

# Aeolus L2B horizontal HLOS wind product monthly quality report

Period: For the month of April 2023 (the final one for the mission)

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## Introduction

Information on the derivation of ECMWF Aeolus Level-2B (L2B) HLOS (horizontal line-of-sight) wind monitoring statistics is available on the ESA CAL/VAL webpage (under L2B Data Quality Handbook); for those people that have access. Section 2.3 of the [Technical Memorandum](#) also explains how ECMWF's 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 are produced for Rayleigh-clear and Mie-cloudy winds and not for the unassimilated Rayleigh-cloudy and Mie-clear. An expert interpretation of these statistics for the past month is provided in this report, including insights into any relevant data events.

Quality Control (QC) is applied when calculating the ECMWF "all data" statistics:

- Rejection of observations with Level-2B processor estimated instrument error (1- $\sigma$ ) exceeding 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 were found to help the non-robust metrics (like mean and standard deviation).
- Rejection of observations if the Level-2B HLOS wind result overall confidence flag is invalid.
- Rejection of 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). This is effectively a gross-error QC.

The website also has available the "used" or actively assimilated observation statistics.

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

## Other NWP monitoring websites for Aeolus L2B winds:

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

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

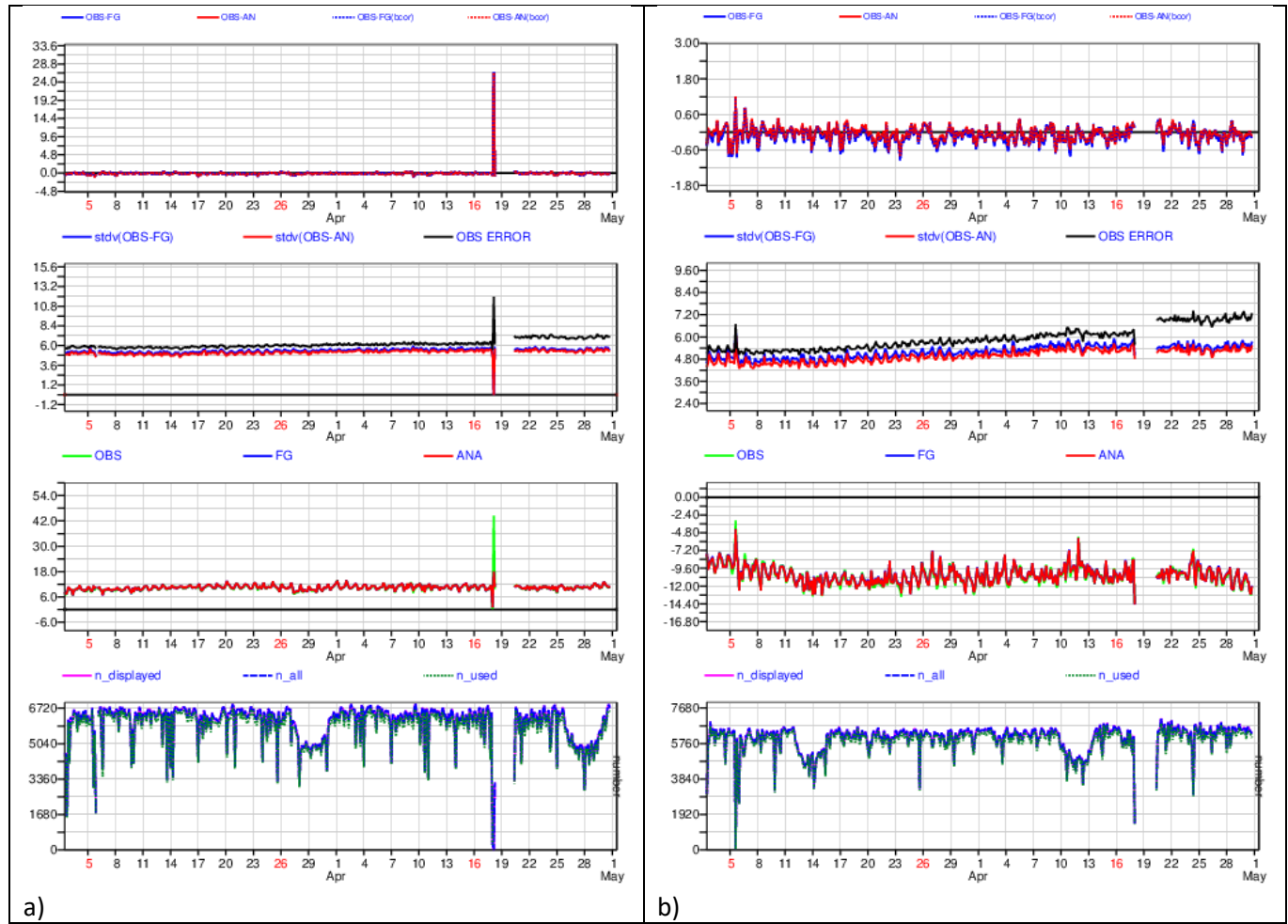


Figure 1. This figure shows changes with time in the O-B and O-A departure statistics of the L2B Rayleigh-clear winds with respect to the ECMWF model. The statistics are calculated every 3 hours for the 0-400 hPa pressure range. Panel a) is for ascending and panel b) is for descending orbit phase. The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

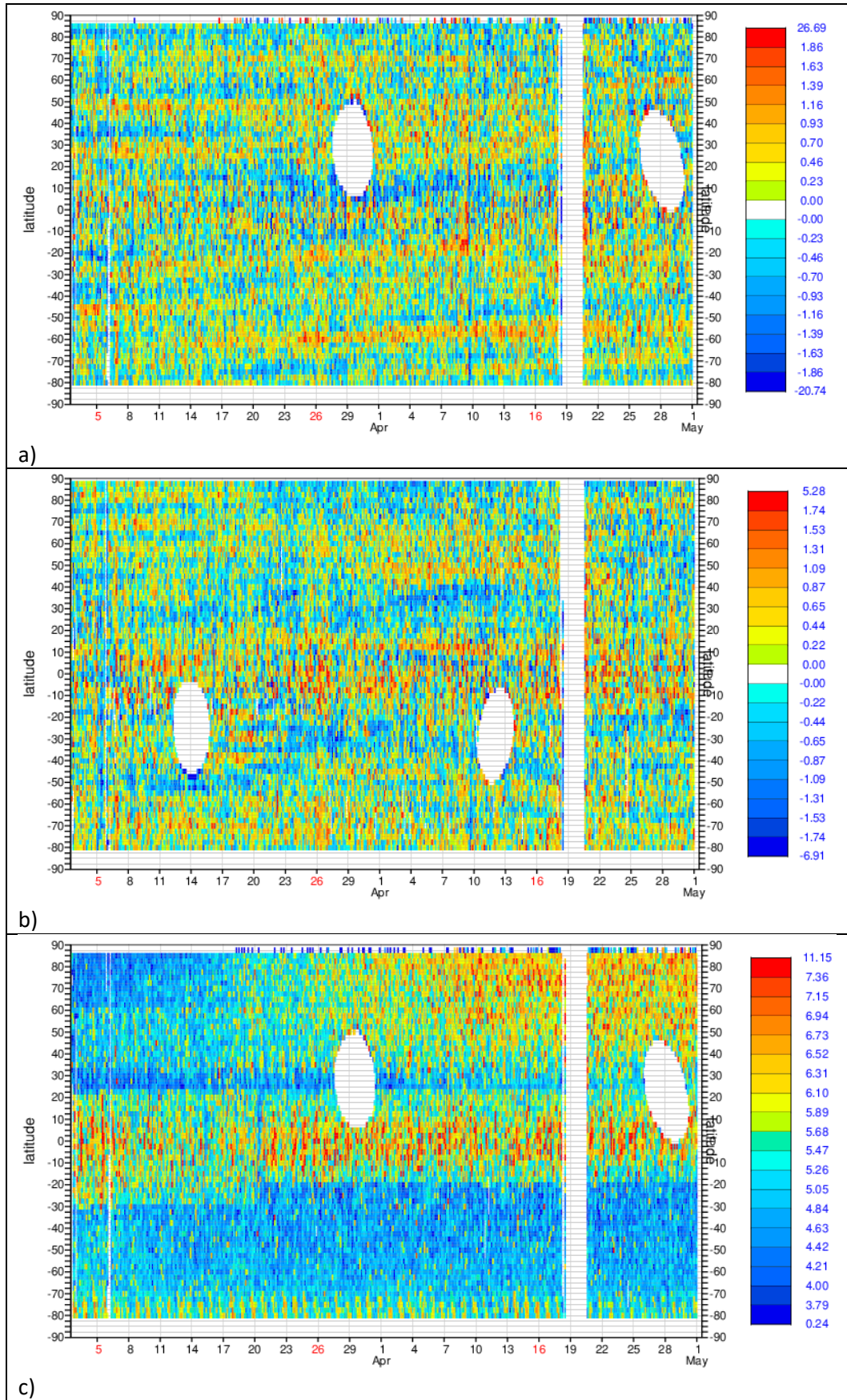


Figure 2. Latitude-time dependence statistics for L2B Rayleigh-clear HLOS winds for the 0-400 hPa pressure range with a) mean(O-B) ascending; b) mean(O-B) descending and c) stdev(O-B) for ascending orbit phase. Unit: m/s.



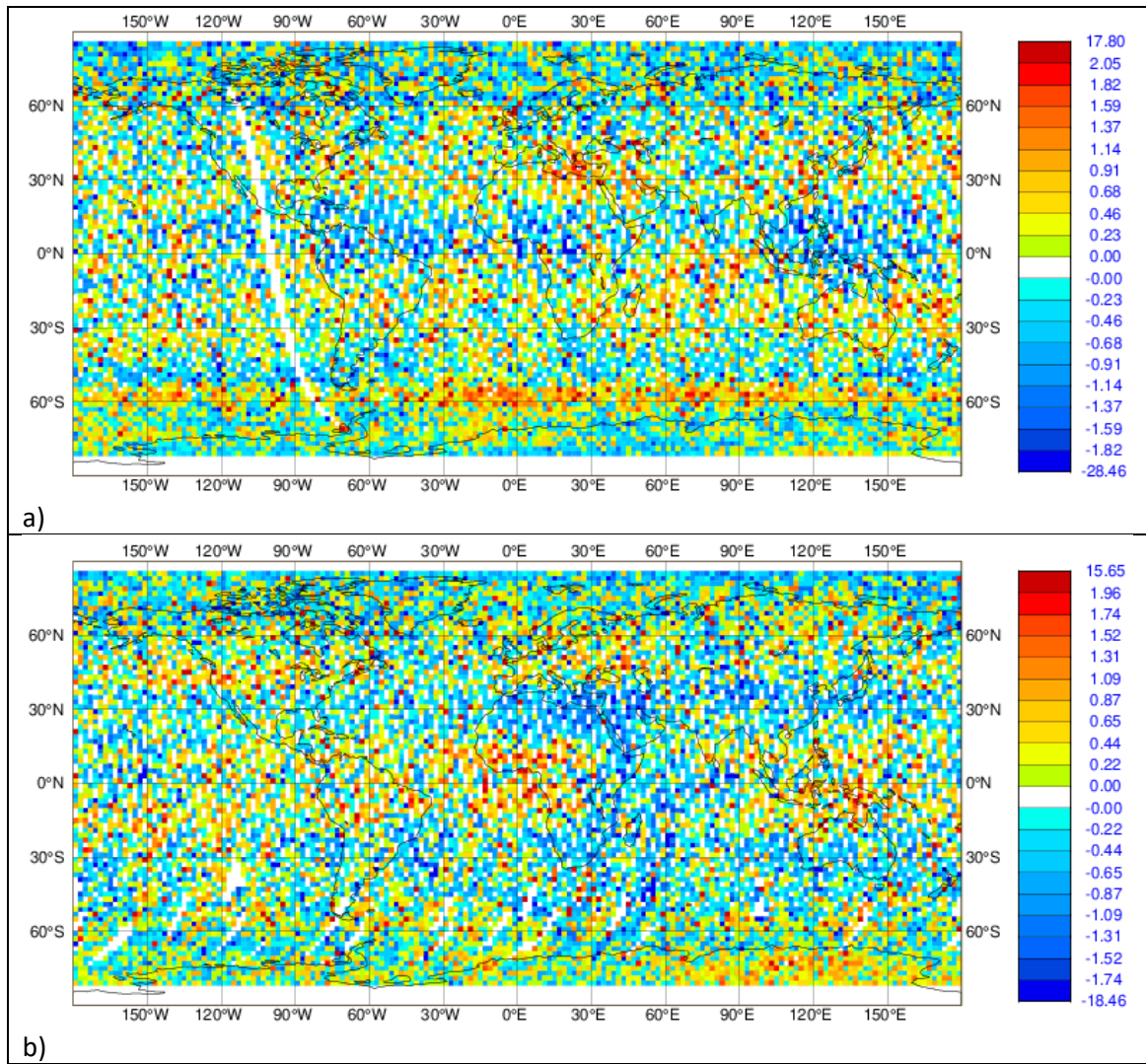


Figure 3. Maps of L2B Rayleigh-clear mean(O-B) for the 0-400 hPa pressure range for a) ascending and b) descending orbit phases. Unit: m/s. For the period: 31 March 2023 to 28 April 2023. These plots are only updated once per week.

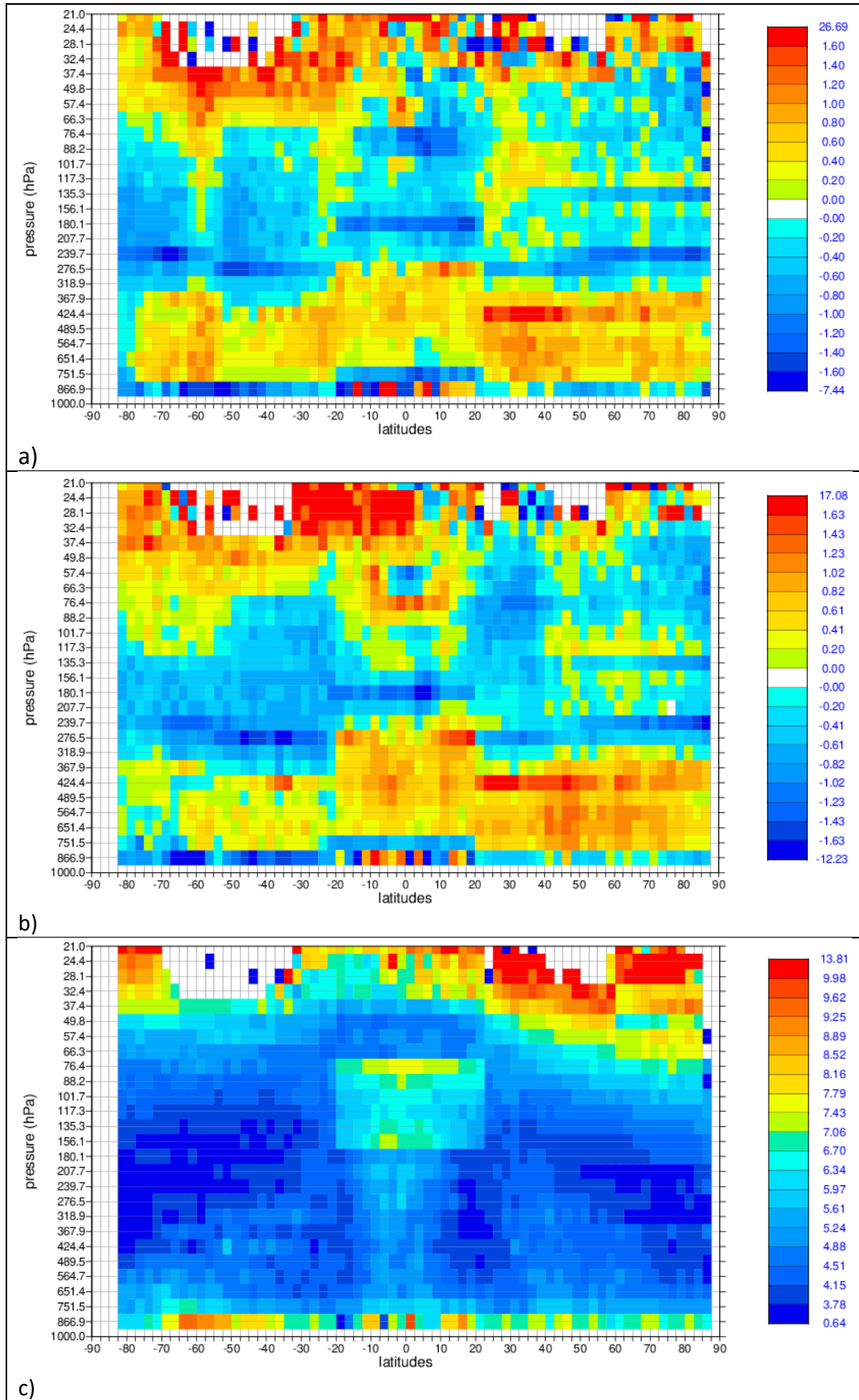


Figure 4. Pressure versus latitude dependence of the L2B Rayleigh-clear mean(O-B) for a) ascending and b) descending orbits. Panel c) is the standard deviation of (O-B) for ascending orbits. Unit: m/s. For the period: 20 March 2023 to 29 April 2023.

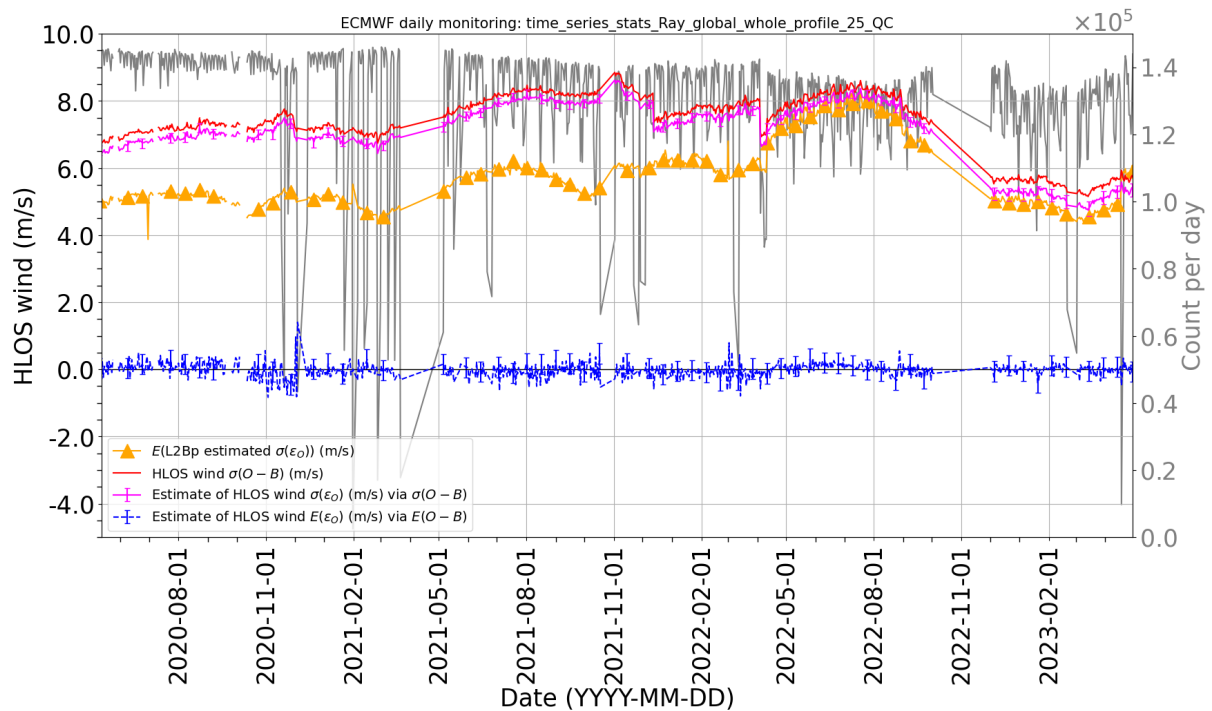


Figure 5. Times-series of daily, global, whole profile L2B Rayleigh-clear HLOS wind related statistics since 12 May 2020 (when L2B data was made available for public release). QC for this type of plot is to reject winds if  $\text{abs}(O-B) > 25$  m/s. Data up to 30 April 2023.

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

- The end-of-life testing phase began on 1 May 2023, which was triggered due to limited fuel supplies left on Aeolus for de-orbiting.
- There was an update of the operational processing baseline from B15 to B16 on 18 April. This was followed by L2B blocklisting until 20 April to allow the M1 temperature dependent bias correction to settle down, after the significant processing update.
- B16 slightly improved the stdev(O-B) for Rayleigh-clear, but the assigned observation error (in data assimilation) increased by 8% because of the baseline update. The L2Bp estimated error is more realistic in B16 but our in-house ECMWF scaling by 1.4 is no longer appropriate (scaling too large). With only a limited period of operations left, before the end-of-life, it was not worth the hassle of updating the scaling in ECMWF operations.
- The change in range-bin settings since 20 March in the tropical band (with 20 degrees latitude) significantly increased the vertical resolution in the upper troposphere/lower stratosphere for the assessment of Aeolus' ability to represent sharp vertical wind shear in this region. The thinner range-bins led to a significant increase in noise (as expected and evident in the zonal average stdev(O-B) plot).
- Biases still show an interesting pattern with altitude: with perhaps warmer temperatures cause positive bias (as opposed to negative bias with FM-B) and some residual hot pixel (range-bin) specific biases seem to be present (causing bands of negative bias).

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

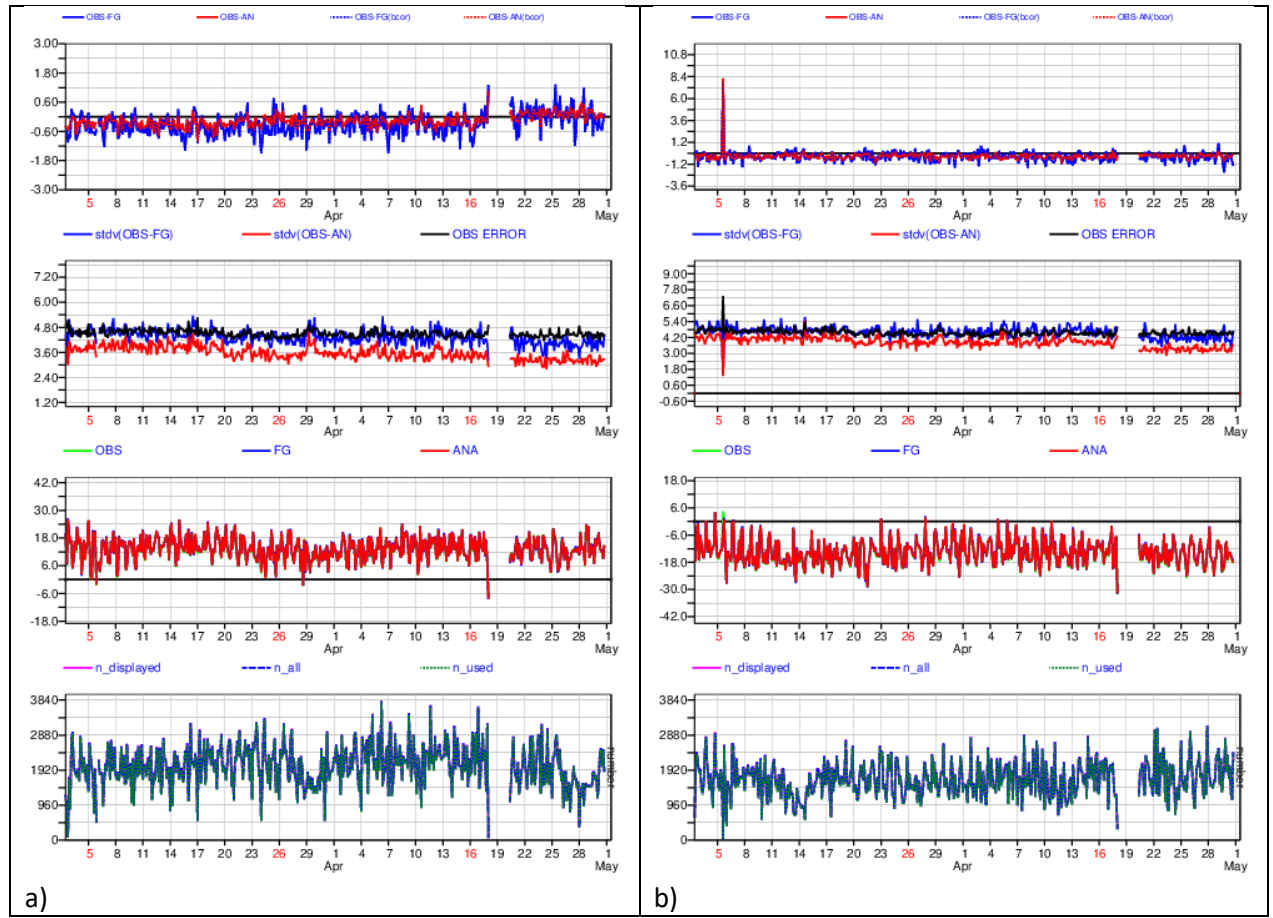


Figure 6. Same type of plots as in Figure 1, but for L2B Mie-cloudy HLOS winds.

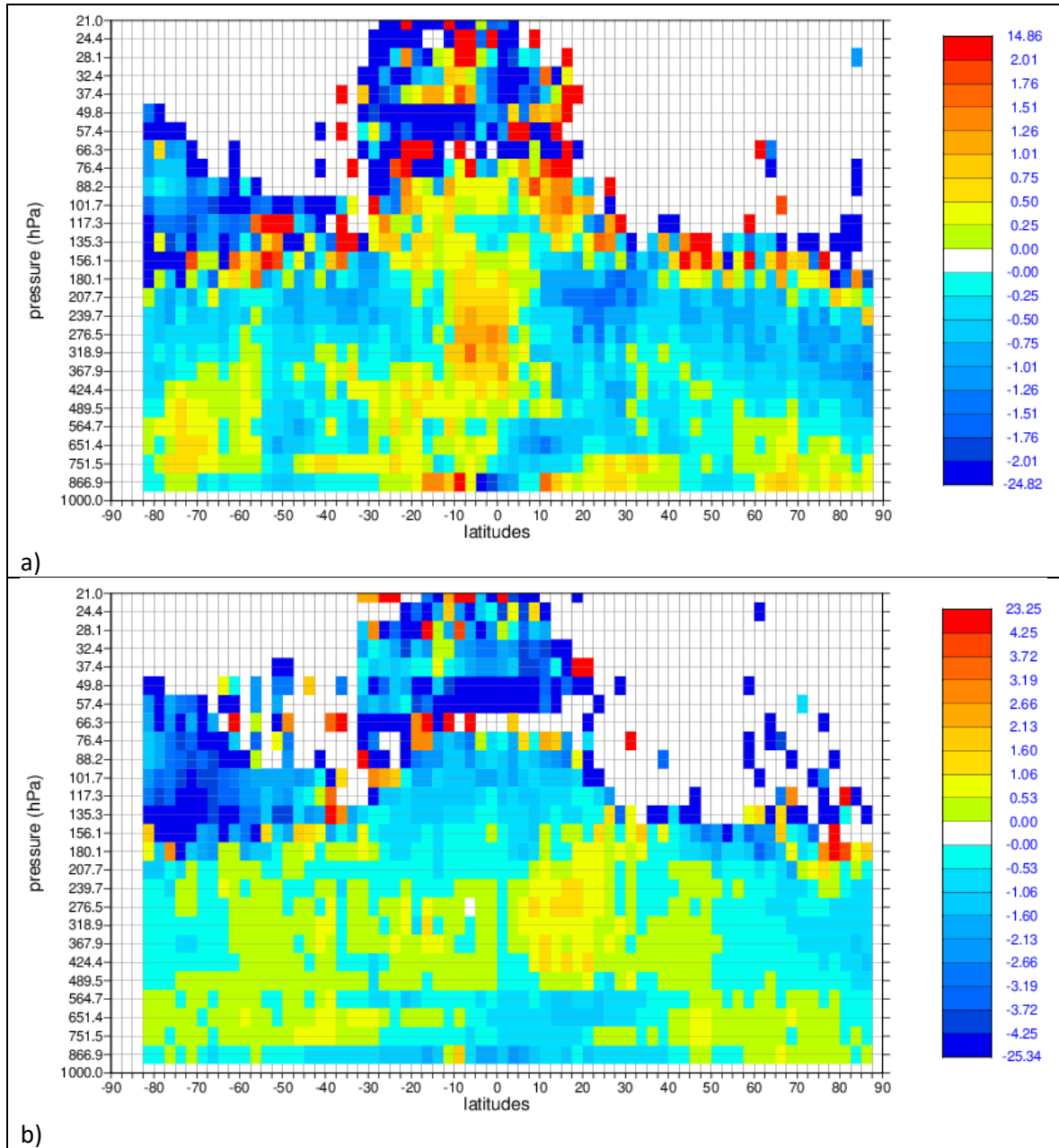


Figure 7. Pressure versus latitude dependence of the L2B Mie-cloudy mean(O-B) for a) ascending and b) descending orbits. Unit: m/s. For the period: 20 February 2023 to 1 April 2023.



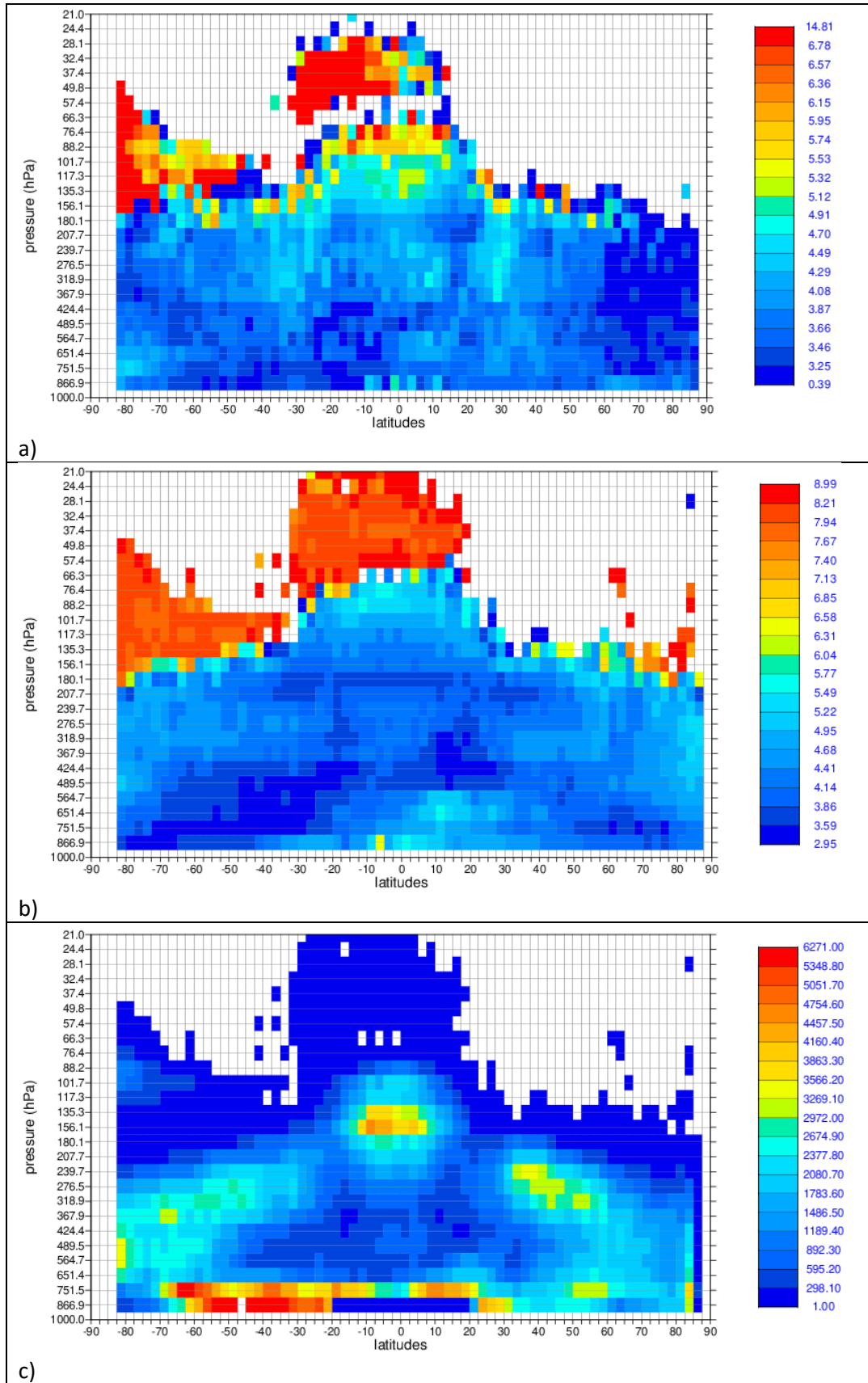


Figure 8. Pressure versus latitude dependence of the ascending L2B Mie-cloudy a)  $\text{stdev}(\text{O}-\text{B})$  m/s, b) assigned observation error in DA (via scaled L2Bp error estimates) and c) number of observations. For the period: 20 March 2023 to 29 April 2023.

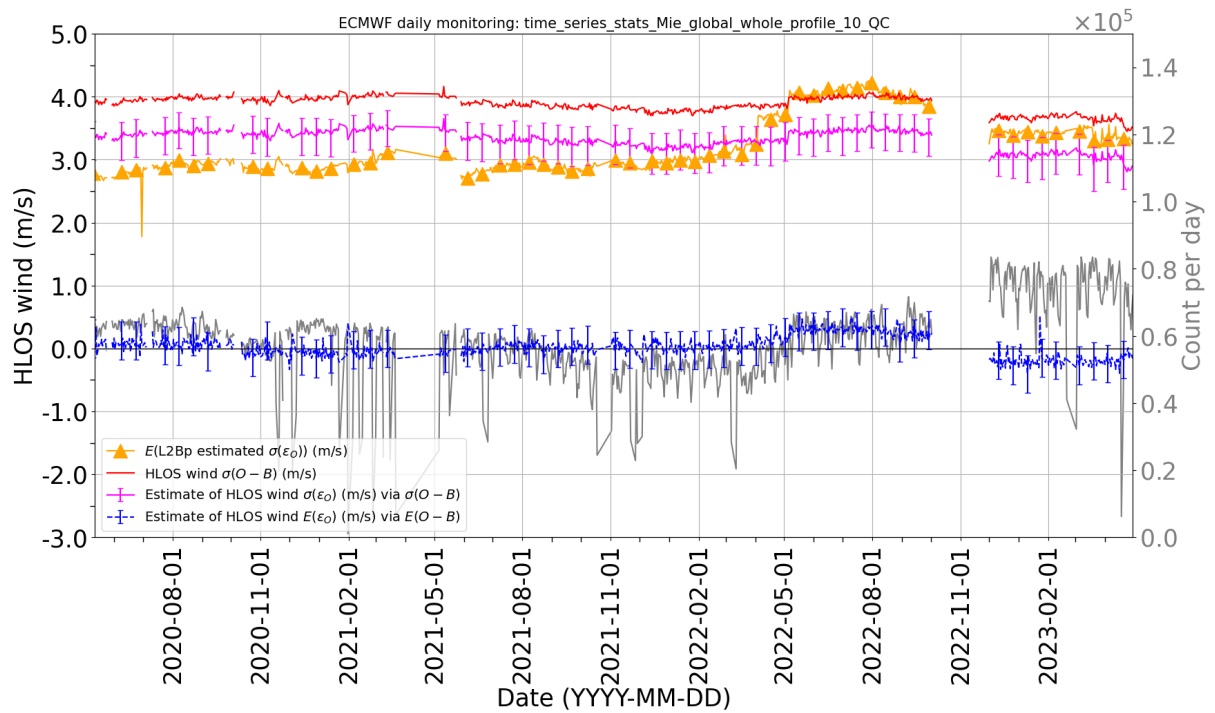


Figure 9. Times-series of daily, global, whole profile L2B Mie-cloudy HLOS wind related statistics since 12 May 2020 (when L2B data was made available for public release). QC for this type of plot is to reject if  $\text{abs}(O-B) > 10$  m/s. Data up to 30 April 2023.

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

- Data quality improved with B16 by about 14% (depending on level of QC) in  $\text{stdev}(O-B)$ .
- A very limited number of Hunga Tonga-Hunga Ha'apai volcano eruption plume (eruption on 15 January 2022) Mie winds remain in the tropics.
- There is still an unusual patch of positive bias ( $\sim 1$  m/s) at  $\sim 350$  hPa in tropics at  $\sim 5$  degree latitude, only for ascending orbits ( $\sim 6$  PM local solar time). This seems more likely to be an ECMWF model bias.

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

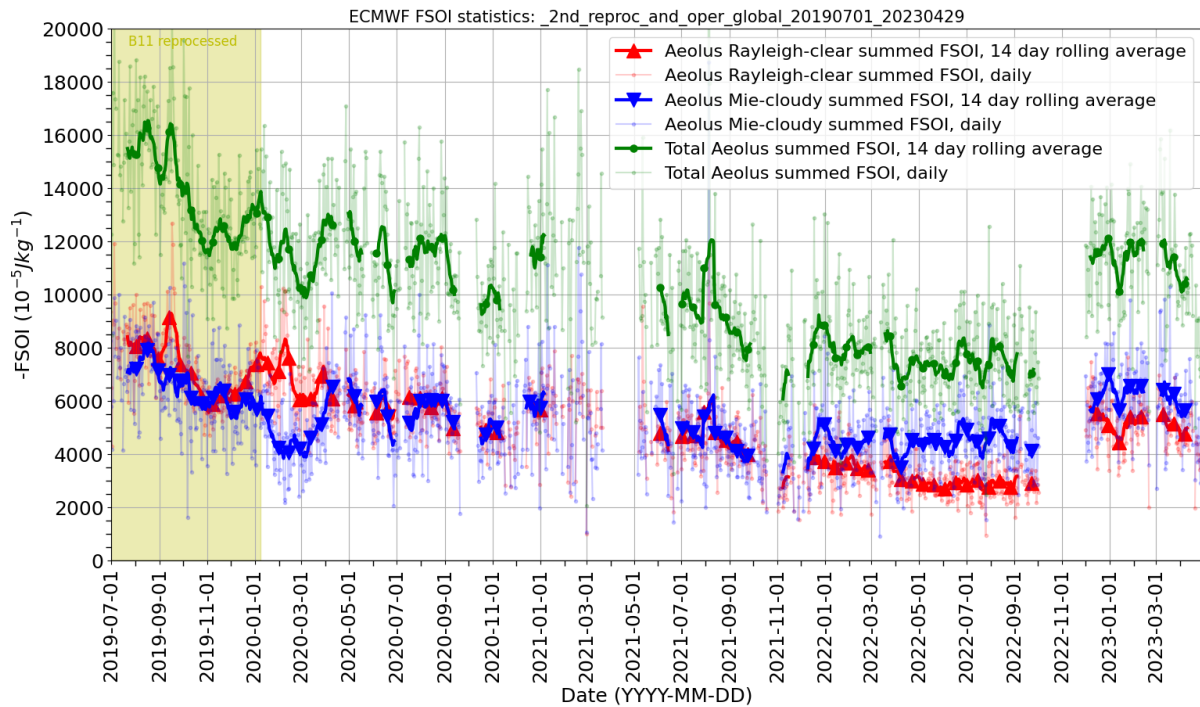


Figure 10. Time-series of the negative of the FSOI of Aeolus L2B HLOS winds with ECMWF reprocessing and ECMWF operations (after 9 January 2020) until 29 April 2023. Therefore, positive values of  $-FSOI$  indicate short-range forecast improvement due to assimilating Aeolus. Partitioned into Mie-cloudy (blue), Rayleigh-clear (red) and combined (green). This metric is based on a global dry energy norm. A 2-week rolling average was applied (thicker lines), and periods with reduced data counts, due to special operations were removed from this averaging.

The short-range forecast impact of Aeolus HLOS winds with recent FM-A operations has perhaps decreased a bit in April 2023.