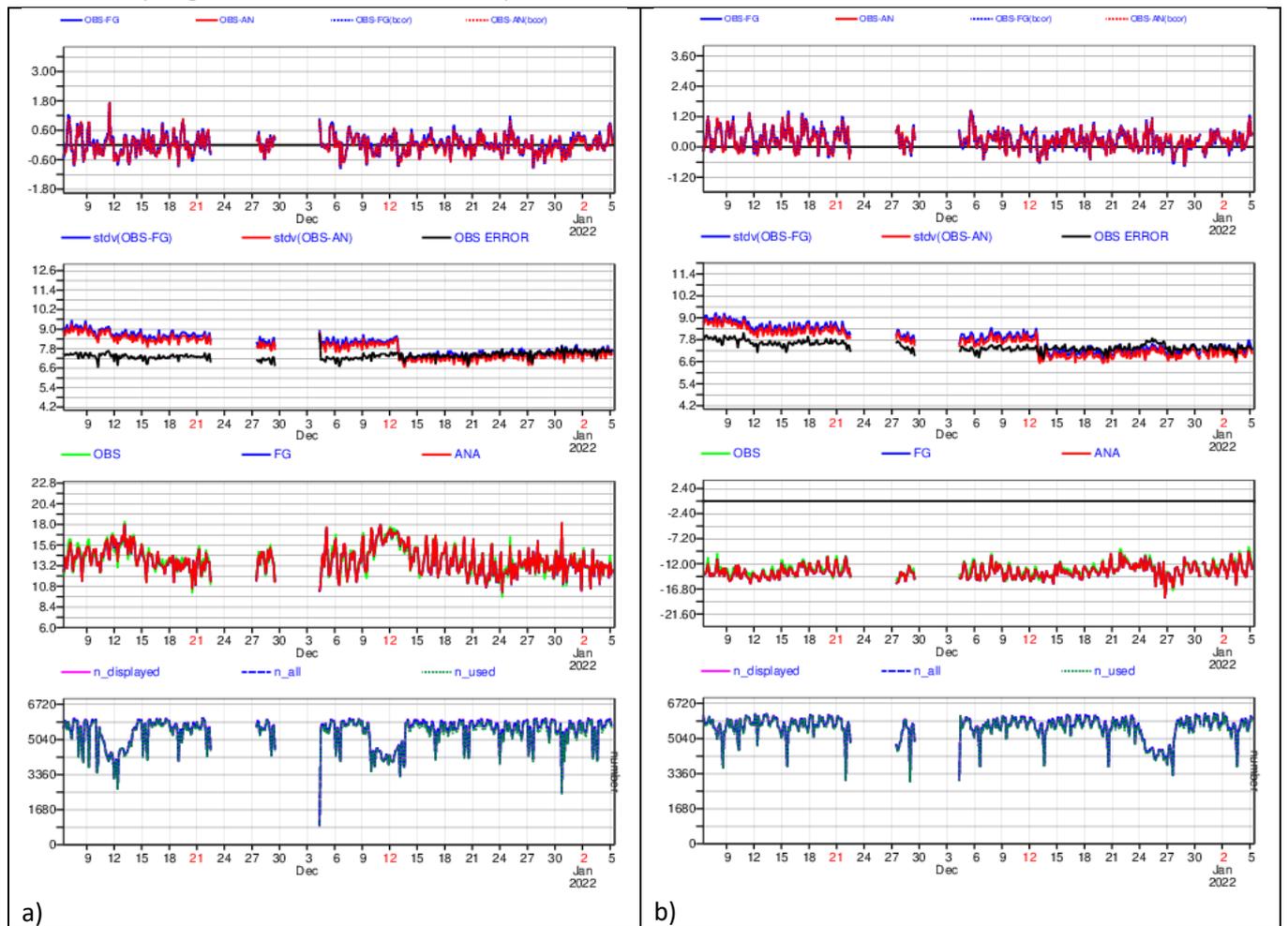


Figure 1. This figure shows changes with time in the O-B and O-A departure statistics of the L2B Rayleigh-clear winds with respect to the ECMWF model. The statistics are calculated every 3 hours for the 0-400 hPa pressure range. Panel a) is for ascending and panel b) is for descending orbit phase. The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

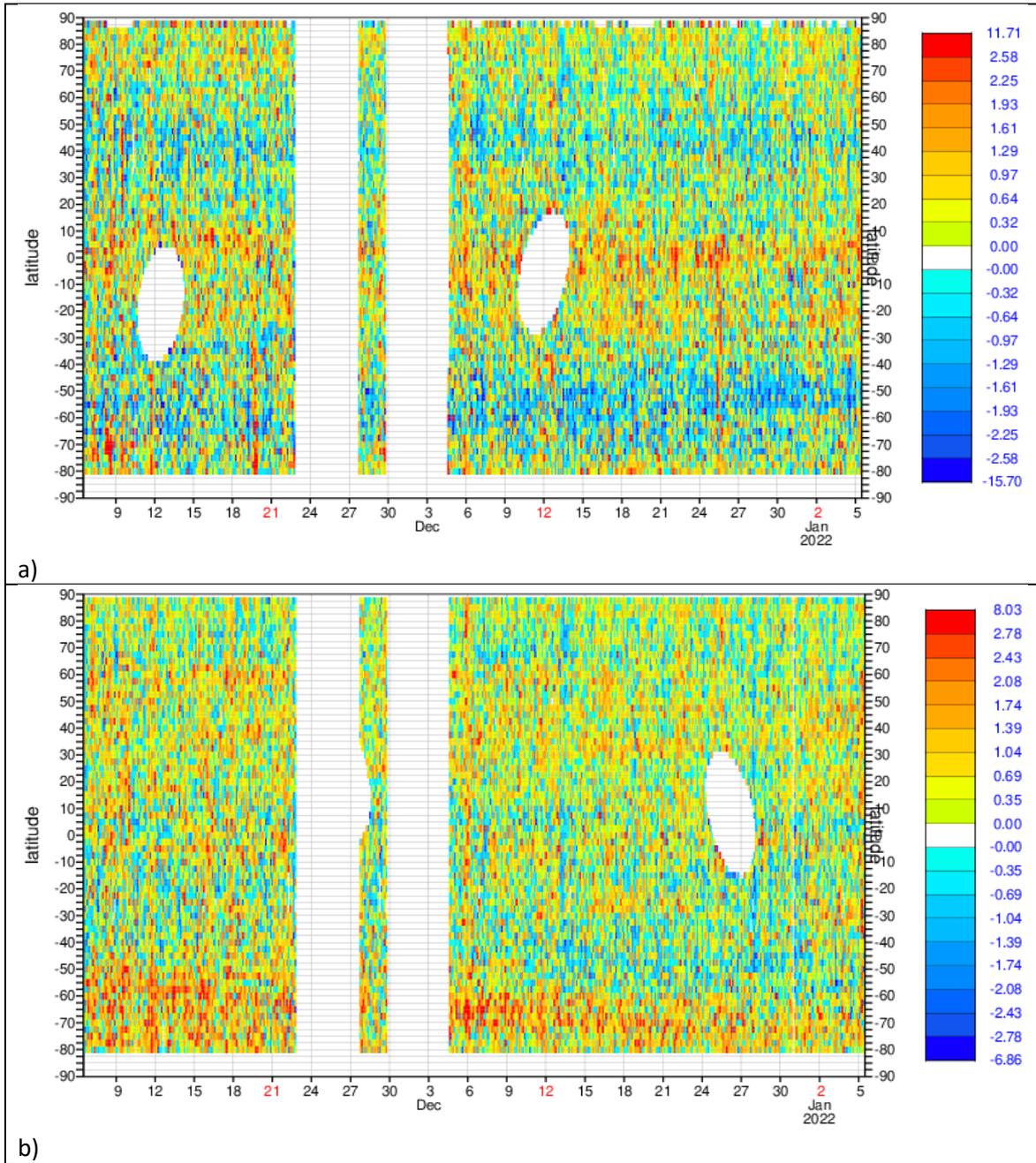


Figure 2. Latitude-time dependence of the mean(O-B) for L2B Rayleigh-clear HLOS winds for the 0-400 hPa pressure range for a) ascending and b) descending orbit phase. Unit: m/s.

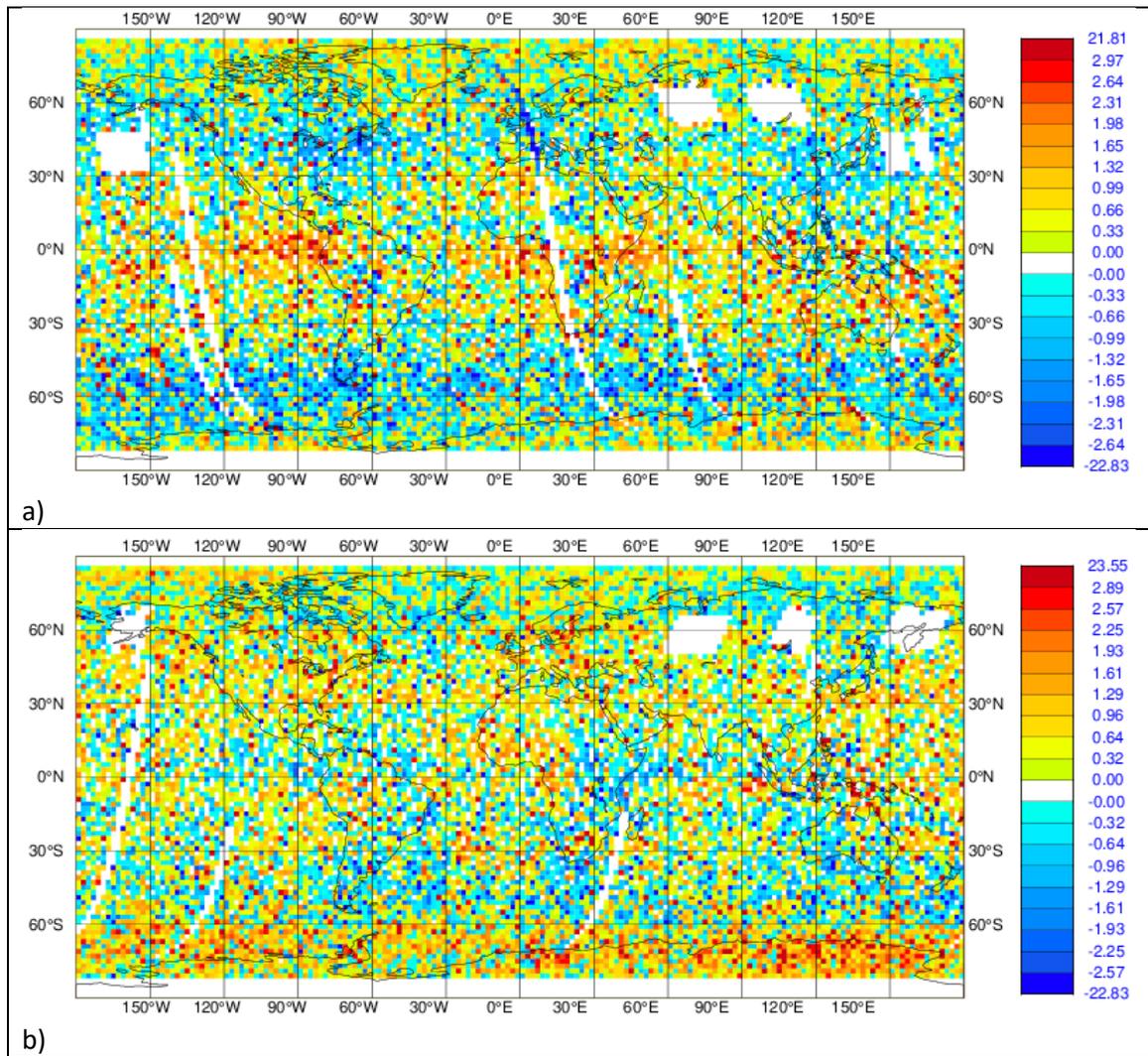
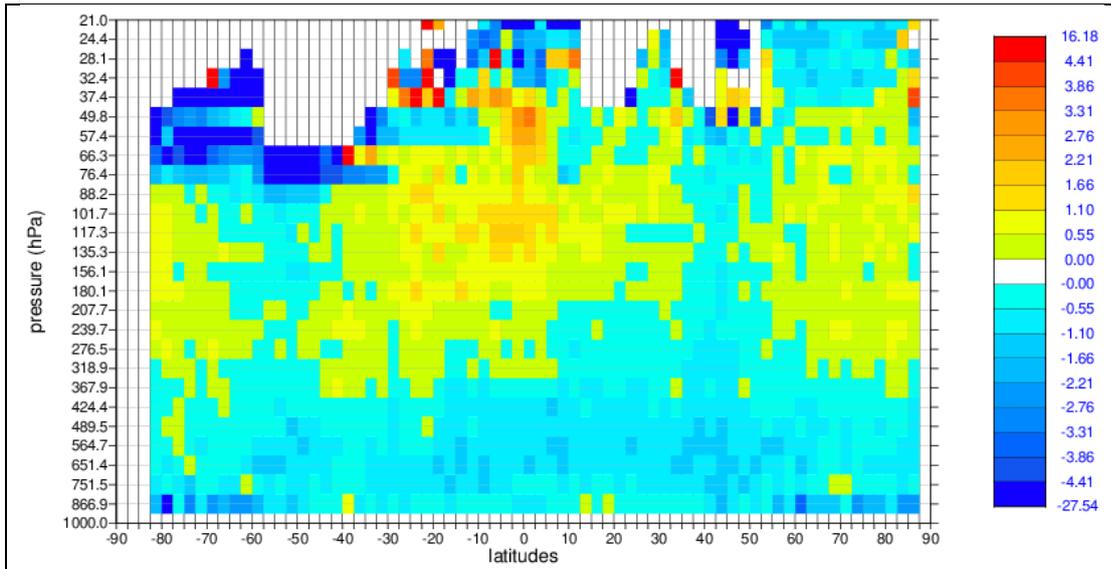
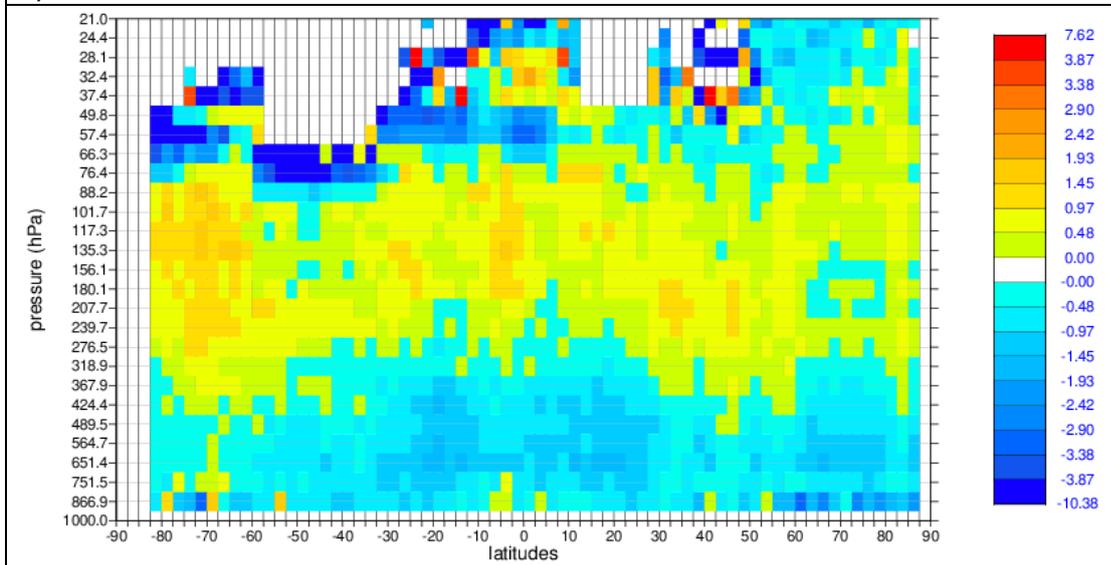


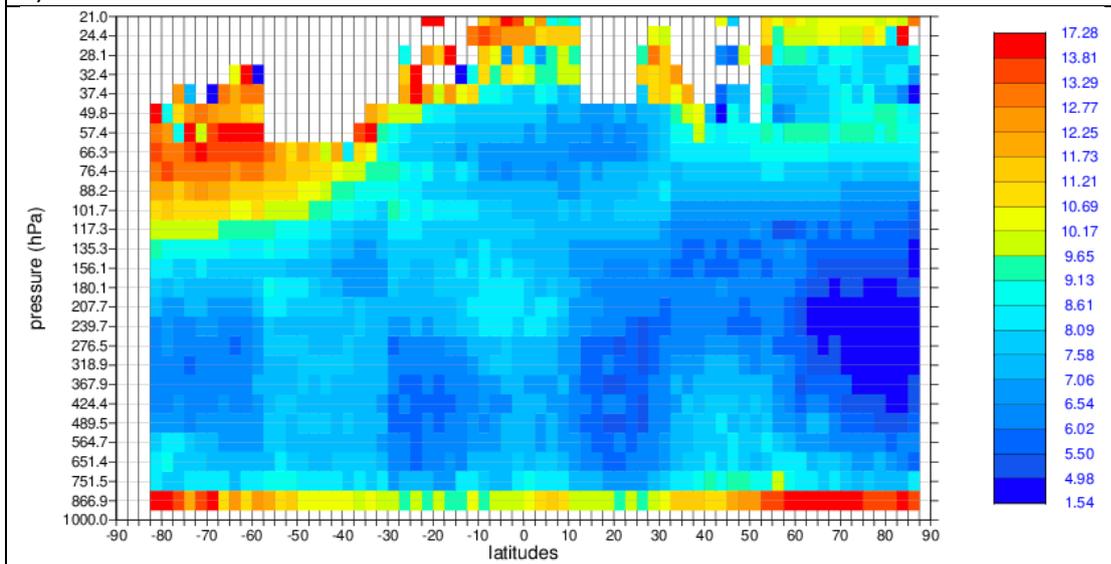
Figure 3. Maps of L2B Rayleigh-clear mean(O-B) for the 0-400 hPa pressure range for a) ascending and b) descending orbit phases. Unit: m/s. For the period: 4 December 2021 to 31 December 2021. These plots are only updated once per week.



a)



b)



c)

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: 29 November 2021 to 05 January 2022.

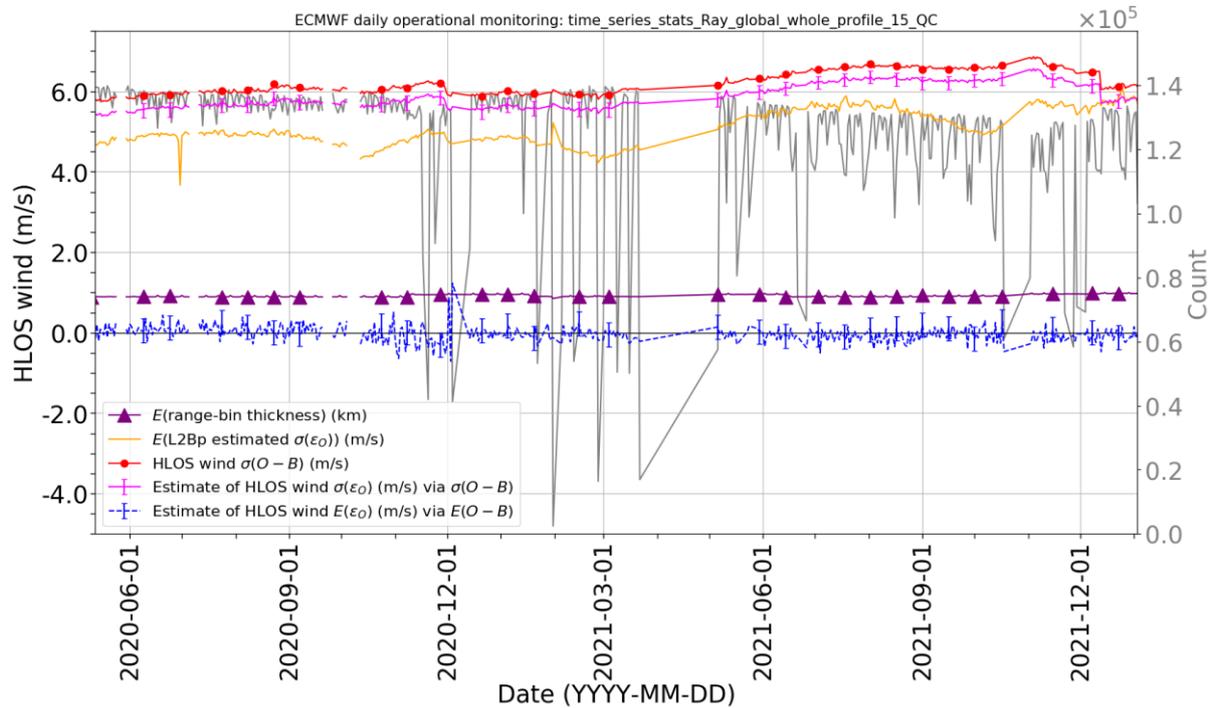


Figure 5. Times-series of daily, global, whole profile L2B Rayleigh-clear HLOS wind related statistics since 12 May 2020 (when L2B data was made available for public release). QC for this type of plot is to reject winds if $abs(O-B) > 15$ m/s.

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

- L2B data was blocklisted from 29 November to 4 December 2021 due to laser sensitivity testing with the aim of improving the atmospheric path signal, hence the gaps in data monitoring for operations. Improvements in Rayleigh noise are evident thanks to the 83-84 mJ operation of the laser after 4 December.
- A new version of the ground processing software (baseline 13, L1Bp v7.11 and L2Bp v3.60) was implemented in operations at 08:25 UTC on 6 December 2021. This did not lead to any obvious changes in the O-B statistics.
- There was a clear improvement in Rayleigh-clear O-B standard deviation on 13 December 2021, due to modifications to the on-board number of laser shots that ALADIN accumulates to generate the measurement-scale (N/P settings). The number of laser shots per measurement was increased from P=19 to P=38, doubling the measurement-scale and halving the number of measurements (N) per BRC (basic repeat cycle). This change improves the SNR per measurement and reduces the number of L1B measurement-scale missing values, which allows the L2Bp to perform better at classification (clear/cloud) and hence to make better use of the available signal, thus improving the noise. The horizontal scale of the L2B Rayleigh-clear HLOS wind observations remains at the one BRC scale of ~ 87 km; so, this is a genuine improvement in noise.
- Looking at the long-term trend (since May 2020), the new N/P settings resulted in the December 2021 Rayleigh noise being similar to NRT data in December 2020, which is a very useful mitigation of the atmospheric path signal decrease; which unfortunately continues. Since the N/P change the noise has shown an increasing trend again due to the ongoing signal decrease.

- There is some bias for ascending orbits with latitude — negatively biased in extratropics and positively bias in tropics. It is not known what is causing this.

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

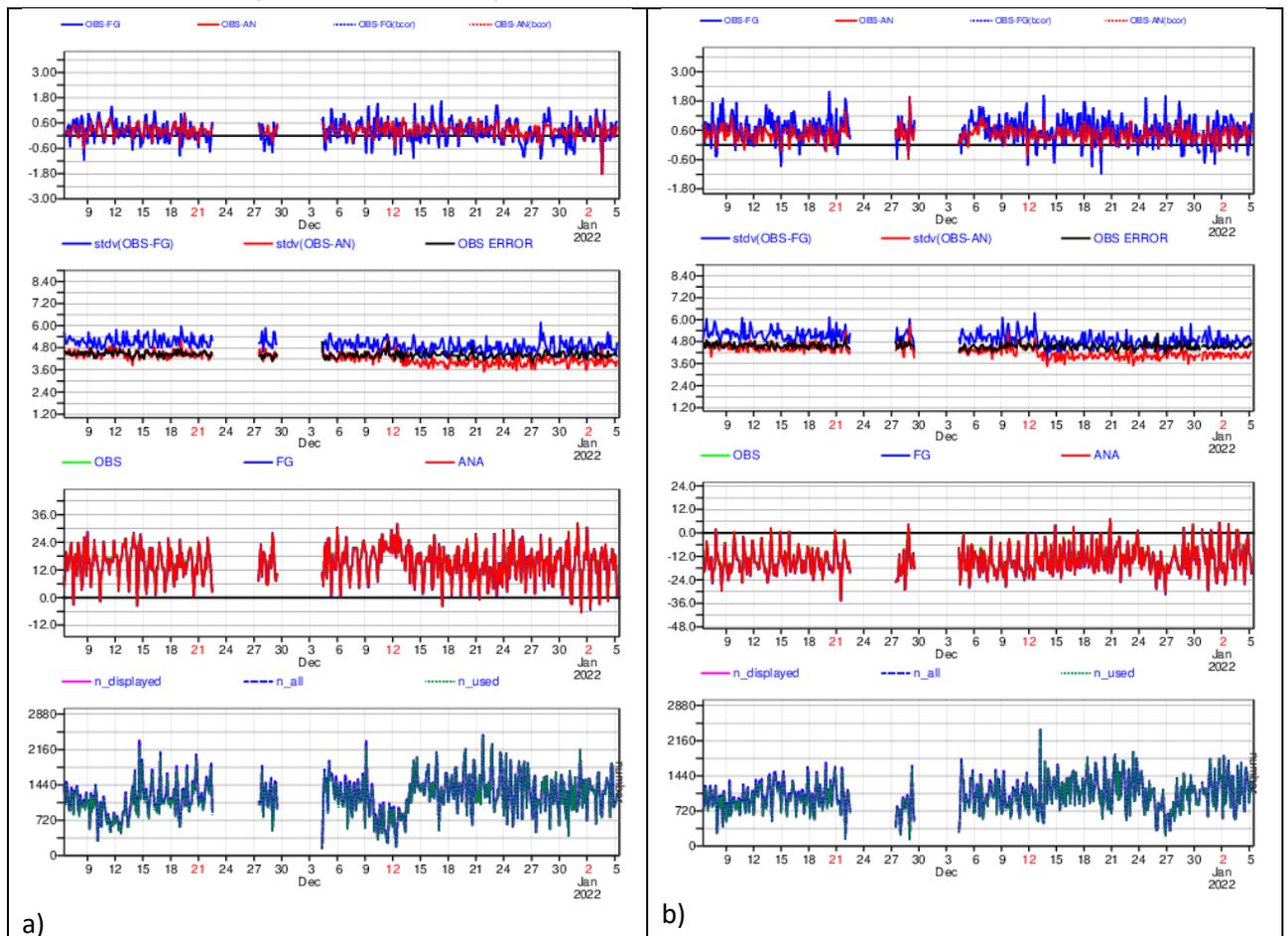


Figure 6. Same type of plots as in Figure 1, but for L2B Mie-cloudy HLOS winds.

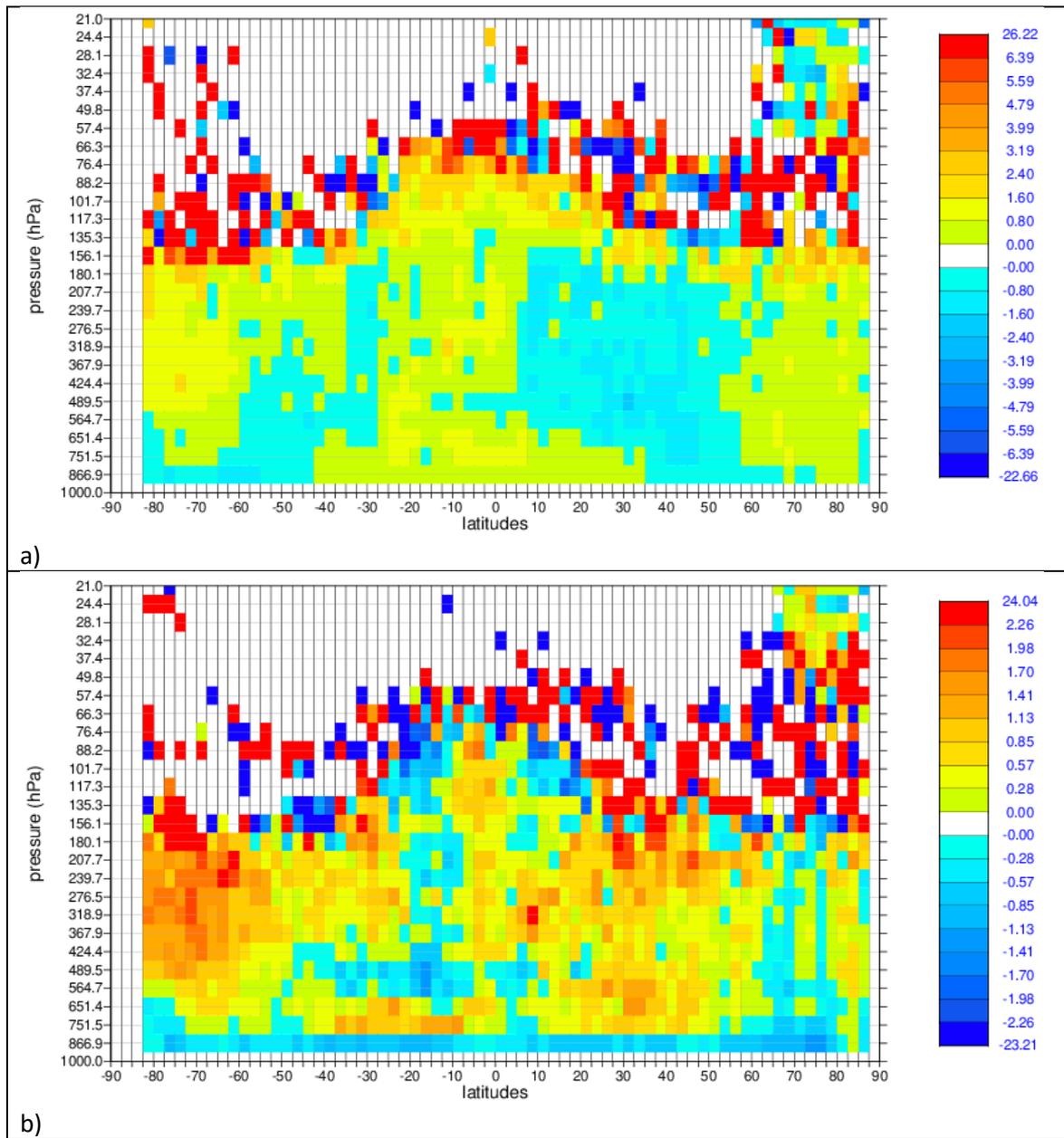
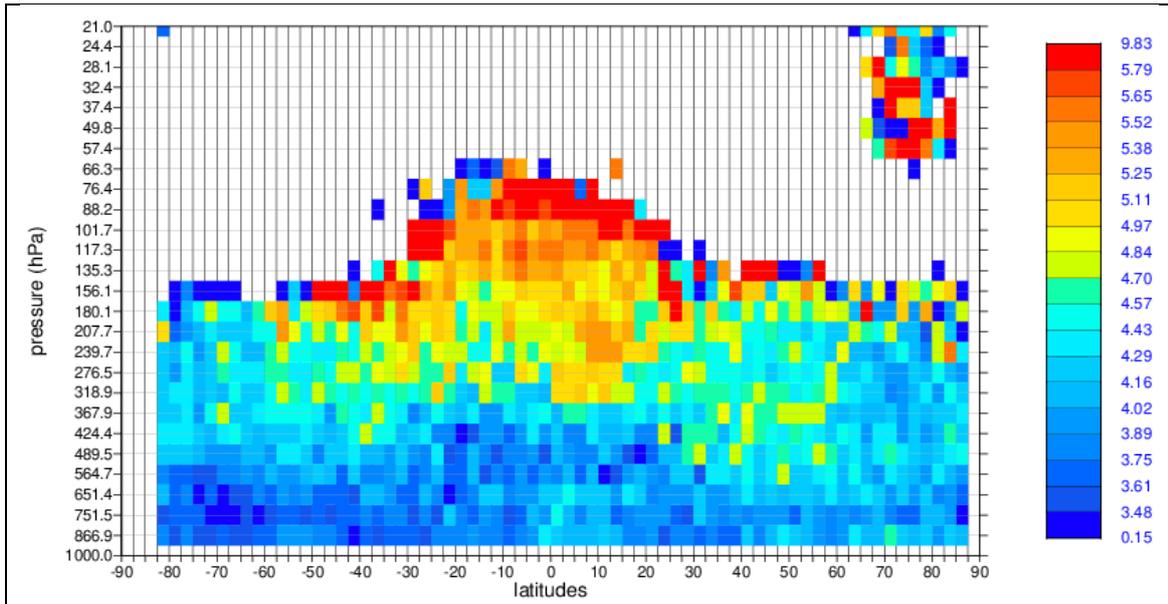
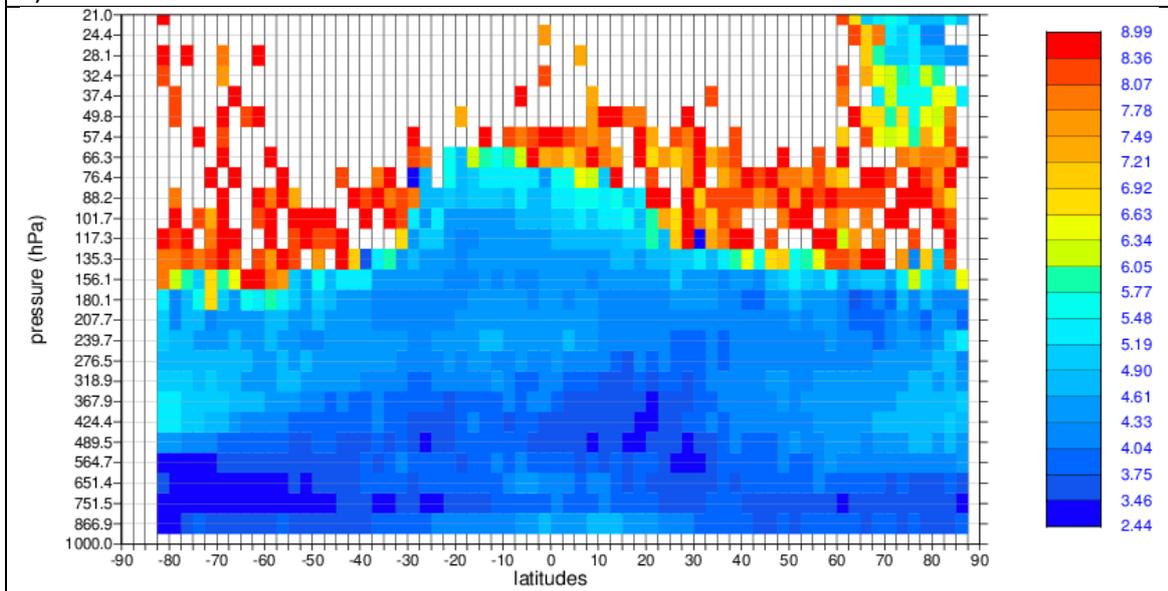


Figure 7. Pressure versus latitude dependence of the L2B Mie-cloudy mean(O-B) for a) ascending and b) descending orbits. Unit: m/s. For the period: 29 November 2021 to 5 January 2022.



a)



b)

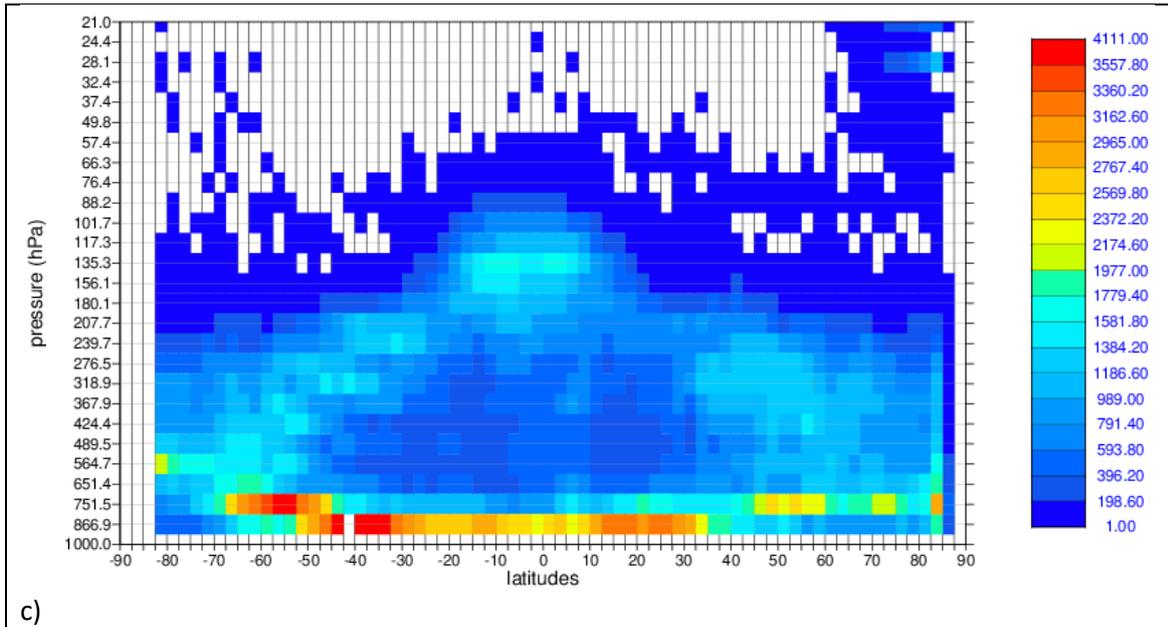


Figure 8. Pressure versus latitude dependence of the L2B Mie-cloudy a) ascending $\text{stddev}(O-B)$ m/s, b) assigned observation error in DA (via scaled L2Bp error estimates) and c) number of observations. For the period: 29 November 2021 to 5 January 2022.

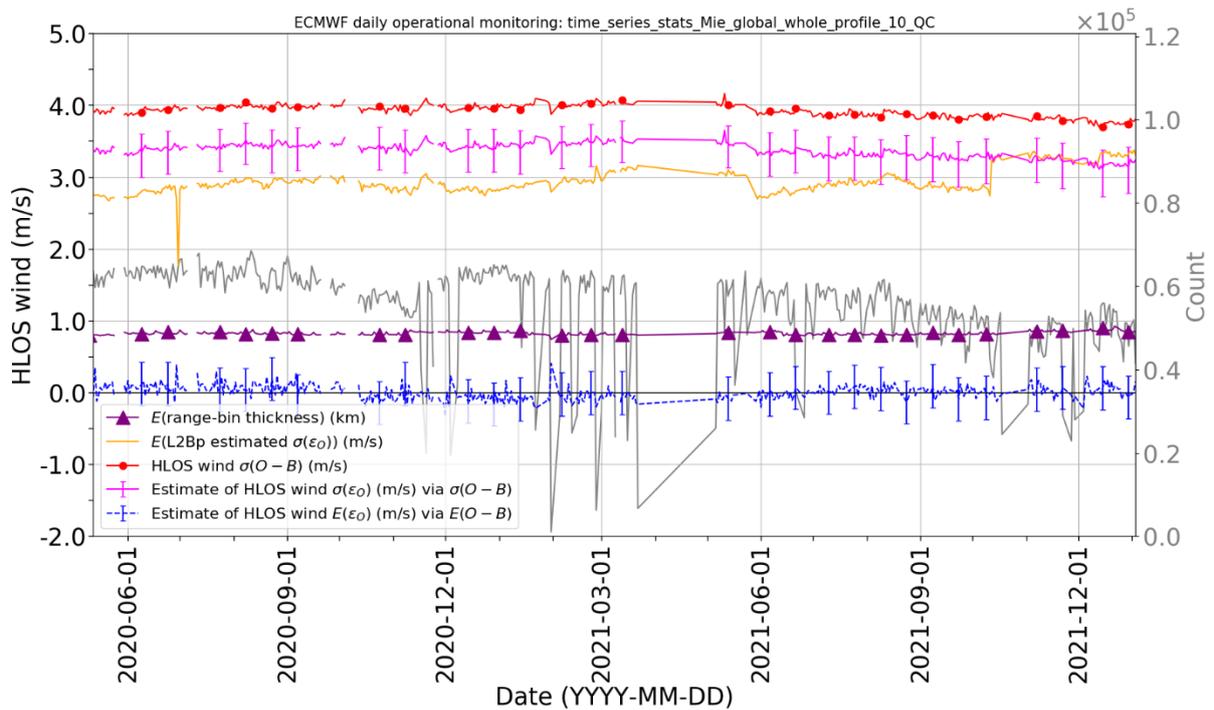


Figure 9. Times-series of daily, global, whole profile L2B Mie-cloudy HLOS wind related statistics since 12 May 2020 (when L2B data was made available for public release). QC for this type of plot is to reject if $\text{abs}(O-B) > 10$ m/s.

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

- See the comments on Rayleigh-clear regarding data gaps due to L2B blocklisting and operational changes.
- There was no obvious change in statistics with the implementation of baseline 13 on 6 December 2021.
- Due to the modified N/P settings on 13 December 2021, the Mie-cloudy observation scale had to be increased to ~ 17 km vs ~ 14 km previously, due to the larger measurement-scale. This

change seemed to improve the standard deviation of O-B and O-A, whilst not adversely affecting the number of Mie-cloudy winds. The number of observations may have been compensated by having better detection of cloud via improvement measurement-scale SNR.

- There are some Polar Stratospheric Cloud Mie winds over the Arctic in December 2021.

3. L2B HLOS wind Forecast Sensitivity Observation Impact (FSOI) statistics from ECMWF's operational data assimilation

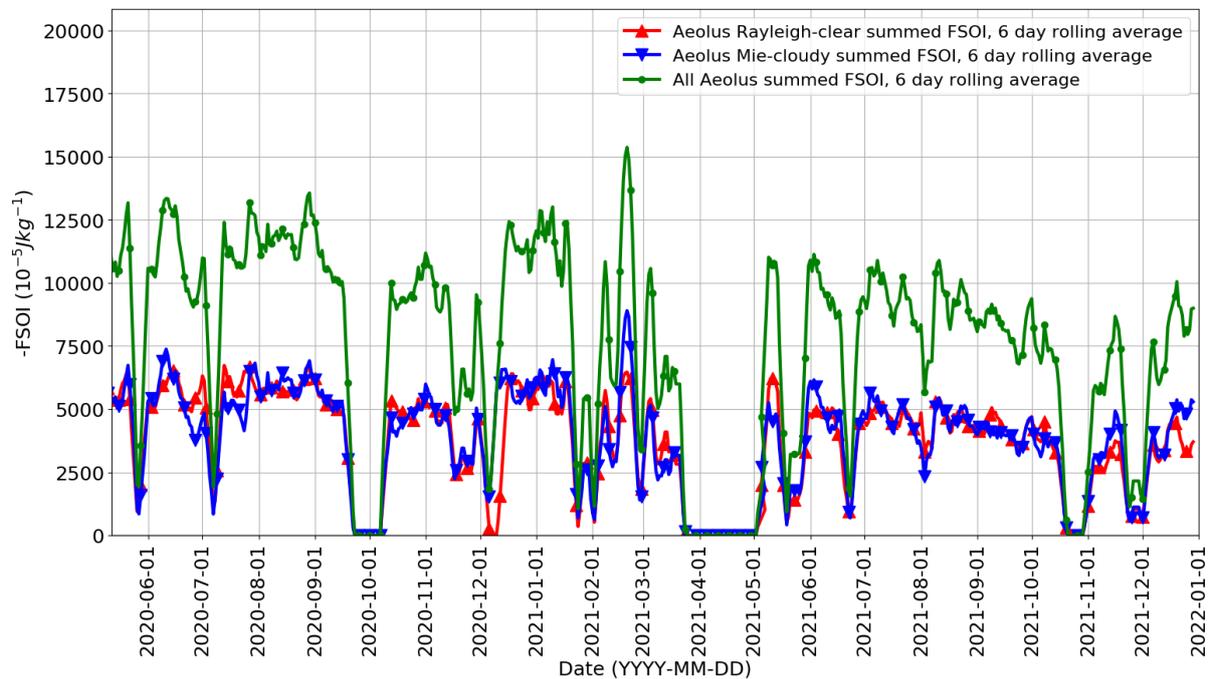


Figure 10. Time-series of the negative of the FSOI of Aeolus L2B HLOS winds in ECMWF operations since the L2B data public release (12 May 2020). Therefore, positive values of $-FSOI$ indicate short-range forecast improvement due to assimilating Aeolus. Partitioned into Mie-cloudy (blue), Rayleigh-clear (red) and combined (green). This metric is based on a global dry energy norm.

The short-range forecast impact of Aeolus HLOS winds remains positive in December 2021 according to the ECMWF FSOI metric. Note that the maximum impact of Aeolus with this FSOI metric was found to be roughly 16250 units in the early FM-B laser period with the largest signal levels of the mission (offline, reprocessed dataset testing). The December 2021 impact of ~ 8750 units is about half of the maximum impact.