Aeolus L2B horizontal HLOS wind product monthly quality report

Period: For the month up to 4 February 2022

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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 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-σ) beyond a threshold: σ_O > 12 m/s for the Rayleigh-clear and σ_O > 5 m/s for the Mie-cloudy to remove outliers which were found to strongly 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)

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

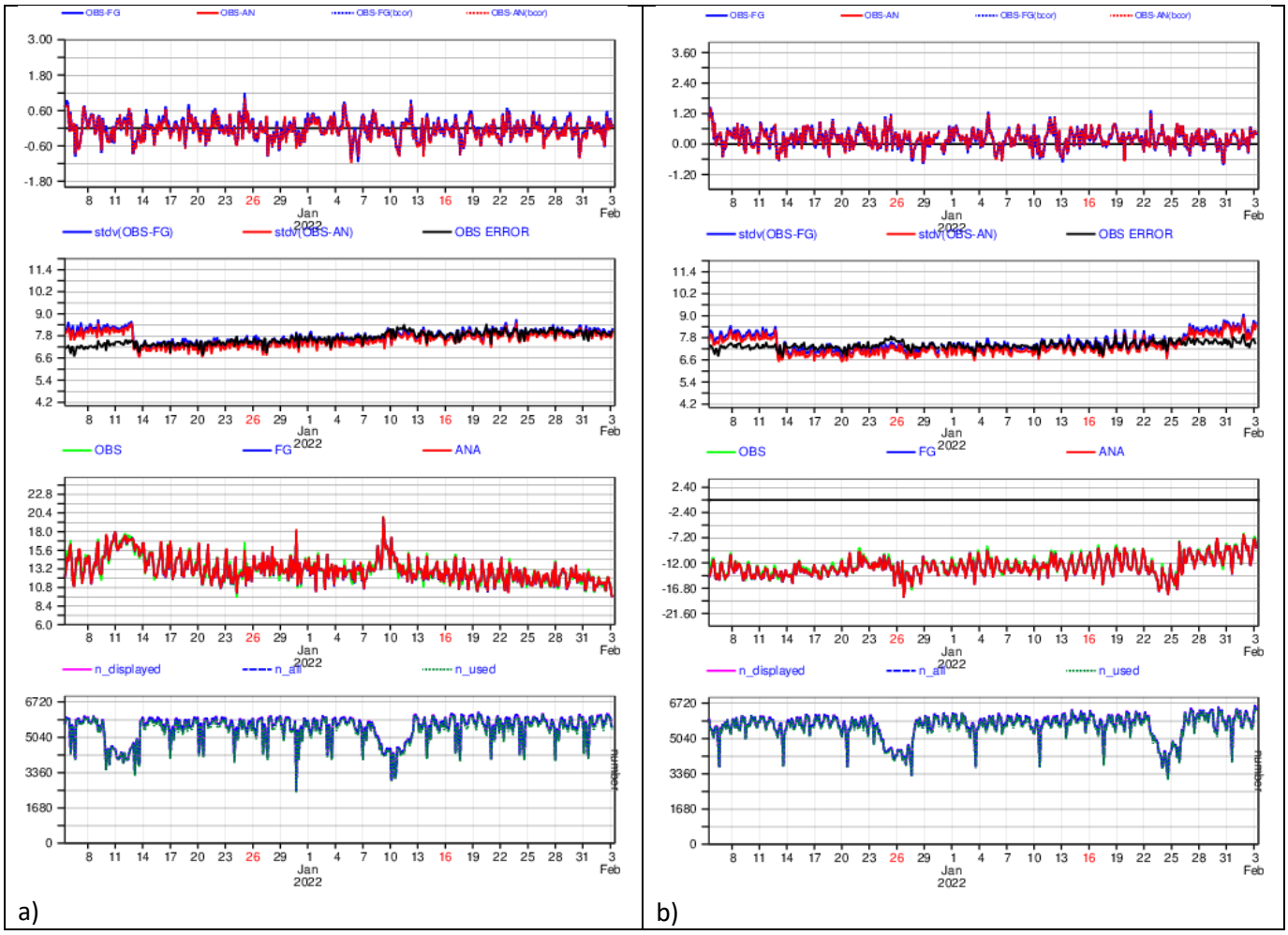


Figure 1. This figure shows changes with time in the O-B and O-A departure statistics of the L2B Rayleigh-clear winds with respect to the ECMWF model. The statistics are calculated every 3 hours for the 0-400 hPa pressure range. Panel a) is for ascending and panel b) is for descending orbit phase. The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

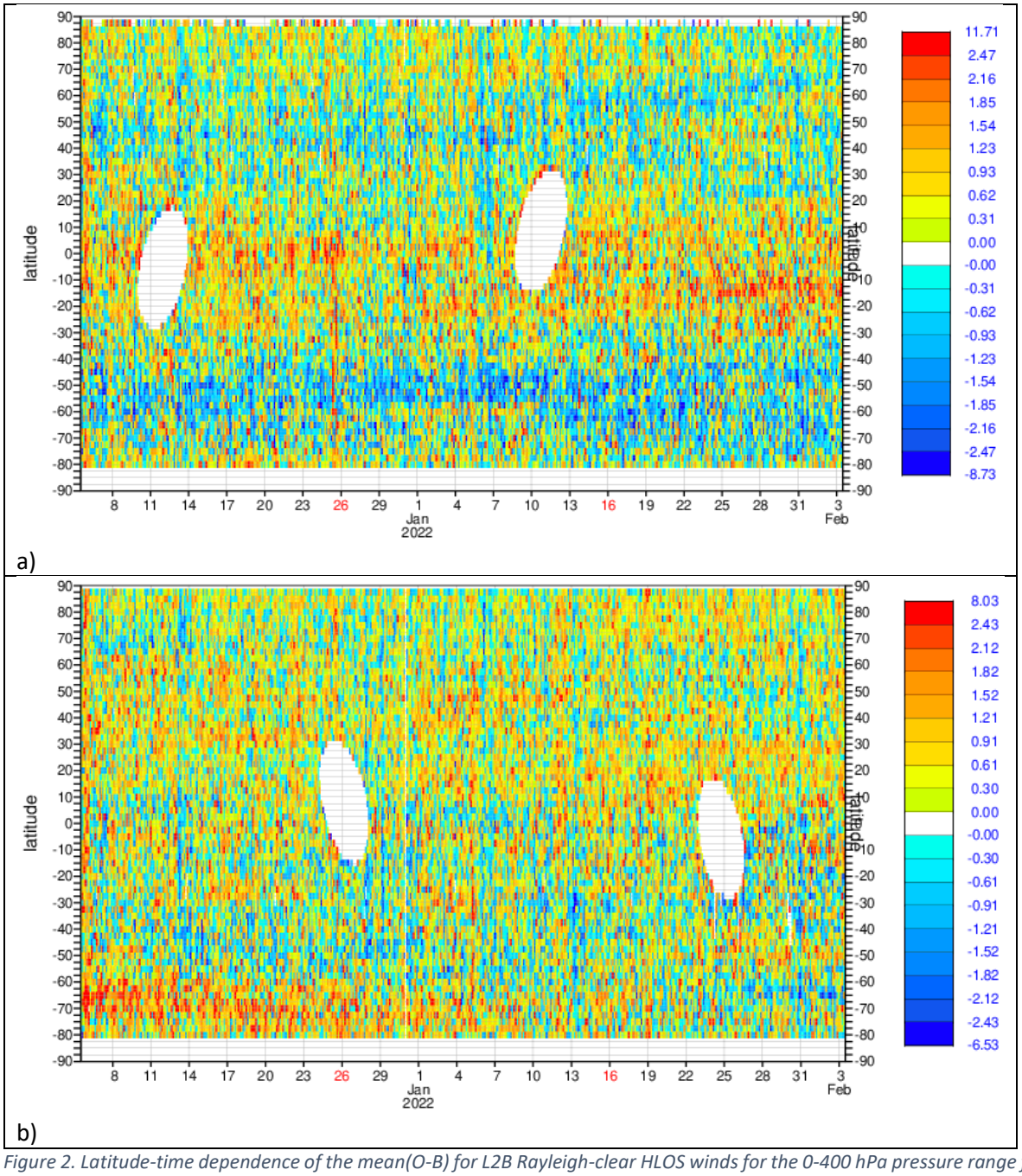


Figure 2. Latitude-time dependence of the mean(O-B) for L2B Rayleigh-clear HLOS winds for the 0-400 hPa pressure range for a) ascending and b) descending orbit phase. Unit: m/s.

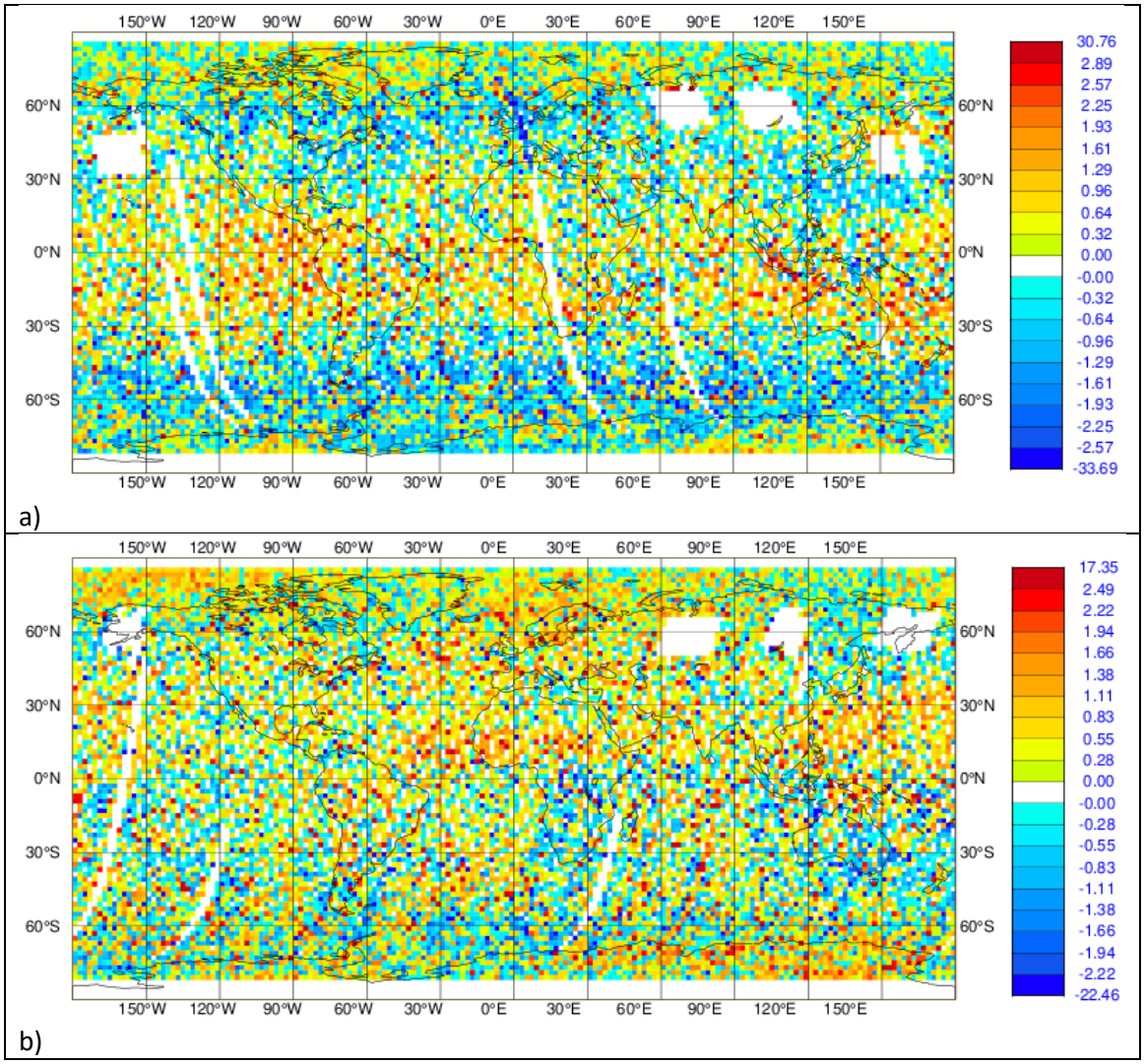


Figure 3. Maps of L2B Rayleigh-clear mean(O-B) for the 0-400 hPa pressure range for a) ascending and b) descending orbit phases. Unit: m/s. For the period: 31 December 2021 to 29 January 2022. These plots are only updated once per week.

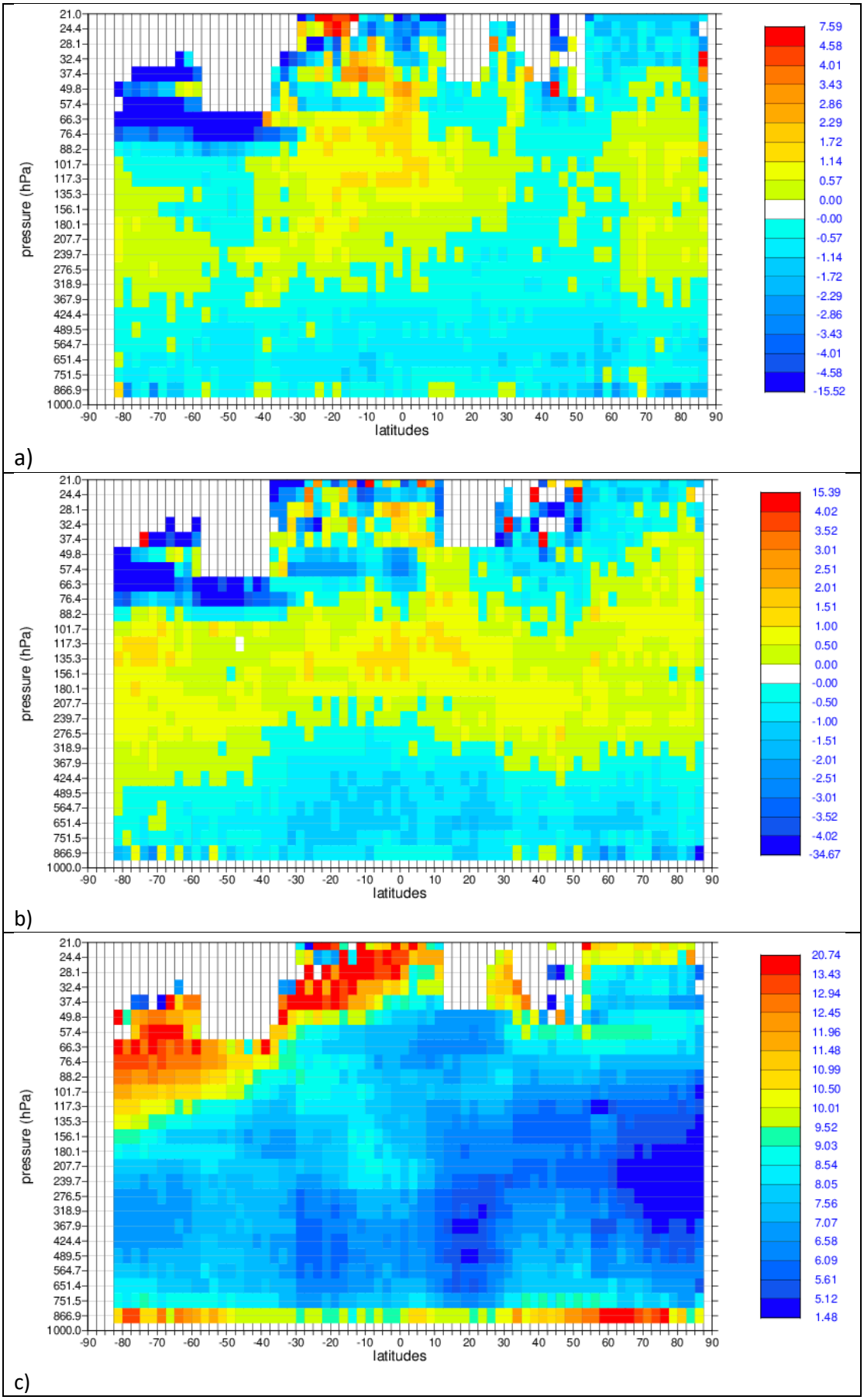

pressure (hPa)
21.0
24.4
28.1
32.4
37.4
49.8
57.4
66.3
76.4
88.2
101.7
117.3
135.3
156.1
180.1
207.7
239.7
276.5
318.9
367.9
424.4
489.5
564.7
651.4
751.5
866.9
1000.0
-90 -80 -70 -60 -50 -40 -30 -20 -10 0 10 20 30 40 50 60 70 80 90
latitudes
7.59
4.58
4.01
3.43
2.86
2.29
1.72
1.14
0.57
0.00
-0.00
-0.57
-1.14
-1.72
-2.29
-2.86
-3.43
-4.01
-4.58
-15.52
a)
pressure (hPa)
latitudes
15.39
4.02
3.52
3.01
2.51
2.01
1.51
1.00
0.50
0.00
-0.00
-0.50
-1.00
-1.51
-2.01
-2.51
-3.01
-3.52
-4.02
-34.67
b)
pressure (hPa)
latitudes
20.74
13.43
12.94
12.45
11.96
11.48
10.99
10.50
10.01
9.52
9.03
8.54
8.05
7.56
7.07
6.58
6.09
5.61
5.12
1.48
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: 20 December 2021 to 29 January 2022.

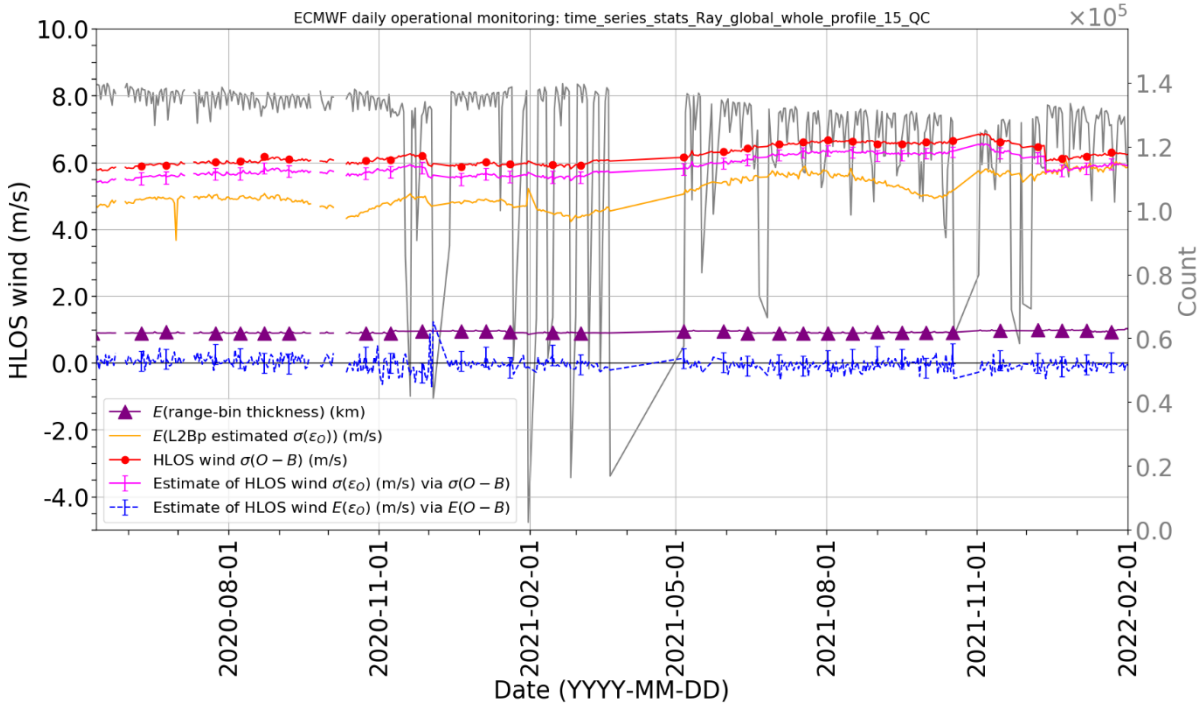


Figure 5. Times-series of daily, global, whole profile L2B Rayleigh-clear HLOS wind related statistics since 12 May 2020 (when L2B data was made available for public release). QC for this type of plot is to reject winds if abs(O-B) > 15 m/s.

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

- There has been an increase in noise during this period, as a result of the ongoing decrease in atmospheric path useful signal (transmission loss).
- As for last month, there is bias for ascending orbits with latitude — negatively biased in extratropics and positively bias in tropics. It is not completely understood what is causing this, but perhaps some issues with low SNR in high solar background areas in S. Hemisphere causing negative bias and perhaps a temperature dependence to the bias causing positive bias in cold areas.
- There was a change in range-bin settings in the latitude band 0 to -35 degrees since 24 January (and 10 to -35 degrees since 31 January). The top range-bin was raised to 30 km to capture the plume from the Hunga Tonga-Hunga Ha'apai volcano eruption (on 15 January). The leads to some Rayleigh-clear winds at high altitudes which are very noisy. Due to smaller solar background noise on descending orbits compared to ascending orbits, then more of these winds pass the QC more on descending orbit, which is evident in the time-series of stdev(O-B) increase.

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

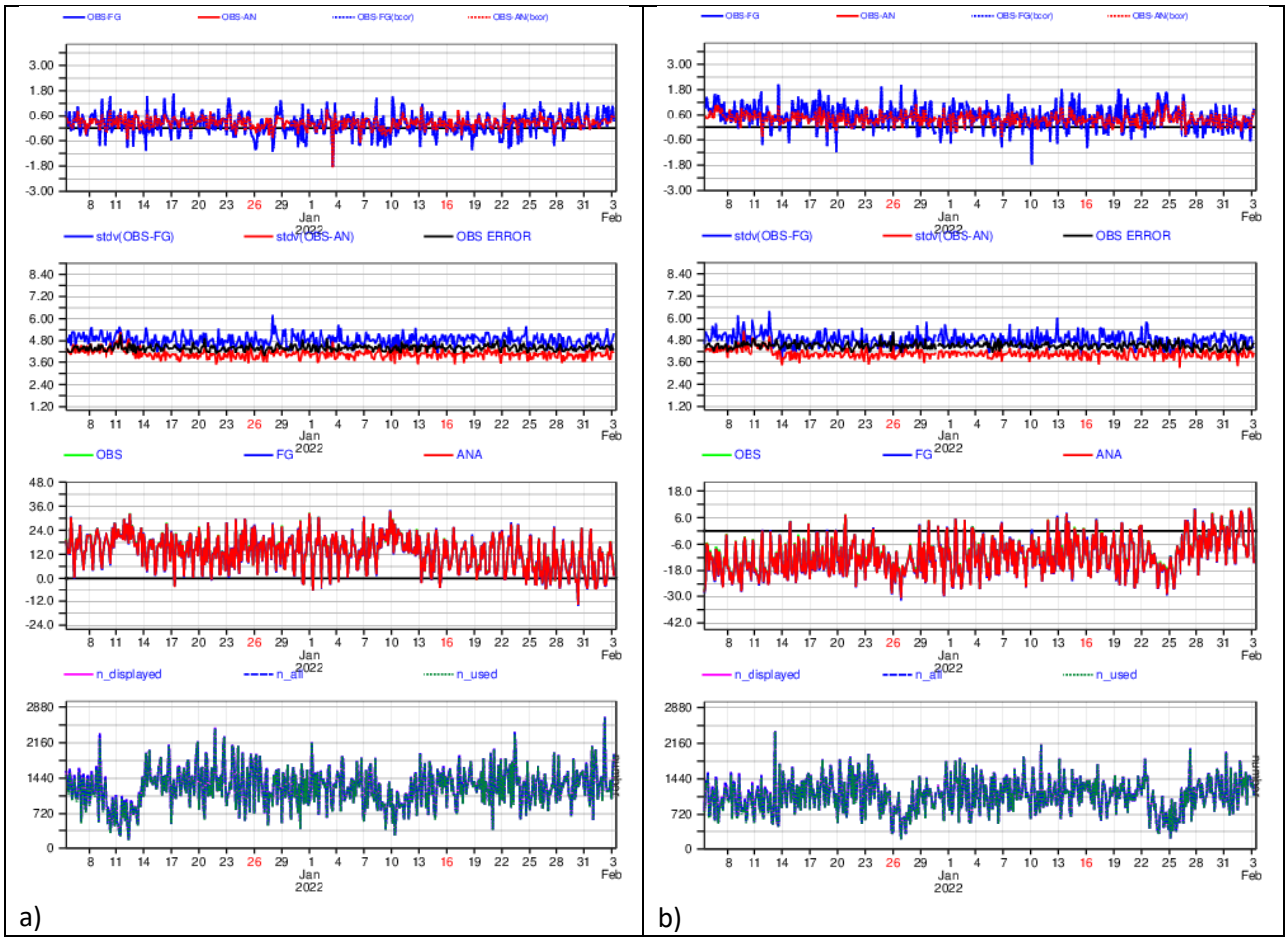


Figure 6. Same type of plots as in Figure 1, but for L2B Mie-cloudy HLOS winds.

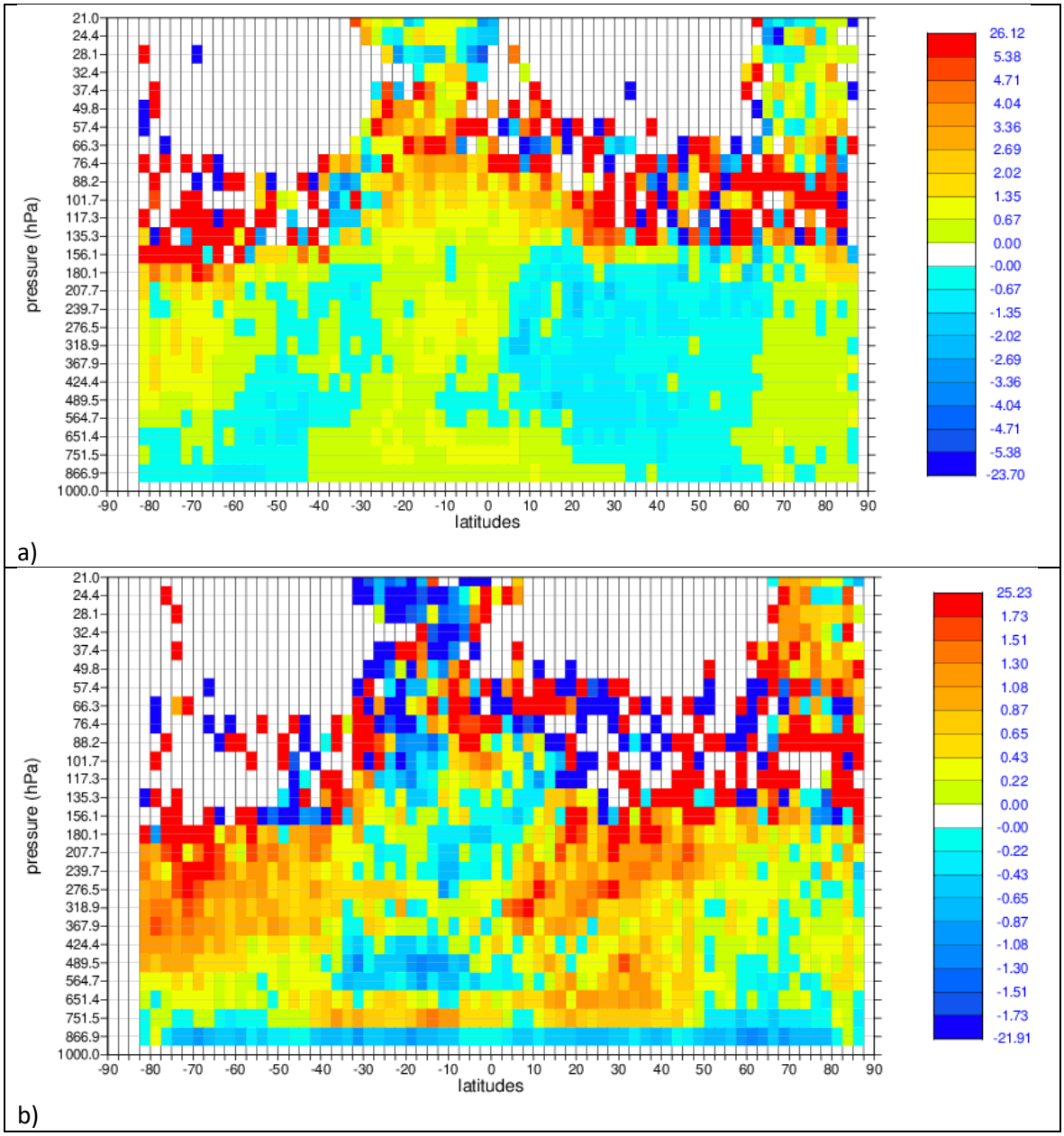
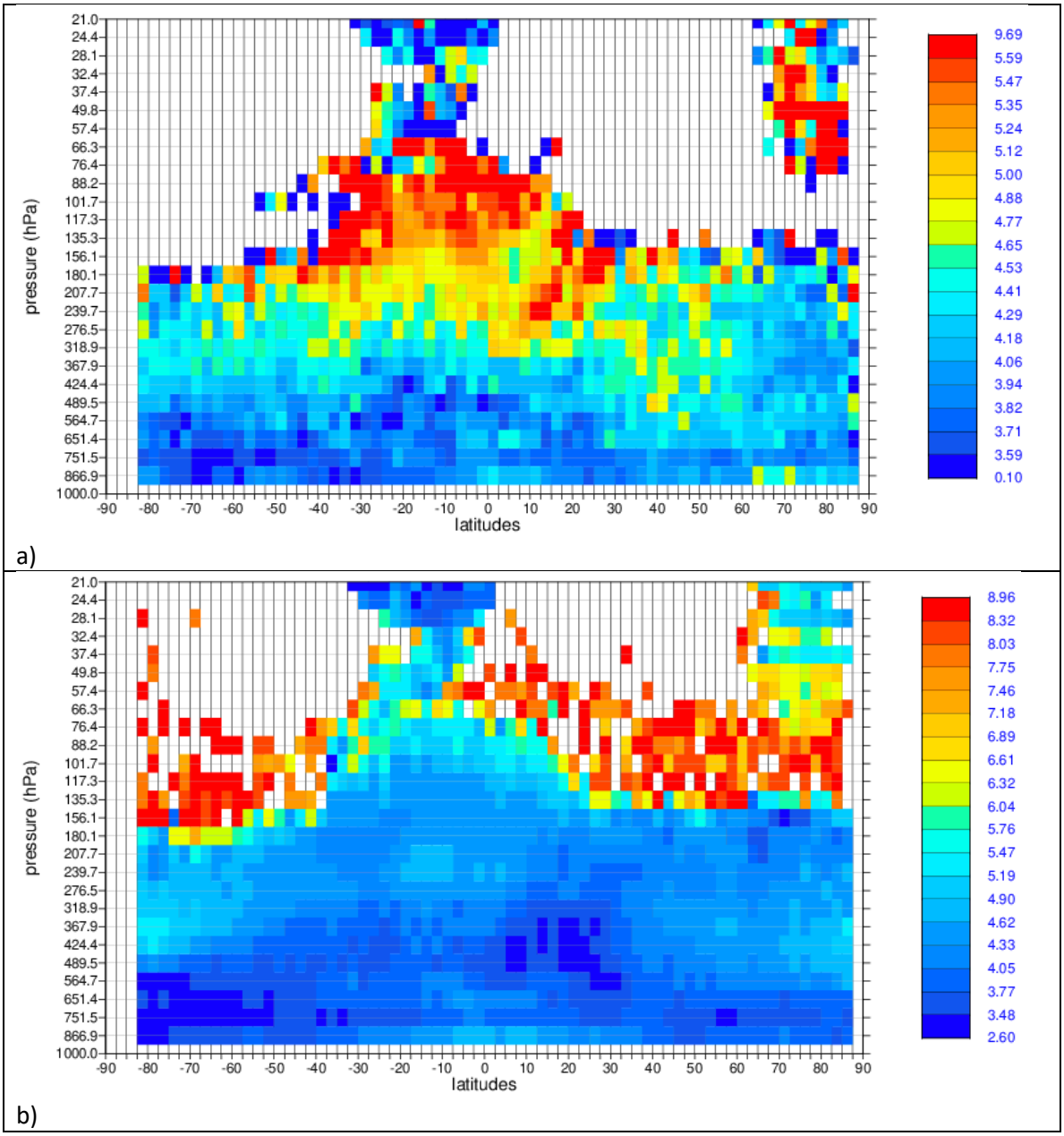


Figure 7. Pressure versus latitude dependence of the L2B Mie-cloudy mean(O-B) for a) ascending and b) descending orbits. Unit: m/s. For the period: 20 December 2021 to 29 January 2022.


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
9.69
5.59
5.47
5.35
5.24
5.12
5.00
4.88
4.77
4.65
4.53
4.41
4.29
4.18
4.06
3.94
3.82
3.71
3.59
0.10
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
8.96
8.32
8.03
7.75
7.46
7.18
6.89
6.61
6.32
6.04
5.76
5.47
5.19
4.90
4.62
4.33
4.05
3.77
3.48
2.60
b)

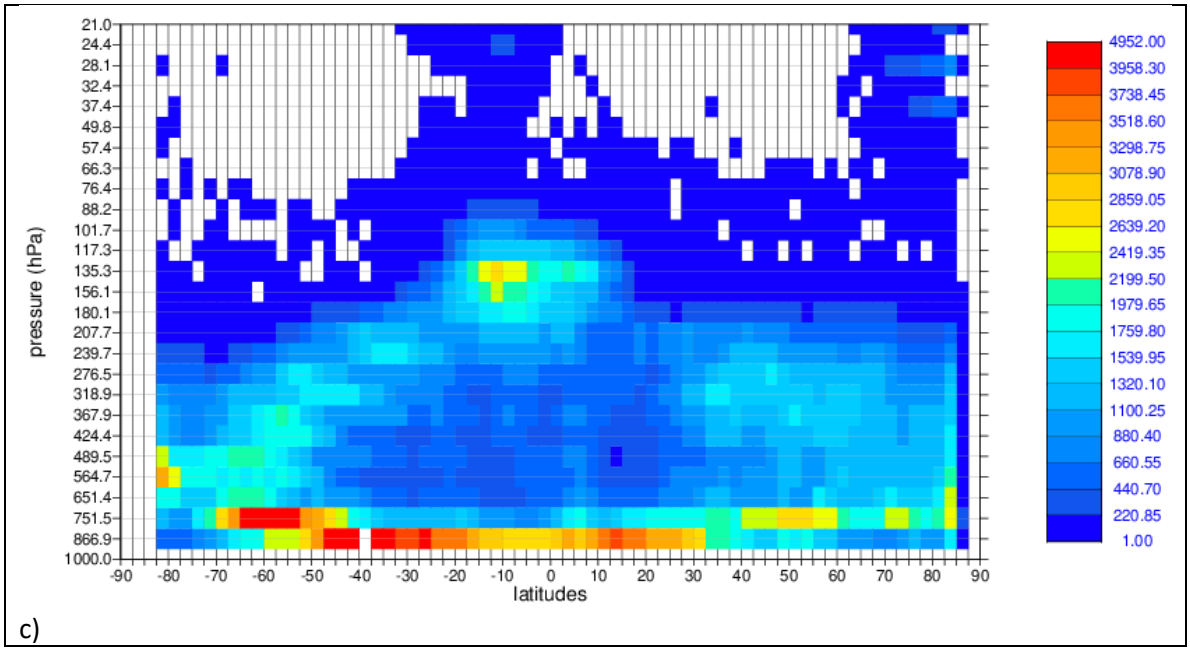


Figure 8. Pressure versus latitude dependence of the L2B Mie-cloudy a) ascending stdev(O-B) m/s, b) assigned observation error in DA (via scaled L2Bp error estimates) and c) number of observations. For the period: 20 December 2021 to 29 January 2022.

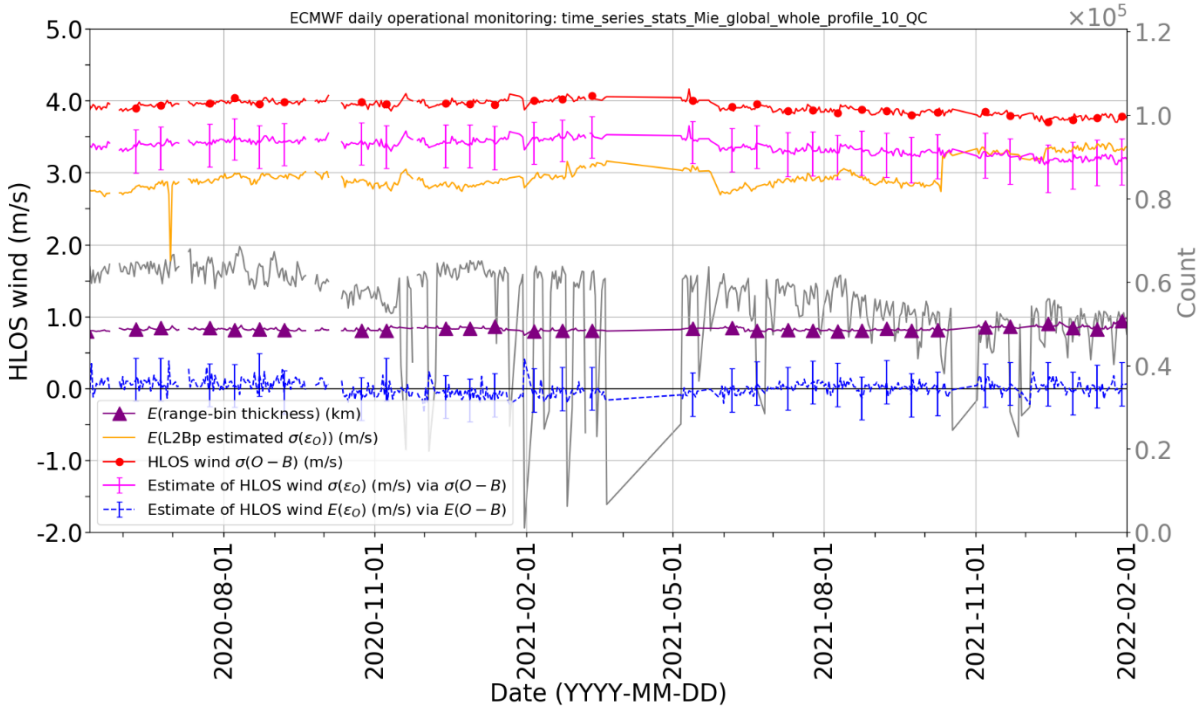


Figure 9. Times-series of daily, global, whole profile L2B Mie-cloudy HLOS wind related statistics since 12 May 2020 (when L2B data was made available for public release). QC for this type of plot is to reject if abs(O-B) > 10 m/s.

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

- Random and systematic errors have remained fairly stable during January 2022.
- Thanks to the Hunga Tonga-Hunga Ha'apai volcano eruption and range-bin settings up to 30 km since 24 January, there are a good sample of Mie-cloudy winds of high quality (estimated errors ~3 m/s) in the 22-28 km altitude range in the tropics. Also, there are PSC Mie-winds over North Pole recently.

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

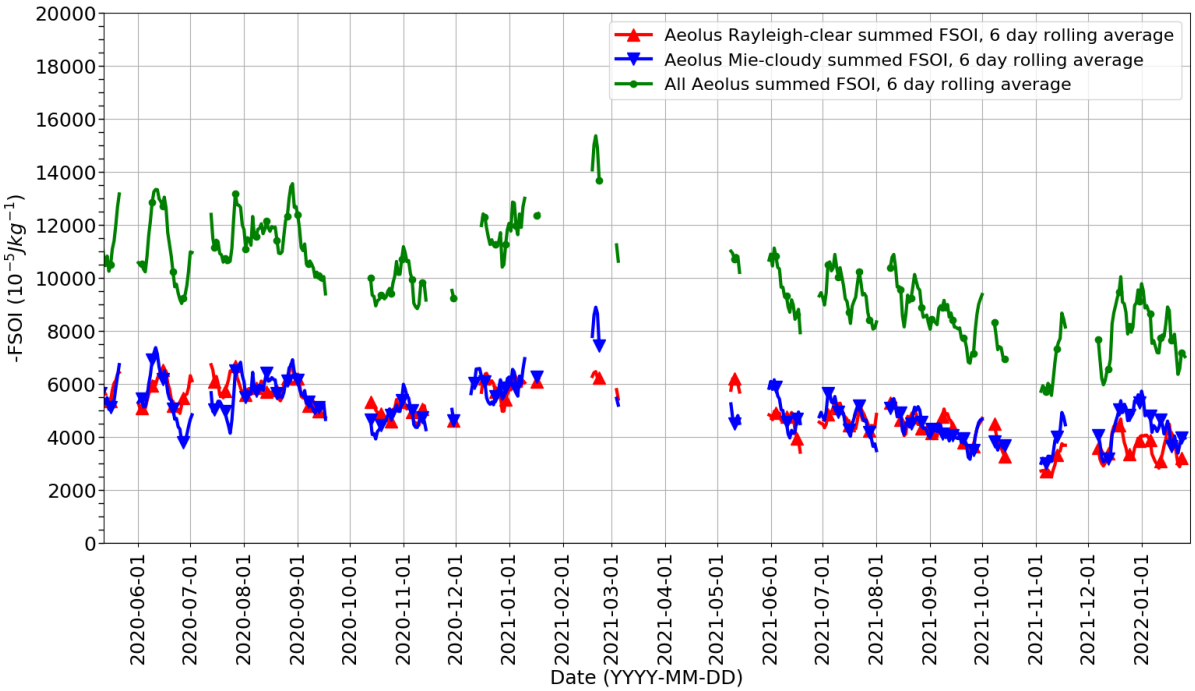


Figure 10. Time-series of the negative of the FSOI of Aeolus L2B HLOS winds in ECMWF operations since the L2B data public release (12 May 2020). Therefore, positive values of -FSOI indicate short-range forecast improvement due to assimilating Aeolus. Partitioned into Mie-cloudy (blue), Rayleigh-clear (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 January 2022 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 2022 impact of ~7500 units is about 46% of the maximum impact. There is perhaps a downward trend which should be monitored in upcoming months.