

# Aeolus L2B horizontal HLOS wind product monthly quality report

**Period:** For the month of January 2023 and up to 5 February 2023

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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

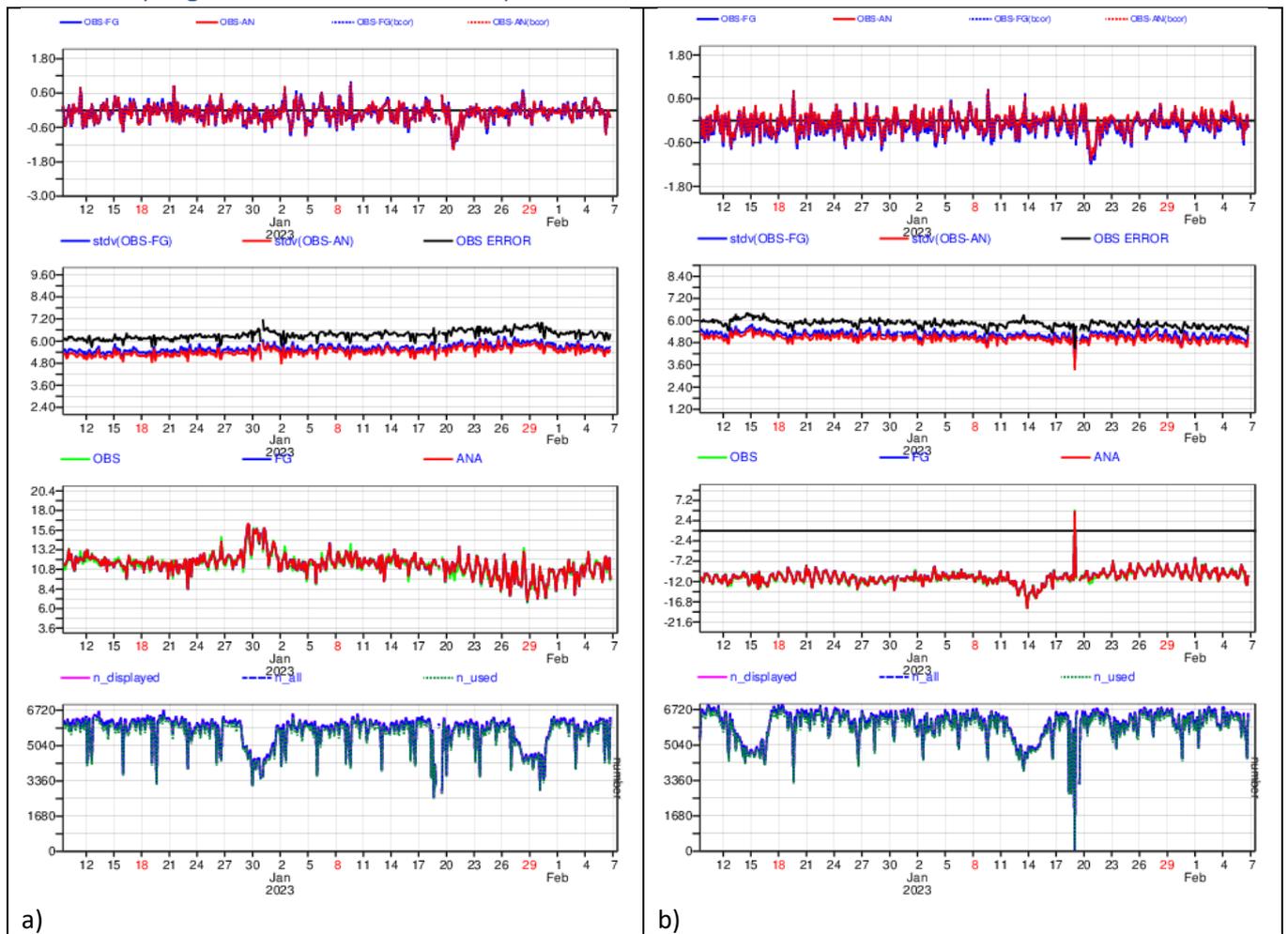


Figure 1. This figure shows changes with time in the O-B and O-A departure statistics of the L2B Rayleigh-clear winds with respect to the ECMWF model. The statistics are calculated every 3 hours for the 0-400 hPa pressure range. Panel a) is for ascending and panel b) is for descending orbit phase. The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

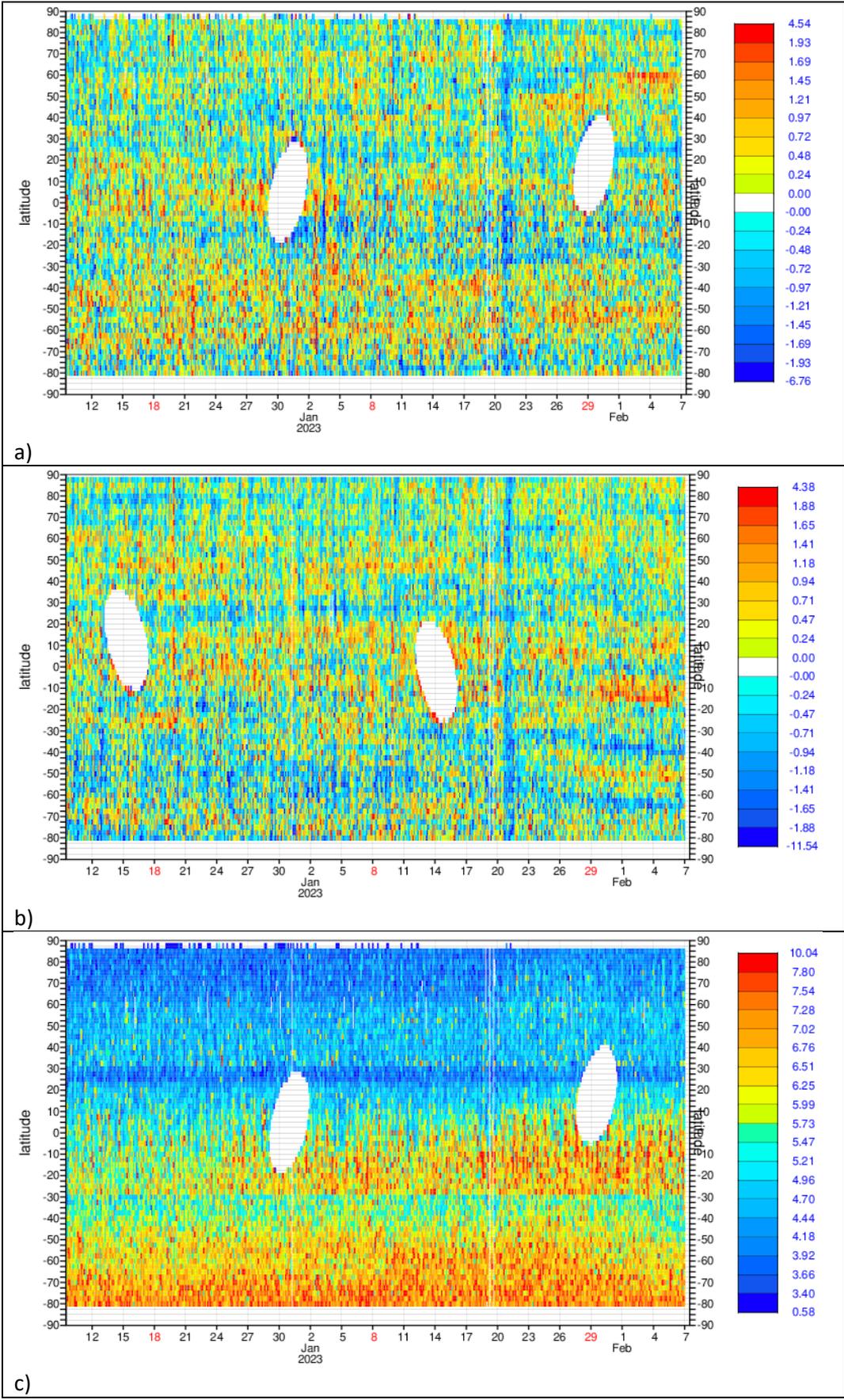


Figure 2. Latitude-time dependence statistics for L2B Rayleigh-clear HLOS winds for the 0-400 hPa pressure range with a) mean(O-B) ascending; b) mean(O-B) descending and c) stdev(O-B) for ascending orbit phase. Unit: m/s.

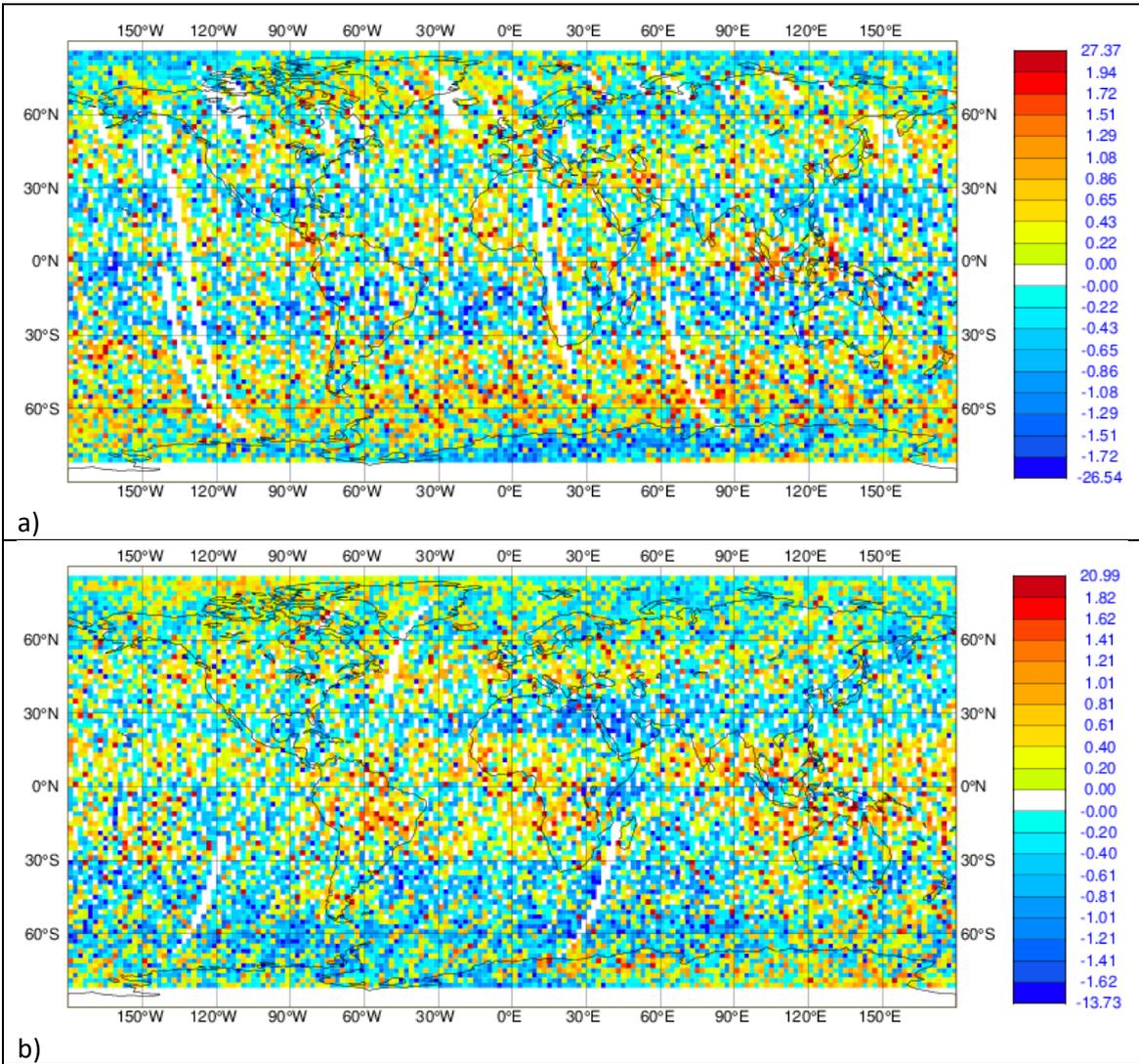


Figure 3. Maps of L2B Rayleigh-clear mean(O-B) for the 0-400 hPa pressure range for a) ascending and b) descending orbit phases. Unit: m/s. For the period: 31 December 2022 to 4 February 2023. These plots are only updated once per week.

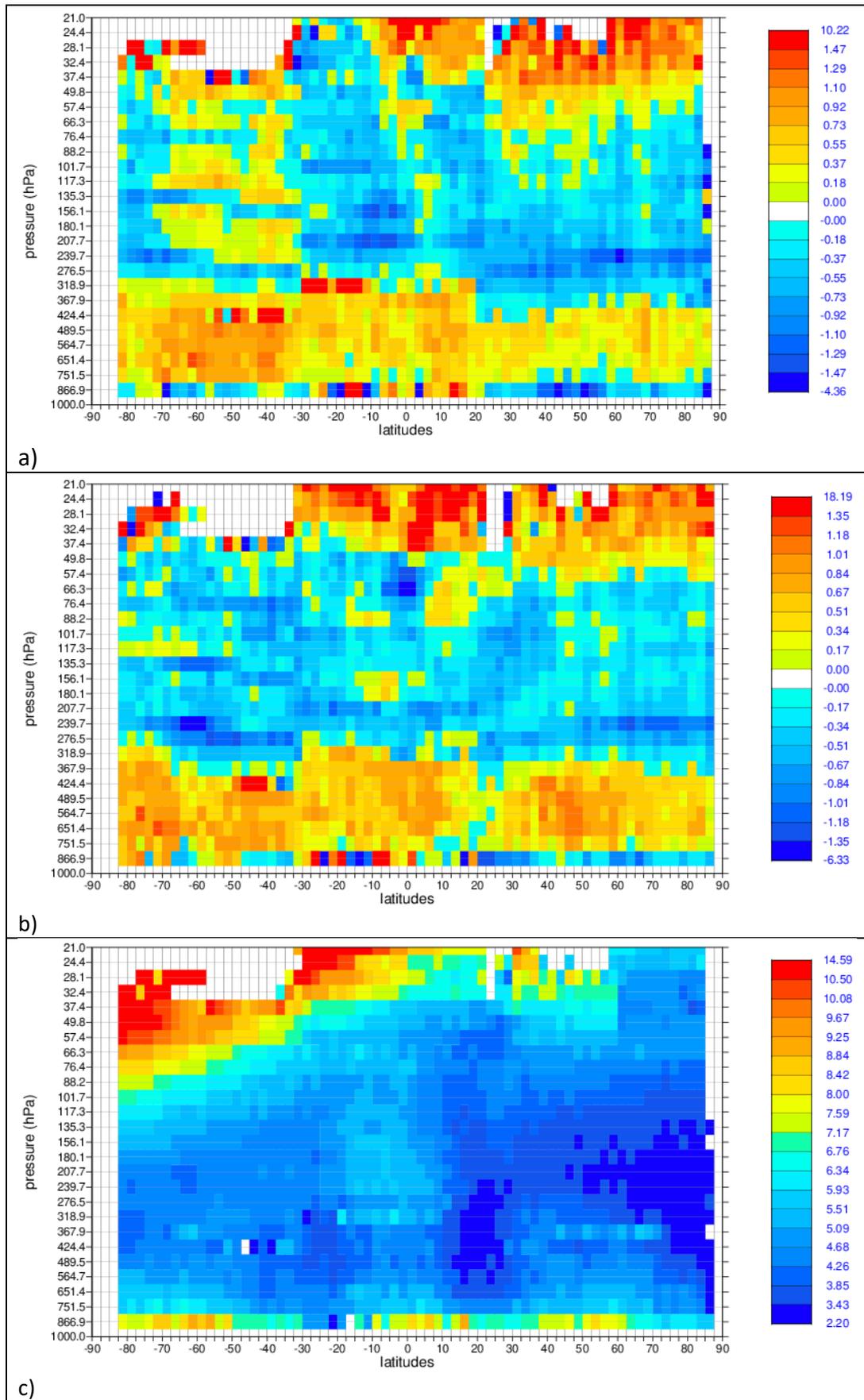


Figure 4. Pressure versus latitude dependence of the L2B Rayleigh-clear mean(O-B) for a) ascending and b) descending orbits. Panel c) is the standard deviation of (O-B) for ascending orbits. Unit: m/s. For the period: 26 December 2022 to 4 February 2023.

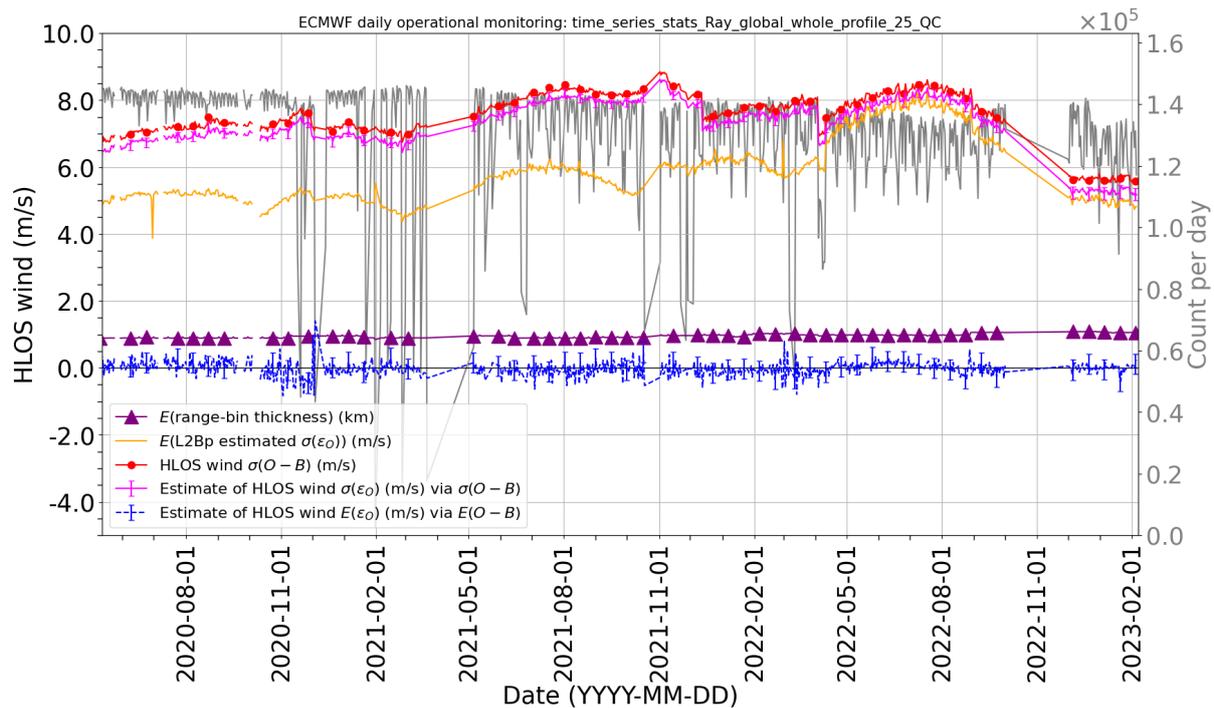


Figure 5. Times-series of daily, global, whole profile L2B Rayleigh-clear HLOS wind related statistics since 12 May 2020 (when L2B data was made available for public release). QC for this type of plot is to reject winds if  $\text{abs}(O-B) > 25 \text{ m/s}$ . Data up to 5 February 2023.

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

- The random errors continue to be at their best level since public data release, thanks to the FM-A switch. The noise since December until end of January has remained quite stable.
- 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 biases).
- Not shown in the plots above, but it was noticed that the ascending orbits have a lot more solar background noise than descending orbits recently. This is being investigated, but so far it may be explained by the local solar time at the equator crossing being more like 05:54 hours (descending) and 17:54 hours (ascending), rather than the expected 06/18 hours.

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

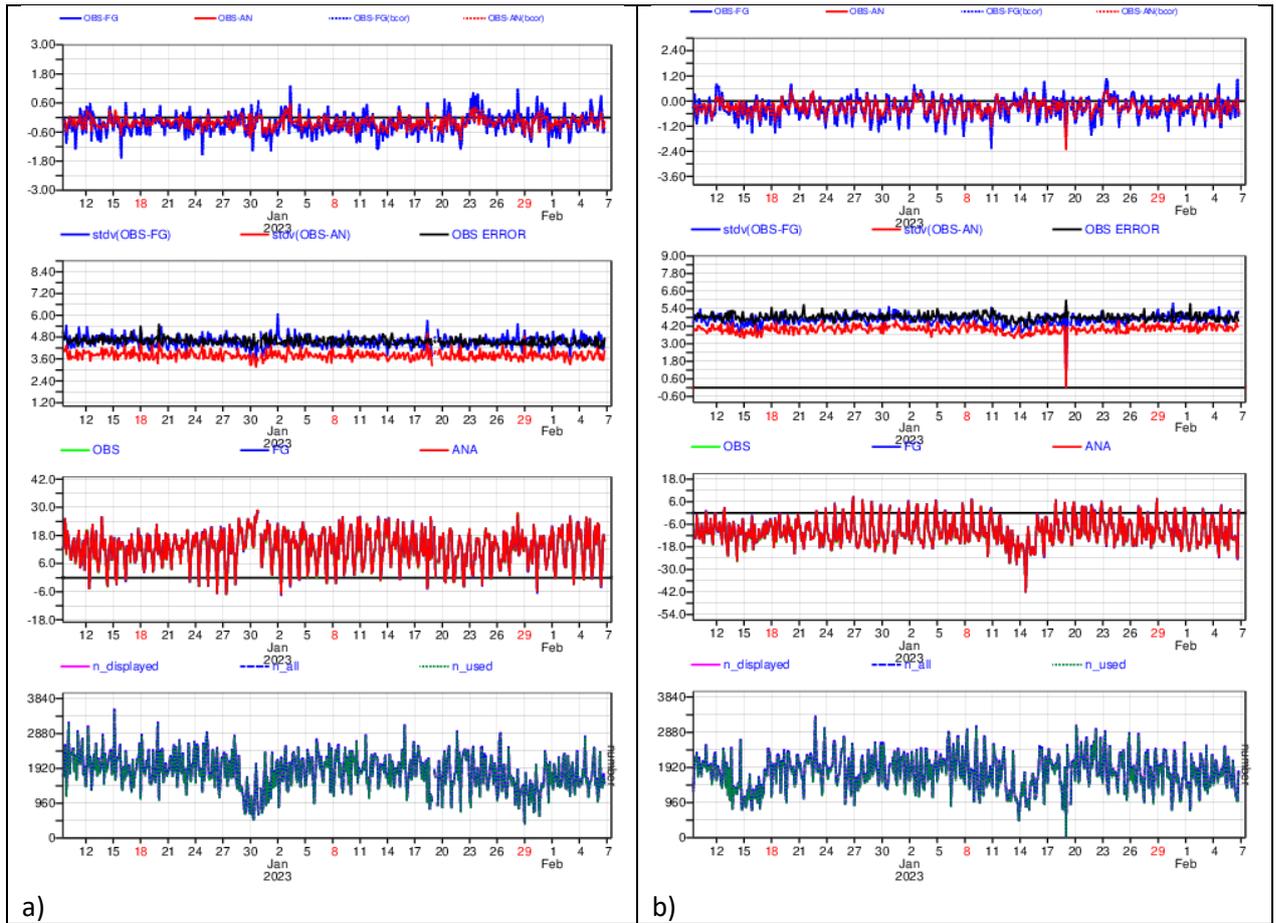
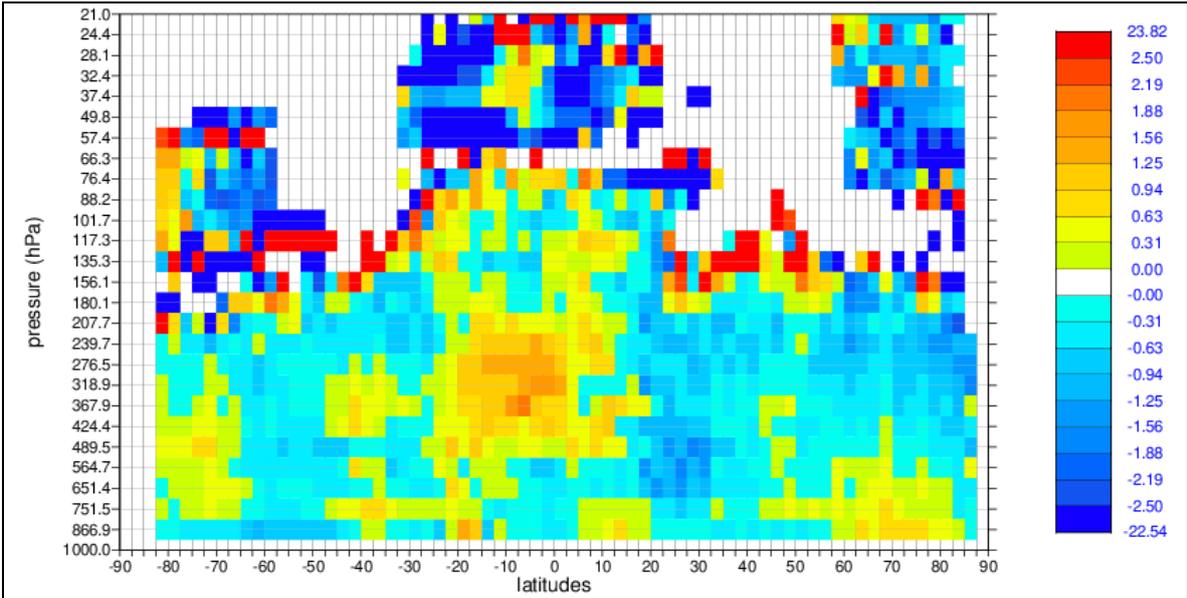
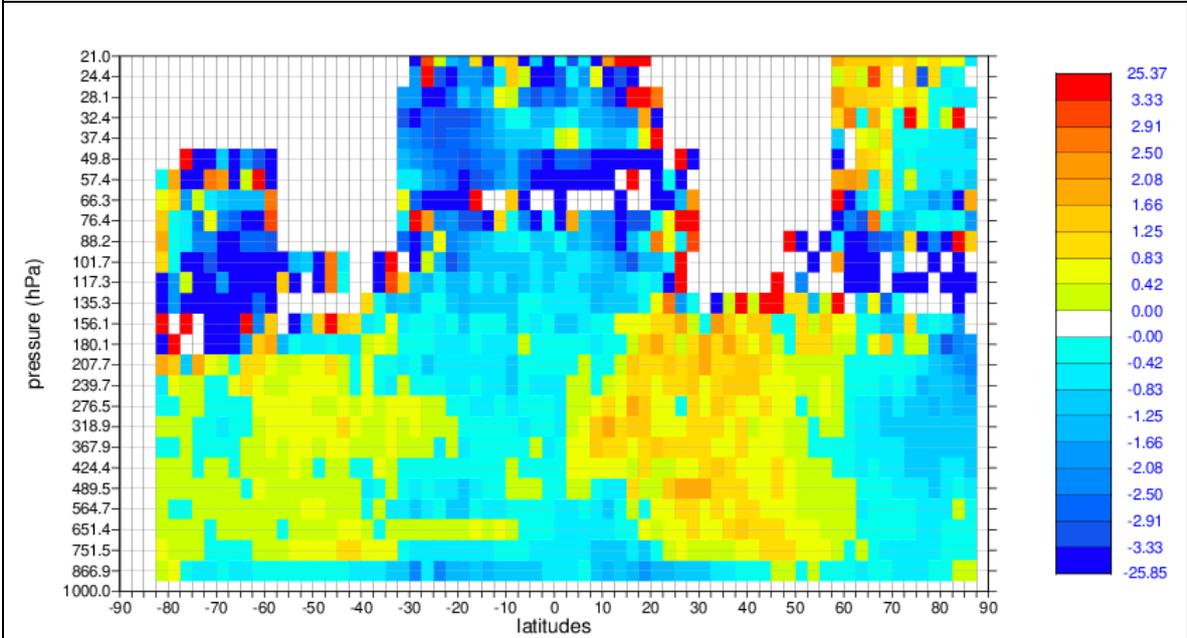


Figure 6. Same type of plots as in Figure 1, but for L2B Mie-cloudy HLOS winds.



a)



b)

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: 26 December 2022 to 4 February 2023.

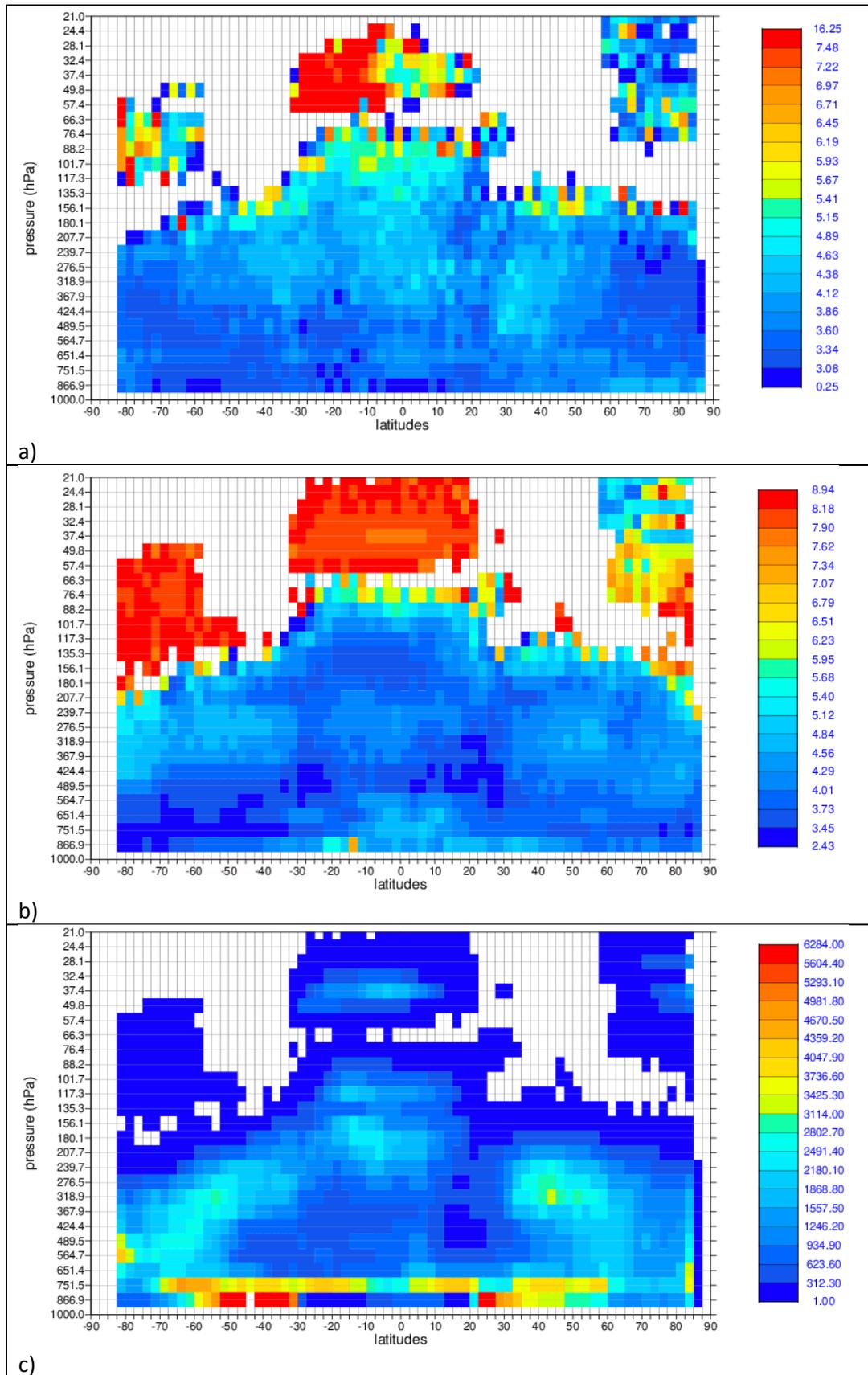


Figure 8. Pressure versus latitude dependence of the ascending L2B Mie-cloudy a)  $\text{stdev}(O-B)$  m/s, b) assigned observation error in DA (via scaled L2Bp error estimates) and c) number of observations. For the period: 26 December 2022 to 4 February 2023.

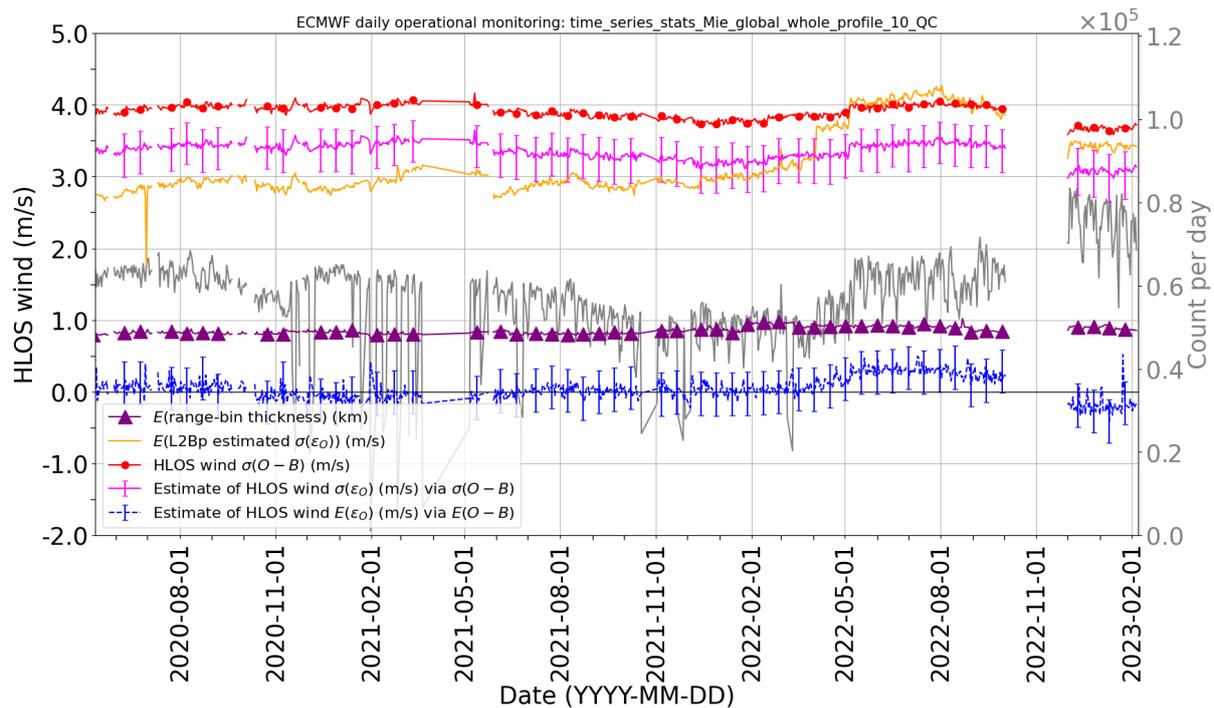


Figure 9. Times-series of daily, global, whole profile L2B Mie-cloudy HLOS wind related statistics since 12 May 2020 (when L2B data was made available for public release). QC for this type of plot is to reject if  $\text{abs}(O-B) > 10$  m/s. Data up to 5 February 2023.

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

- The significant improvement in random error and data counts since FM-A came into operation on 1 December 2022 continues.
- The Hunga Tonga-Hunga Ha'apai volcano eruption plume (eruption on 15 January 2022) continues to have enough backscatter for Mie winds. The peak in data count is  $\sim 37$  hPa in the tropics.
- There has been a reasonable sample of PSC Mie-cloudy winds in N. polar regions.
- 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

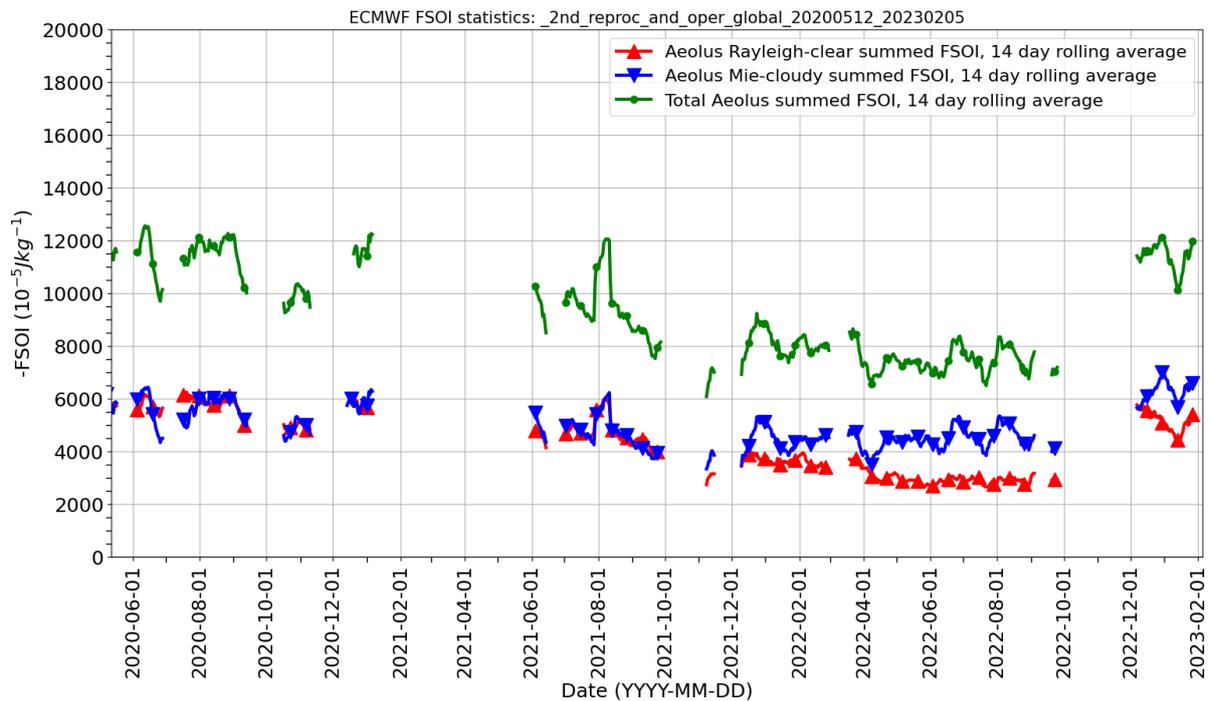


Figure 10. Time-series of the negative of the FSOI of Aeolus L2B HLOS winds in ECMWF operations since the L2B data public release (12 May 2020) until 4 February 2023. Therefore, positive values of -FSOI indicate short-range forecast improvement due to assimilating Aeolus. Partitioned into Mie-cloudy (blue), Rayleigh-clear (red) and combined (green). This metric is based on a global dry energy norm. A 2-week rolling average was applied, and periods with reduced data counts, due to special operations were removed from this averaging

The short-range forecast impact of Aeolus HLOS winds improved by about 60% in December 2022 with FM-A operations and continues to remain at a similar level in January 2023. The Mie-cloudy impact is a bit larger than in mid-2020, but the Rayleigh-clear is a bit smaller – so combined the FSOI is similar to mid-2020.