

PyCAMA report generated by trop12-proc

trop12-proc

2025-05-03 (03:15)

1 Short Introduction

1.1 The list of parameters

You may want to keep the list given in table 1 at hand when viewing the results.

2 Definitions

The averages shown here are *unweighed* averages:

$$\bar{x} = \frac{1}{N} \sum_{i=1}^N x_i \quad (1)$$

with N the number of observations in the dataset.

The spread of the measurements is indicated with the variance $V(x)$, or rather the standard deviation $\sigma(x) = \sqrt{V(x)}$.

$$V(x) = \frac{1}{N-1} \sum_{i=1}^N (x_i - \bar{x})^2 \quad (2)$$

We also report the more robust statistics median, minimum, maximum, various percentiles and inter quartile range.

The median m is the value of parameter x for which half of the observations of x is smaller than m :

$$P(x \leq m) = P(x \geq m) = \int_{-\infty}^m f(x) dx = \frac{1}{2} \quad (3)$$

with $f(x)$ the probability density function.

The median is a special case of a percentile. Instead of 1/2 in equation 3, other threshold values can be used. We report results for 1 %, 5 %, 10 %, 15.9 %, 25 %, 75 %, 84.1 %, 90 %, 95 % and 99 %. The inter quartile range is the difference between the 75 % and 25 % percentiles. Similarly the minimum and maximum values correspond to the 0 % and 100 % percentiles respectively.

For normally distributed parameters the mean and median are the same, while the $\mu \pm \sigma$ values and the 15.9 % and 84.1 % percentiles coincide.

To get a measure for the relation of one variable $x_{(k)}$ with another $x_{(l)}$, we calculate the covariance matrix C_{kl} .

$$C_{kl} = C(x_{(k)}, x_{(l)}) = \frac{1}{N-1} \sum_{i=1}^N (x_{(k),i} - \bar{x}_{(k)})(x_{(l),i} - \bar{x}_{(l)}) \quad (4)$$

Rather than a dimensionally dependent covariance, it is often easier to interpret a correlation matrix R_{kl} , a matrix of Pearson's r coefficients:

$$R_{kl} = R(x_{(k)}, x_{(l)}) = \frac{C_{kl}}{\sqrt{C_{kk}C_{ll}}} = \frac{C_{kl}}{\sqrt{V(x_k)V(x_l)}} \quad (5)$$

The diagonal elements of the covariance matrix are the variances of the elements, $V(x_{(k)}) = C_{kk}$ and obviously $R_{kk} = 1$.

Table 1: Parameterlist and basic statistics for the analysis

Variable	mean $\pm \sigma$	Count	Mode	IQR	Median	Minimum	Maximum
qa value [1]	0.590 ± 0.277	7159378	0.705	0.300	0.700	0.0	1.000
carbonmonoxide total column [mol m ⁻²]	$(2.811 \pm 0.775) \times 10^{-2}$	7159378	3.250×10^{-2}	1.208×10^{-2}	2.984×10^{-2}	0.0	0.561
carbonmonoxide total column precision [mol m ⁻²]	$(1.173 \pm 0.612) \times 10^{-3}$	7159378	7.350×10^{-4}	7.549×10^{-4}	1.008×10^{-3}	0.0	0.129
number of spectral points in retrieval [1]	154 ± 1	7159378	155	2.00	154	35.0	156
chi square [1]	$(0.175 \pm 1.007) \times 10^4$	7159378	472	1.335×10^3	1.152×10^3	210	3.894×10^6
degrees of freedom [1]	7.46 ± 0.46	7159378	7.95	0.896	7.51	4.00	8.00
number of iterations [1]	8.40 ± 1.15	7159378	8.17	1.000	8.00	5.00	15.0

Table 2: Percentile ranges										
Variable	1 %	5 %	10 %	15.9 %	25 %	75 %	84.1 %	90 %	95 %	99 %
qa value [1]	0.0	0.0	0.0	0.400	0.400	0.700	0.700	1.000	1.000	1.000
carbonmonoxide total column [mol m ⁻²]	1.230×10^{-2}	1.505×10^{-2}	1.676×10^{-2}	1.848×10^{-2}	2.158×10^{-2}	3.366×10^{-2}	3.522×10^{-2}	3.668×10^{-2}	3.893×10^{-2}	4.452×10^{-2}
carbonmonoxide total column precision [mol m ⁻²]	3.781×10^{-4}	4.861×10^{-4}	5.620×10^{-4}	6.266×10^{-4}	7.218×10^{-4}	1.477×10^{-3}	1.775×10^{-3}	2.062×10^{-3}	2.414×10^{-3}	2.984×10^{-3}
number of spectral points in retrieval [1]	151	152	153	153	153	155	155	156	156	156
chi square [1]	337	408	473	547	672	2.007×10^3	2.558×10^3	3.154×10^3	4.265×10^3	8.511×10^3
degrees of freedom [1]	6.00	7.00	7.00	7.00	7.01	7.91	7.96	7.98	7.99	8.00
number of iterations [1]	6.00	7.00	8.00	8.00	8.00	9.00	9.00	9.00	11.0	13.0

Table 3: Parameterlist and basic statistics for the analysis for observations in the northern hemisphere

Variable	mean $\pm \sigma$	Count	IQR	Median	Minimum	Maximum	25 % percentile	75 % percentile
qa value [1]	0.594 ± 0.289	4956456	0.300	0.700	0.0	1.000	0.400	0.700
carbonmonoxide total column [mol m ⁻²]	$(3.196 \pm 0.526) \times 10^{-2}$	4956456	5.723×10^{-3}	3.218×10^{-2}	0.0	8.925×10^{-2}	2.918×10^{-2}	3.490×10^{-2}
carbonmonoxide total column precision [mol m ⁻²]	$(1.163 \pm 0.605) \times 10^{-3}$	4956456	7.934×10^{-4}	1.012×10^{-3}	0.0	1.074×10^{-2}	6.984×10^{-4}	1.492×10^{-3}
number of spectral points in retrieval [1]	154 ± 1	4956456	2.00	154	35.0	156	153	155
chi square [1]	$(0.191 \pm 1.153) \times 10^4$	4956456	1.542×10^3	1.203×10^3	210	3.894×10^6	658	2.200×10^3
degrees of freedom [1]	7.40 ± 0.47	4956456	0.867	7.35	4.00	8.00	7.01	7.87
number of iterations [1]	8.38 ± 1.17	4956456	1.000	8.00	5.00	15.0	8.00	9.00

Table 4: Parameterlist and basic statistics for the analysis for observations in the southern hemisphere

Variable	mean $\pm \sigma$	Count	IQR	Median	Minimum	Maximum	25 % percentile	75 % percentile
qa value [1]	0.580 ± 0.248	2202922	0.300	0.700	0.0	1.000	0.400	0.700
carbonmonoxide total column [mol m ⁻²]	$(1.945 \pm 0.493) \times 10^{-2}$	2202922	5.862×10^{-3}	1.859×10^{-2}	0.0	0.561	1.612×10^{-2}	2.199×10^{-2}
carbonmonoxide total column precision [mol m ⁻²]	$(1.193 \pm 0.626) \times 10^{-3}$	2202922	6.740×10^{-4}	1.002×10^{-3}	0.0	0.129	7.640×10^{-4}	1.438×10^{-3}
number of spectral points in retrieval [1]	154 ± 1	2202922	2.00	154	147	156	153	155
chi square [1]	$(0.139 \pm 0.554) \times 10^4$	2202922	976	1.078×10^3	213	3.569×10^6	698	1.673×10^3
degrees of freedom [1]	7.59 ± 0.41	2202922	0.743	7.75	4.00	8.00	7.21	7.95
number of iterations [1]	8.46 ± 1.13	2202922	1.000	8.00	5.00	15.0	8.00	9.00

Table 5: Parameterlist and basic statistics for the analysis for observations over water

Variable	mean $\pm \sigma$	Count	IQR	Median	Minimum	Maximum	25 % percentile	75 % percentile
qa value [1]	0.572 ± 0.272	4444816	0.300	0.700	0.0	1.000	0.400	0.700
carbonmonoxide total column [mol m ⁻²]	$(2.738 \pm 0.835) \times 10^{-2}$	4444816	1.473×10^{-2}	2.959×10^{-2}	0.0	0.561	1.925×10^{-2}	3.398×10^{-2}
carbonmonoxide total column precision [mol m ⁻²]	$(1.284 \pm 0.655) \times 10^{-3}$	4444816	8.794×10^{-4}	1.110×10^{-3}	0.0	0.129	7.790×10^{-4}	1.658×10^{-3}
number of spectral points in retrieval [1]	154 ± 1	4444816	2.00	154	35.0	156	153	155
chi square [1]	$(0.141 \pm 0.913) \times 10^4$	4444816	1.039×10^3	983	210	3.894×10^6	612	1.651×10^3
degrees of freedom [1]	7.48 ± 0.43	4444816	0.880	7.56	4.00	8.00	7.02	7.90
number of iterations [1]	8.47 ± 1.17	4444816	1.000	8.00	5.00	15.0	8.00	9.00

Table 6: Parameterlist and basic statistics for the analysis for observations over land

Variable	mean $\pm \sigma$	Count	IQR	Median	Minimum	Maximum	25 % percentile	75 % percentile
qa value [1]	0.623 ± 0.292	1769664	0.300	0.700	0.0	1.000	0.400	0.700
carbonmonoxide total column [mol m ⁻²]	$(2.840 \pm 0.617) \times 10^{-2}$	1769664	8.062×10^{-3}	2.910×10^{-2}	0.0	0.116	2.431×10^{-2}	3.237×10^{-2}
carbonmonoxide total column precision [mol m ⁻²]	$(9.439 \pm 4.688) \times 10^{-4}$	1769664	5.676×10^{-4}	8.308×10^{-4}	0.0	6.393×10^{-3}	6.045×10^{-4}	1.172×10^{-3}
number of spectral points in retrieval [1]	154 ± 1	1769664	2.00	154	143	156	153	155
chi square [1]	$(0.251 \pm 1.040) \times 10^4$	1769664	2.062×10^3	1.637×10^3	211	3.731×10^6	839	2.901×10^3
degrees of freedom [1]	7.37 ± 0.52	1769664	0.894	7.28	4.00	8.00	7.00	7.90
number of iterations [1]	8.29 ± 1.11	1769664	0.0	8.00	5.00	15.0	8.00	8.00

3 Granule outlines

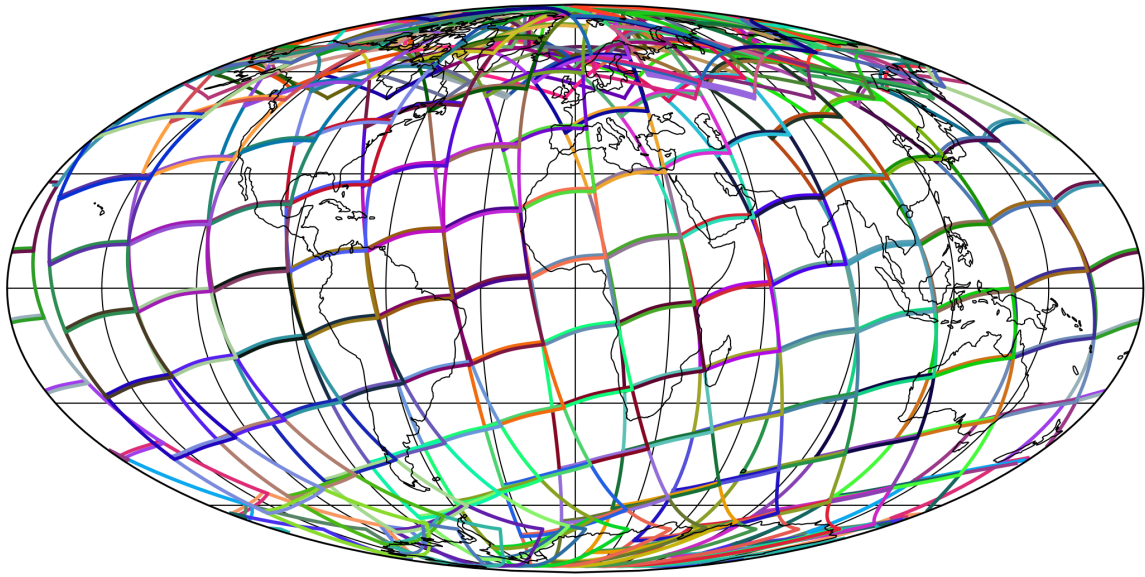


Figure 1: Outline of the granules.

4 Input data monitoring

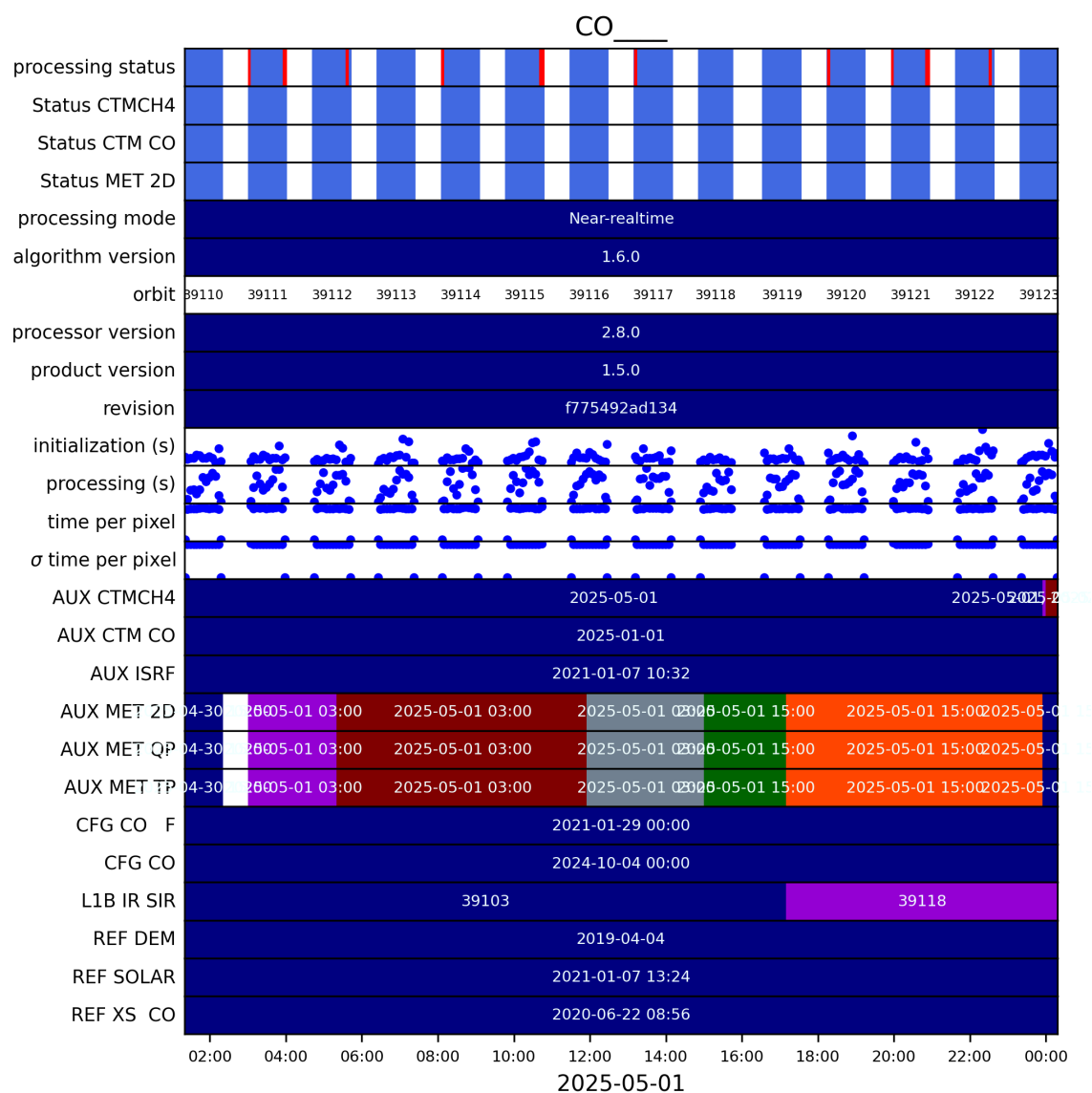


Figure 2: Input data per granule

5 Warnings and errors

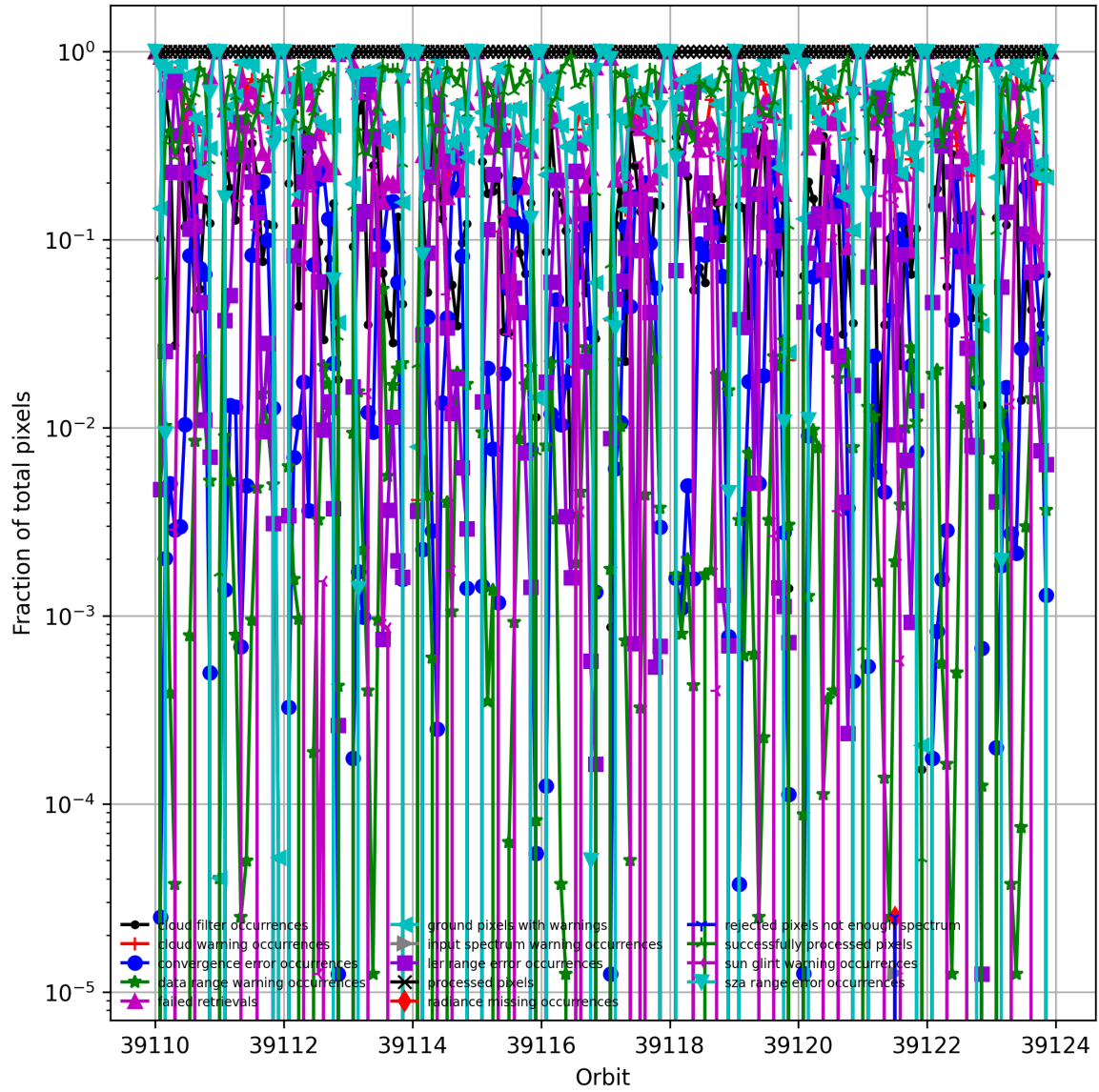


Figure 3: Fraction of pixels with specific warnings and errors during processing

6 World maps

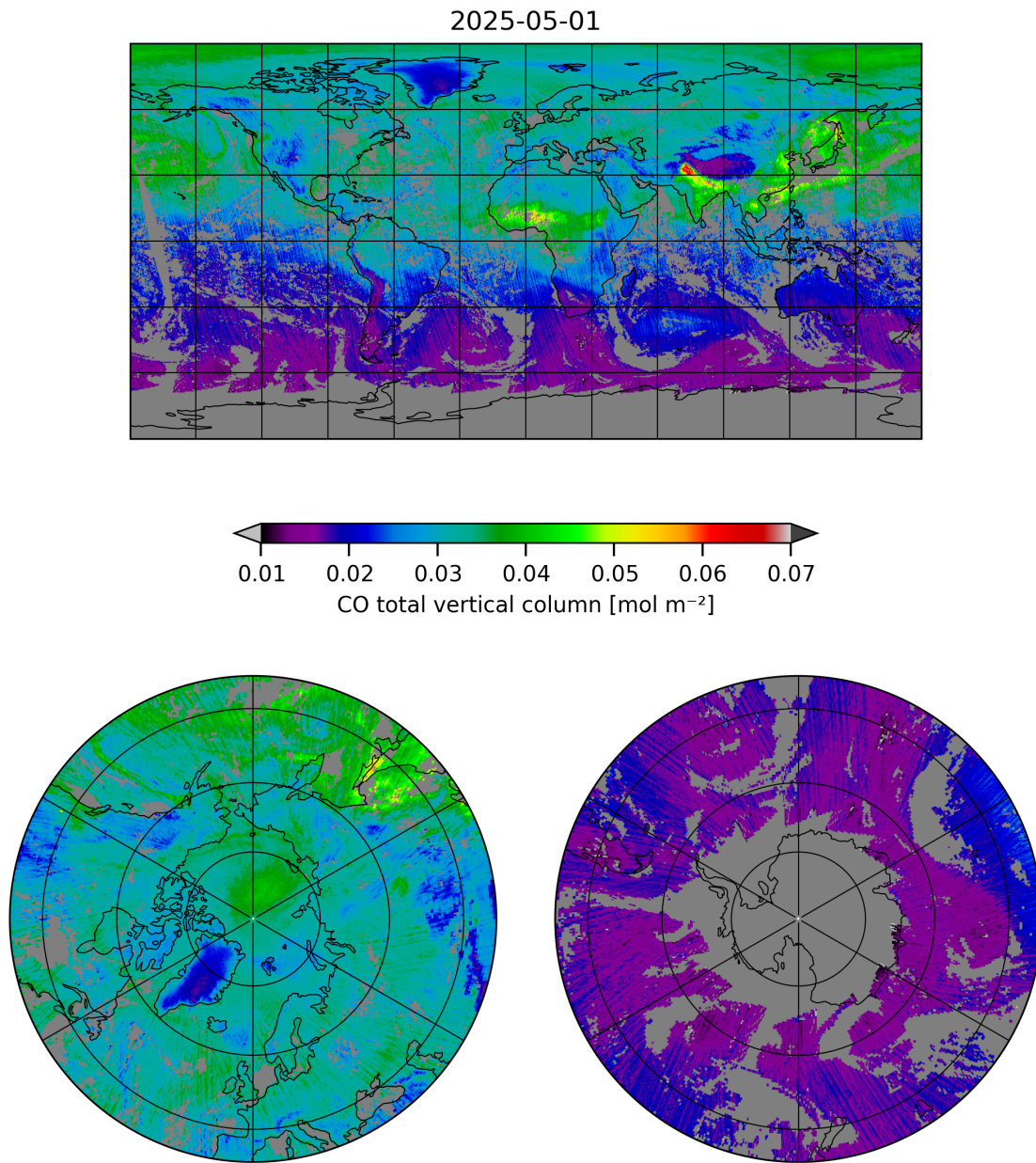


Figure 4: Map of “CO total vertical column” for 2025-05-01 to 2025-05-02

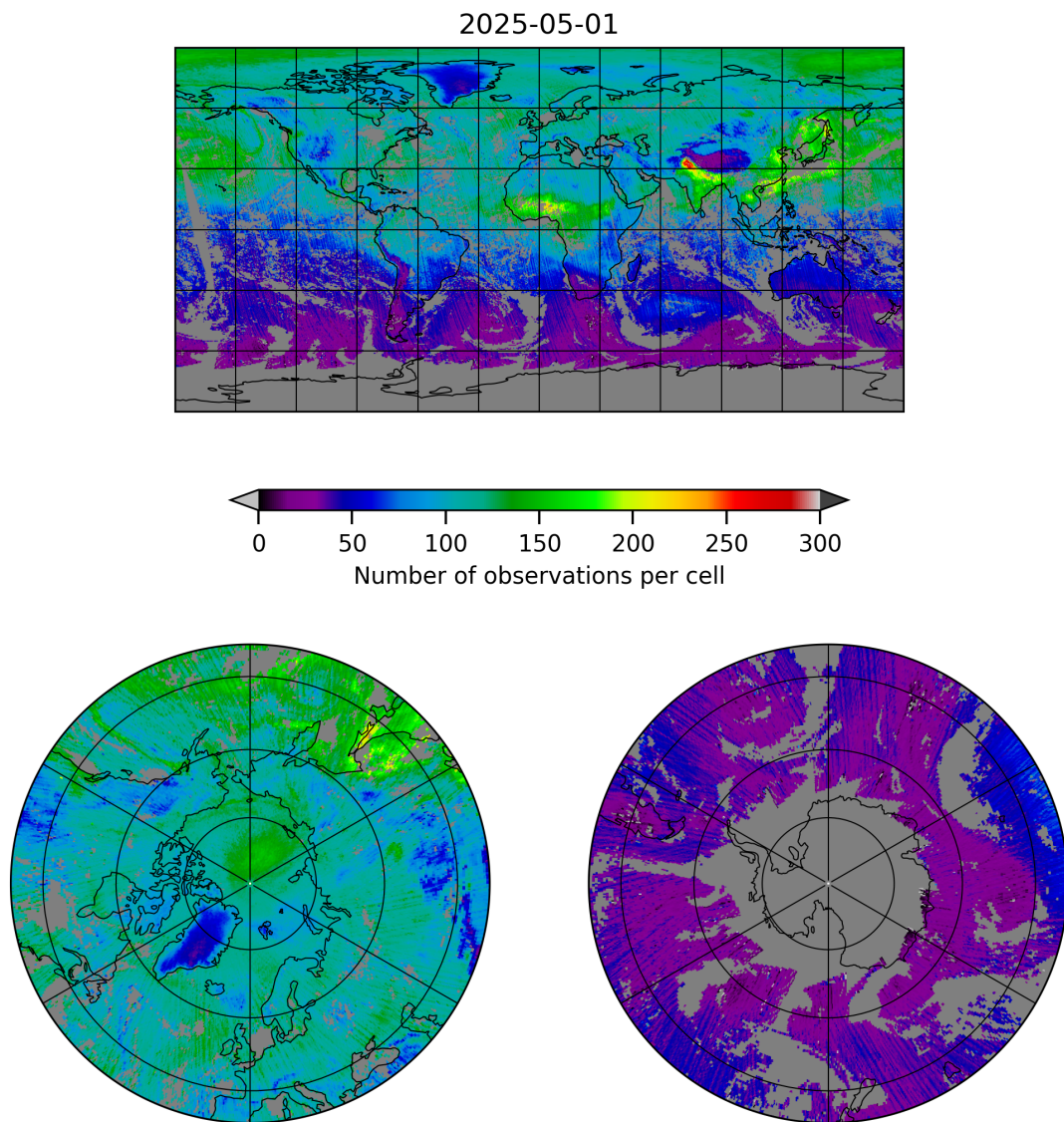


Figure 5: Map of the number of observations for 2025-05-01 to 2025-05-02

7 Zonal average

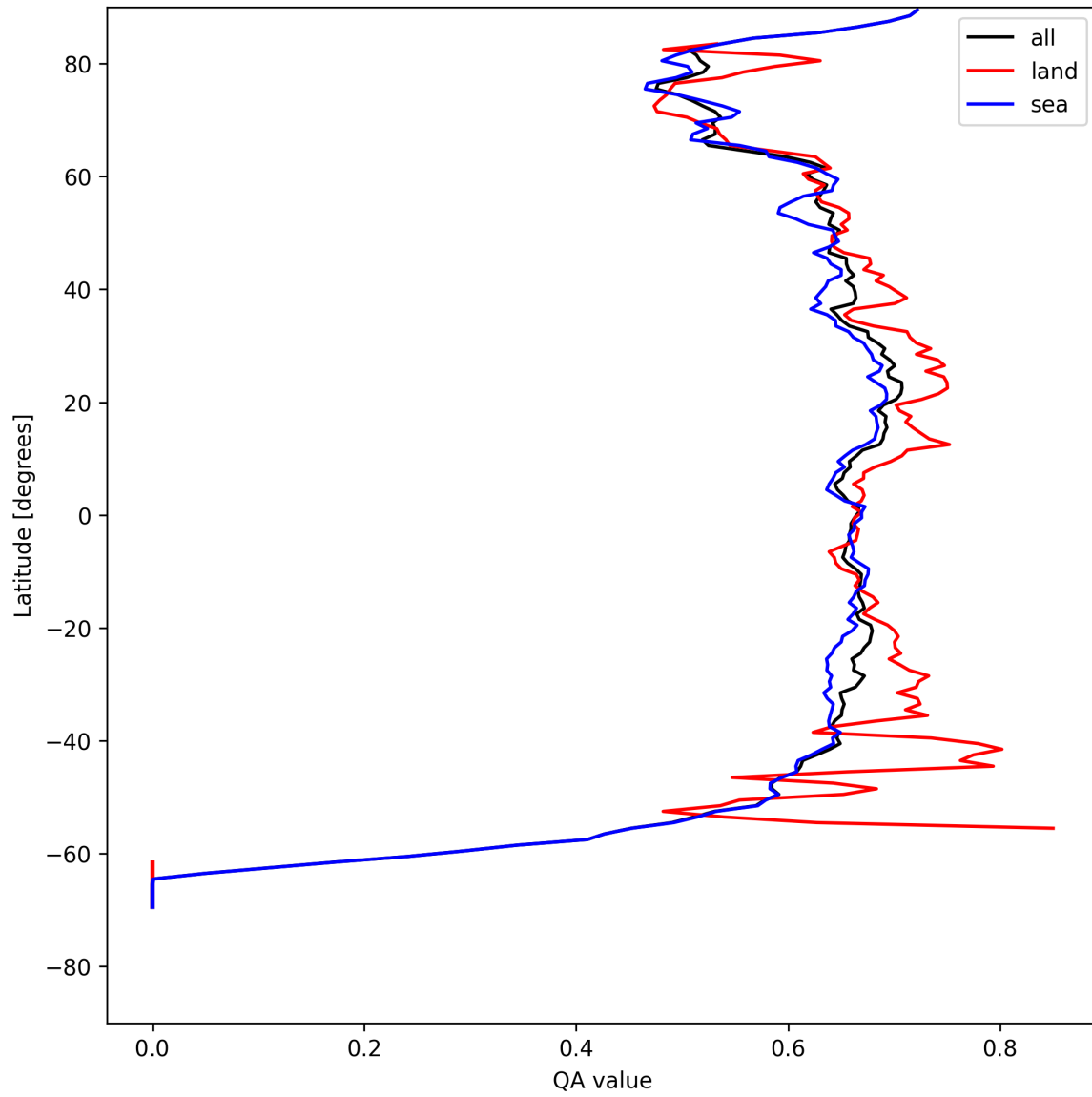


Figure 6: Zonal average of “QA value” for 2025-05-01 to 2025-05-02.

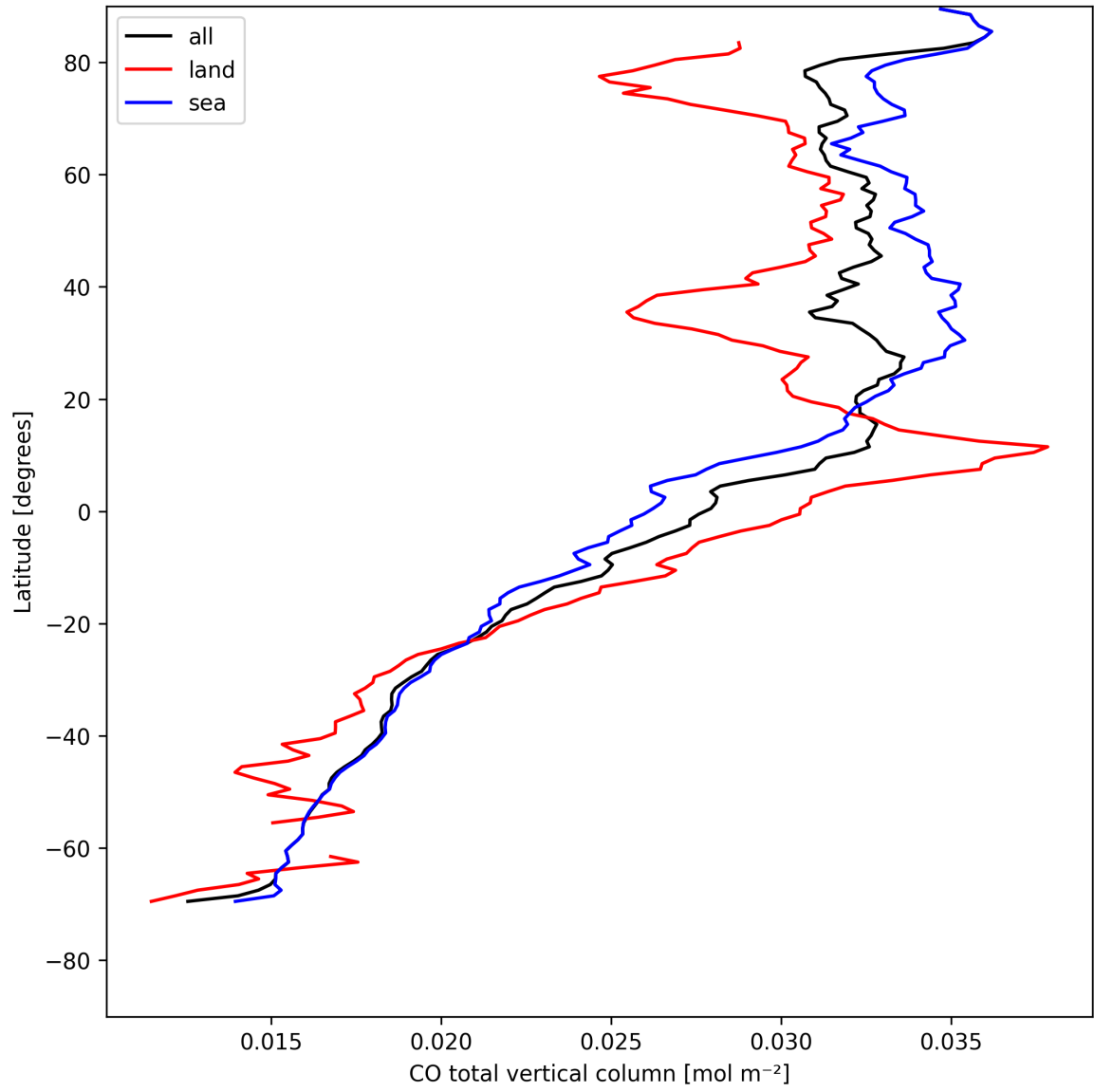


Figure 7: Zonal average of “CO total vertical column” for 2025-05-01 to 2025-05-02.

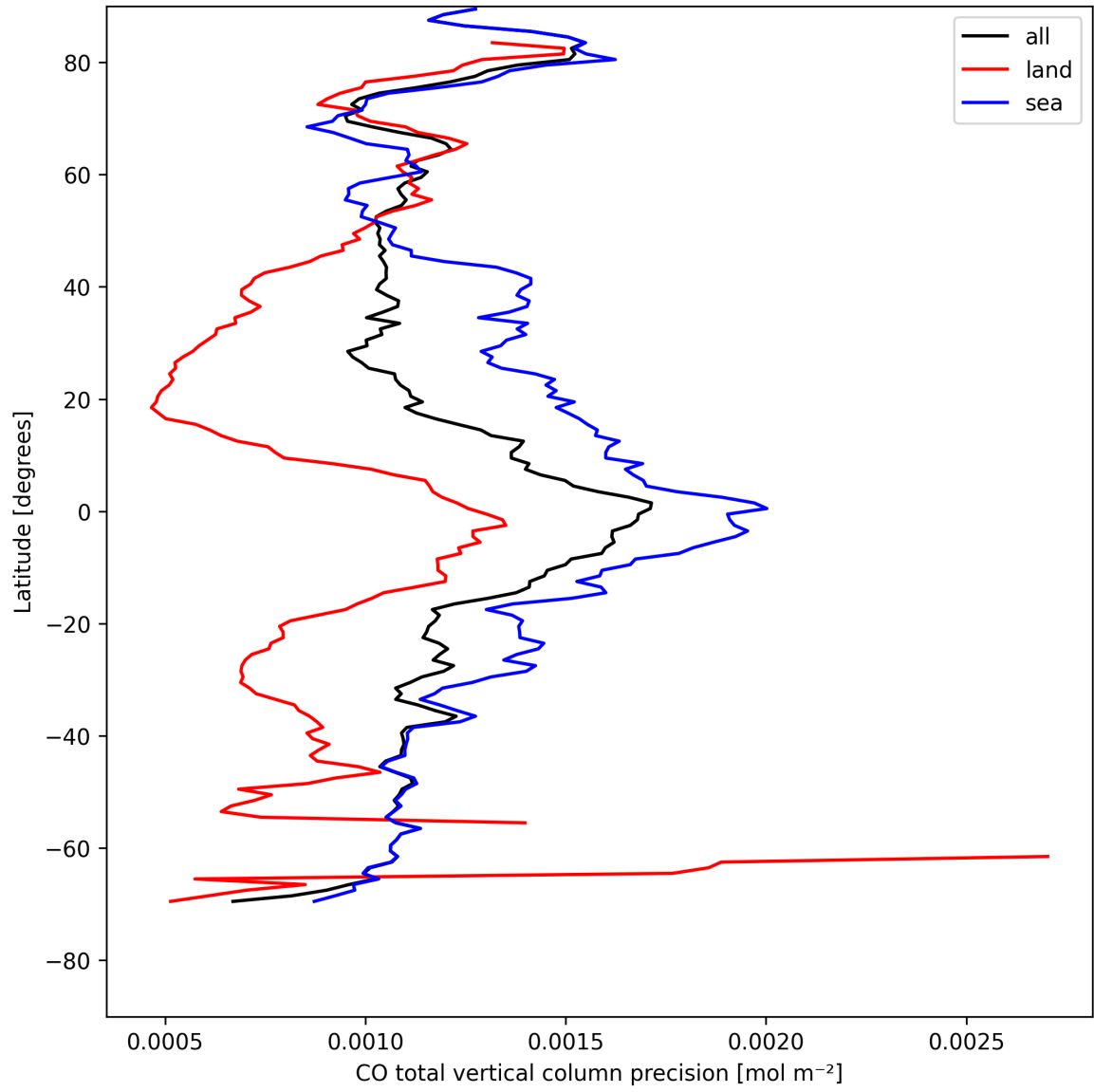


Figure 8: Zonal average of “CO total vertical column precision” for 2025-05-01 to 2025-05-02.

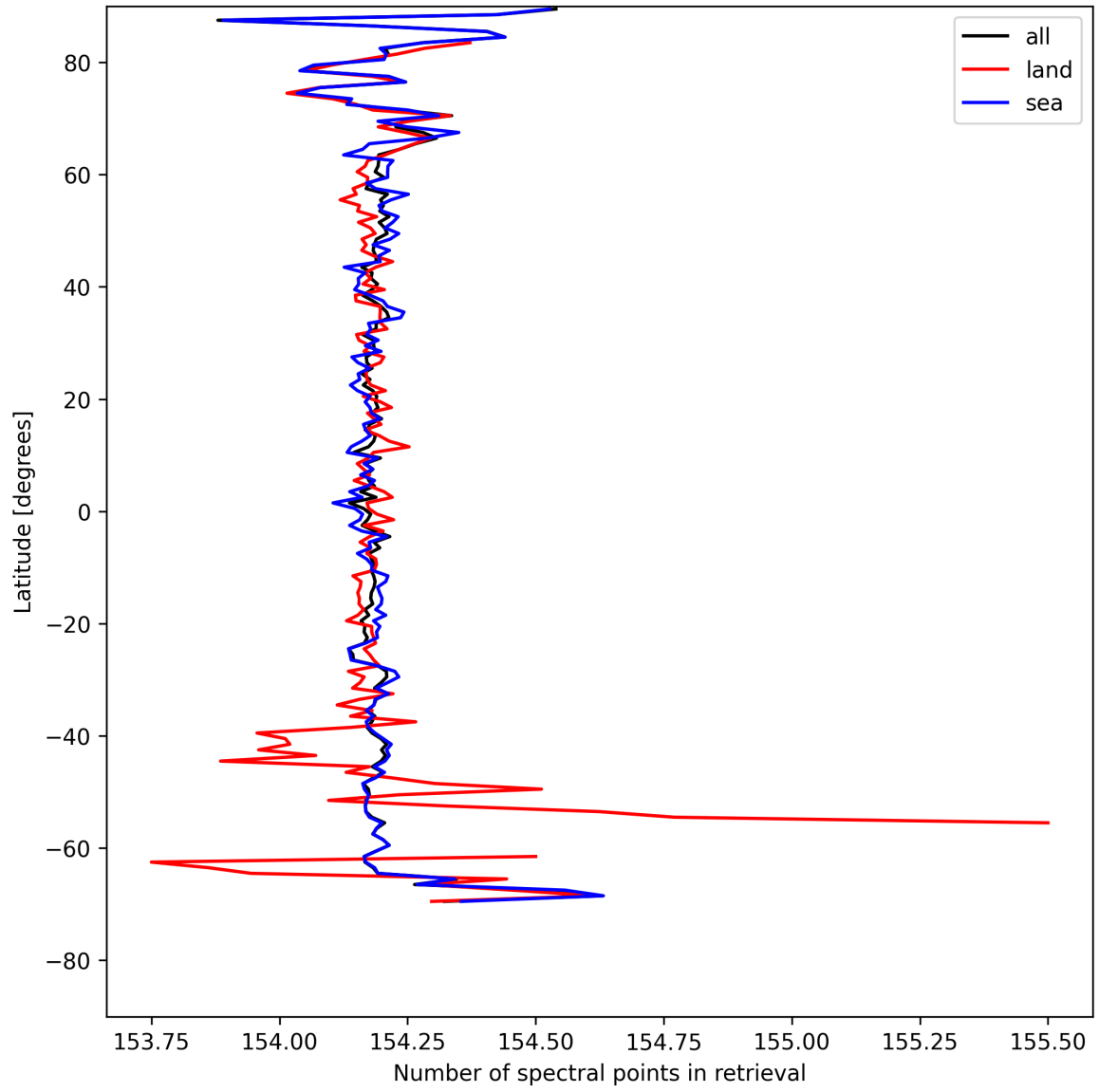


Figure 9: Zonal average of “Number of spectral points in retrieval” for 2025-05-01 to 2025-05-02.

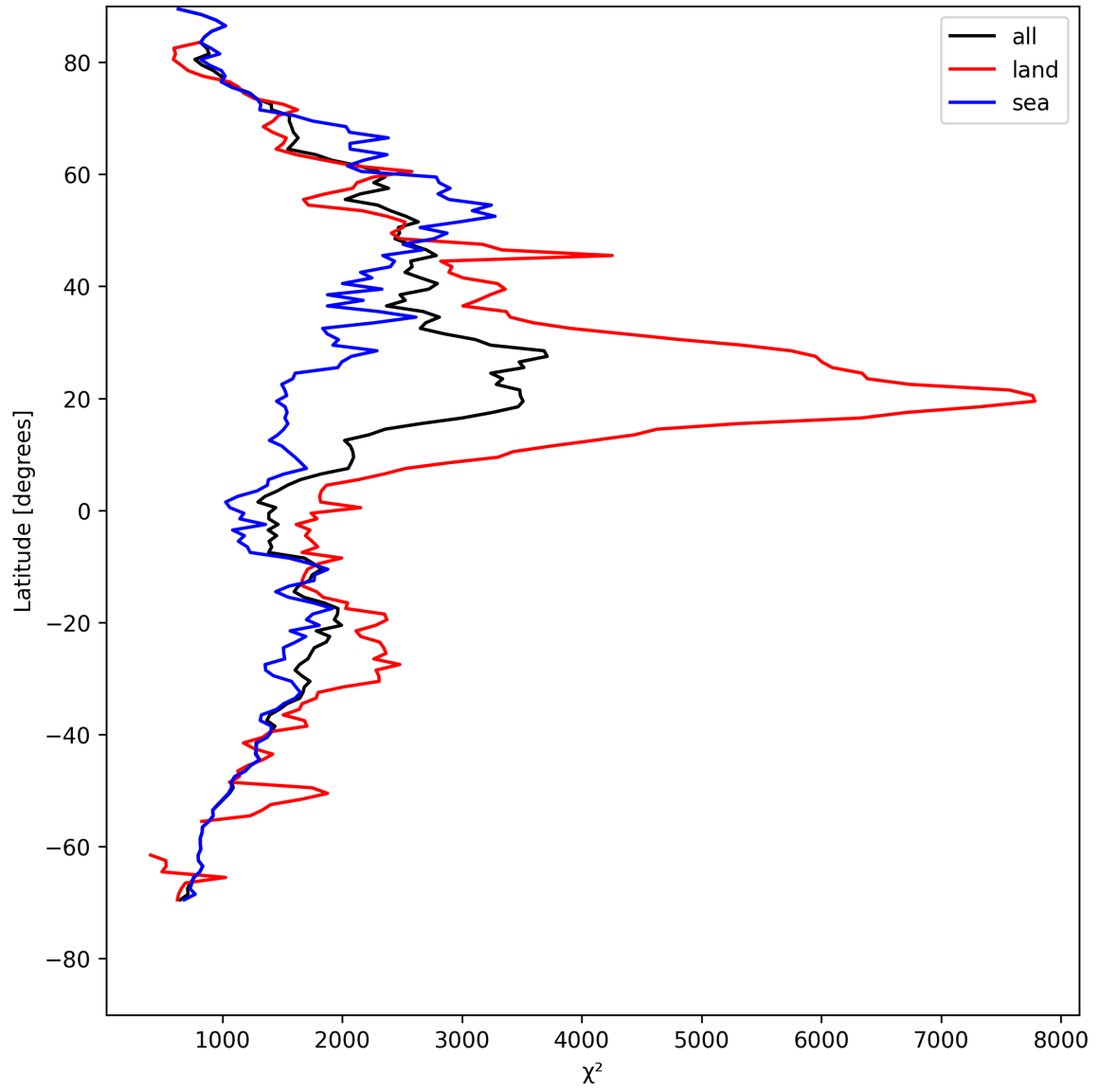


Figure 10: Zonal average of “ χ^2 ” for 2025-05-01 to 2025-05-02.

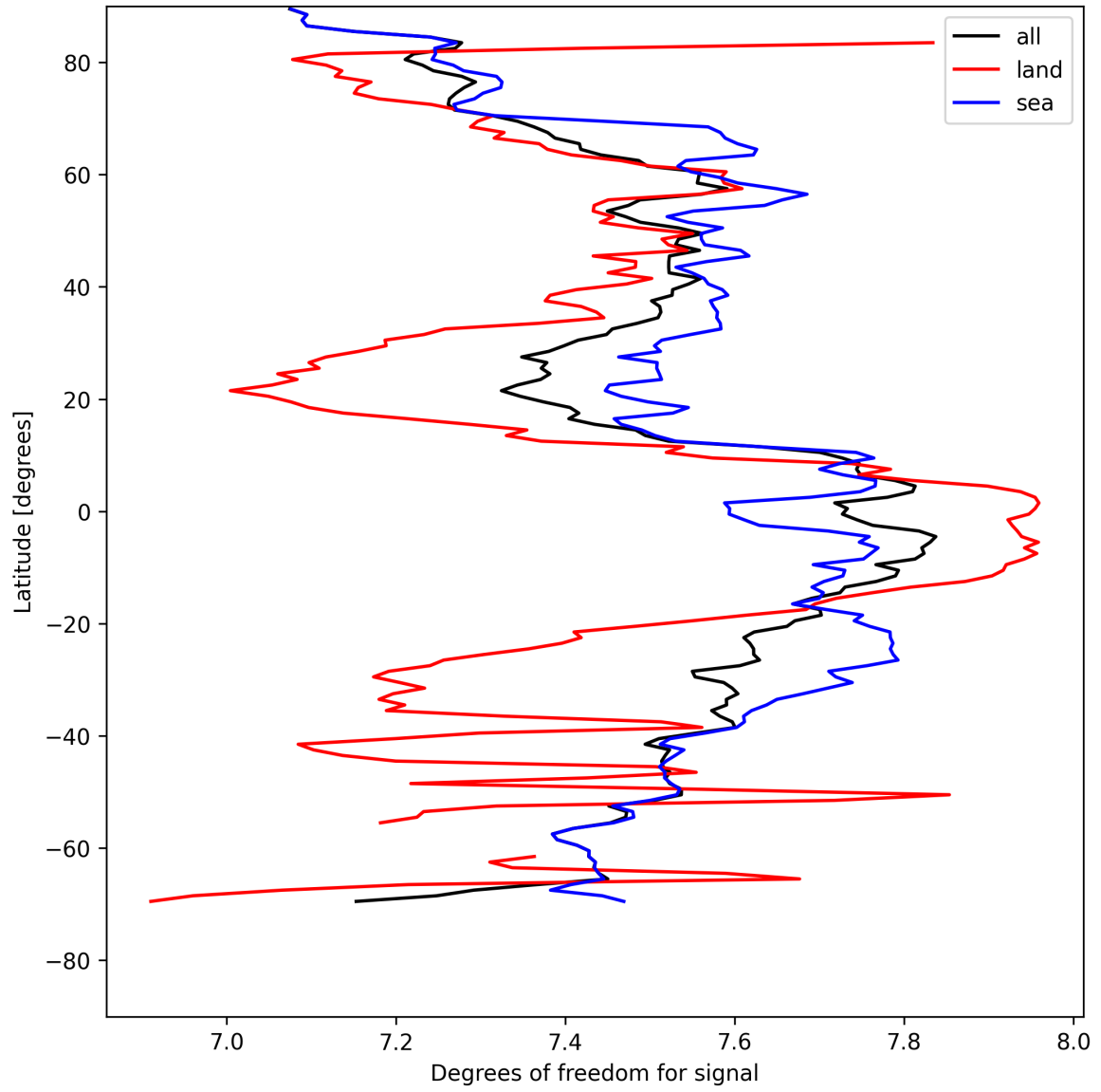


Figure 11: Zonal average of “Degrees of freedom for signal” for 2025-05-01 to 2025-05-02.

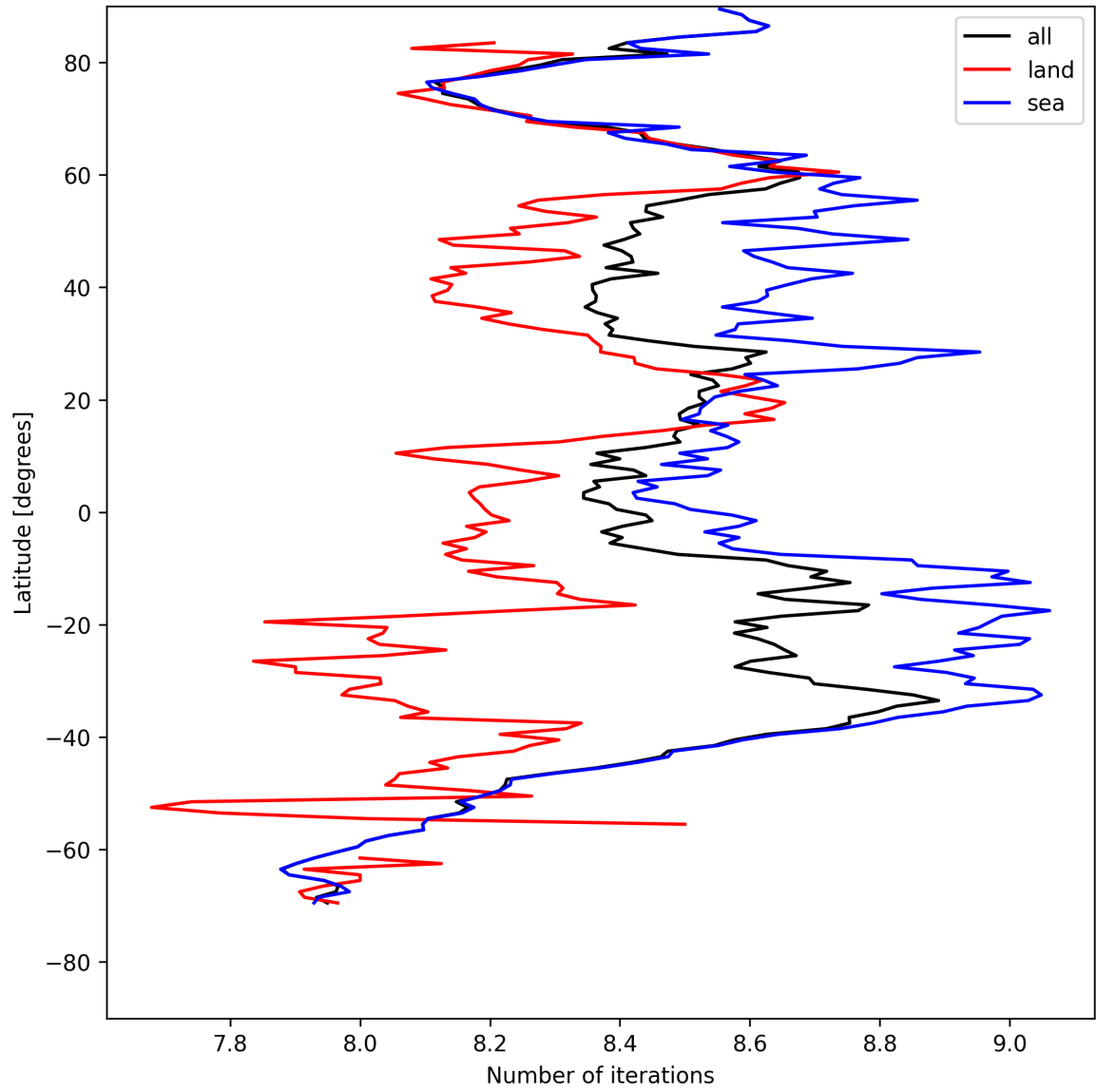


Figure 12: Zonal average of “Number of iterations” for 2025-05-01 to 2025-05-02.

8 Histograms

The definitions of the parameters given in this section can be found in section 2.

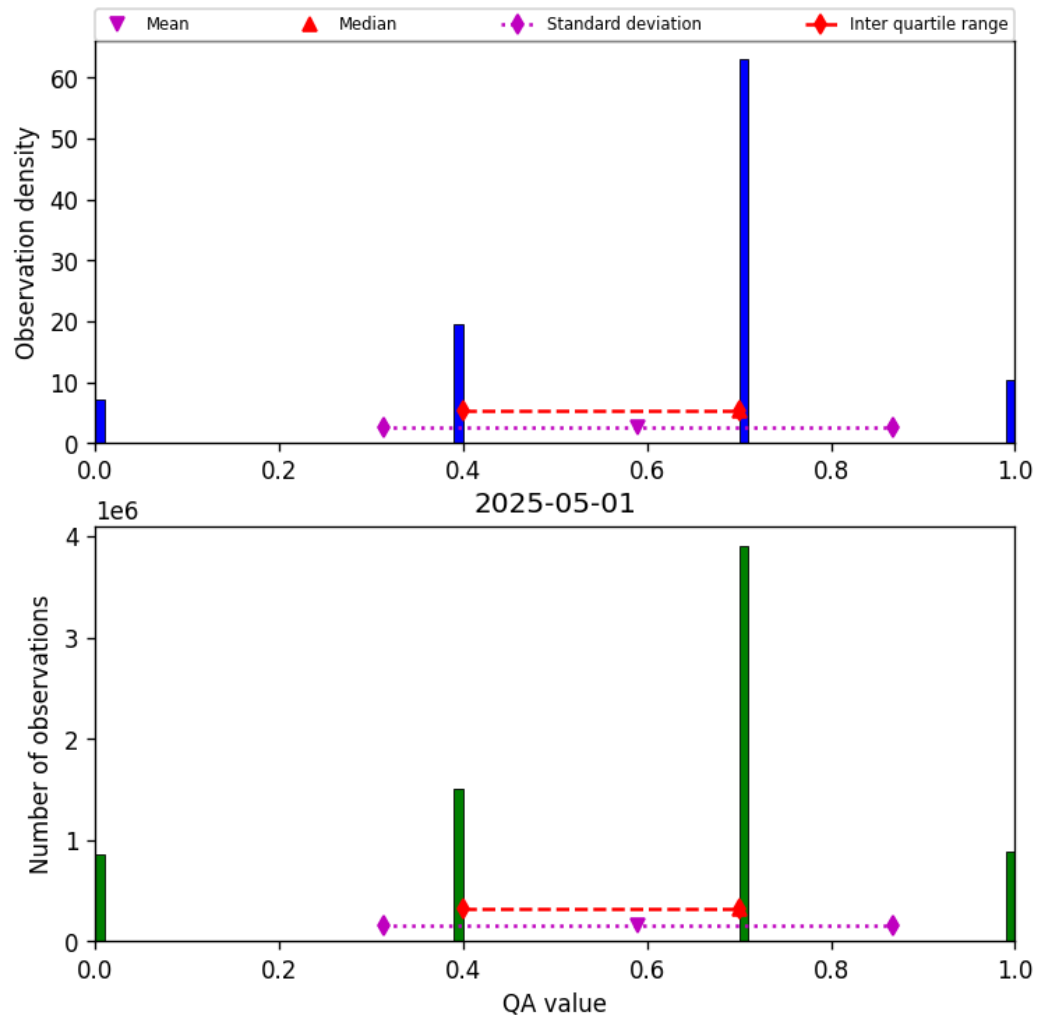


Figure 13: Histogram of “QA value” for 2025-05-01 to 2025-05-02

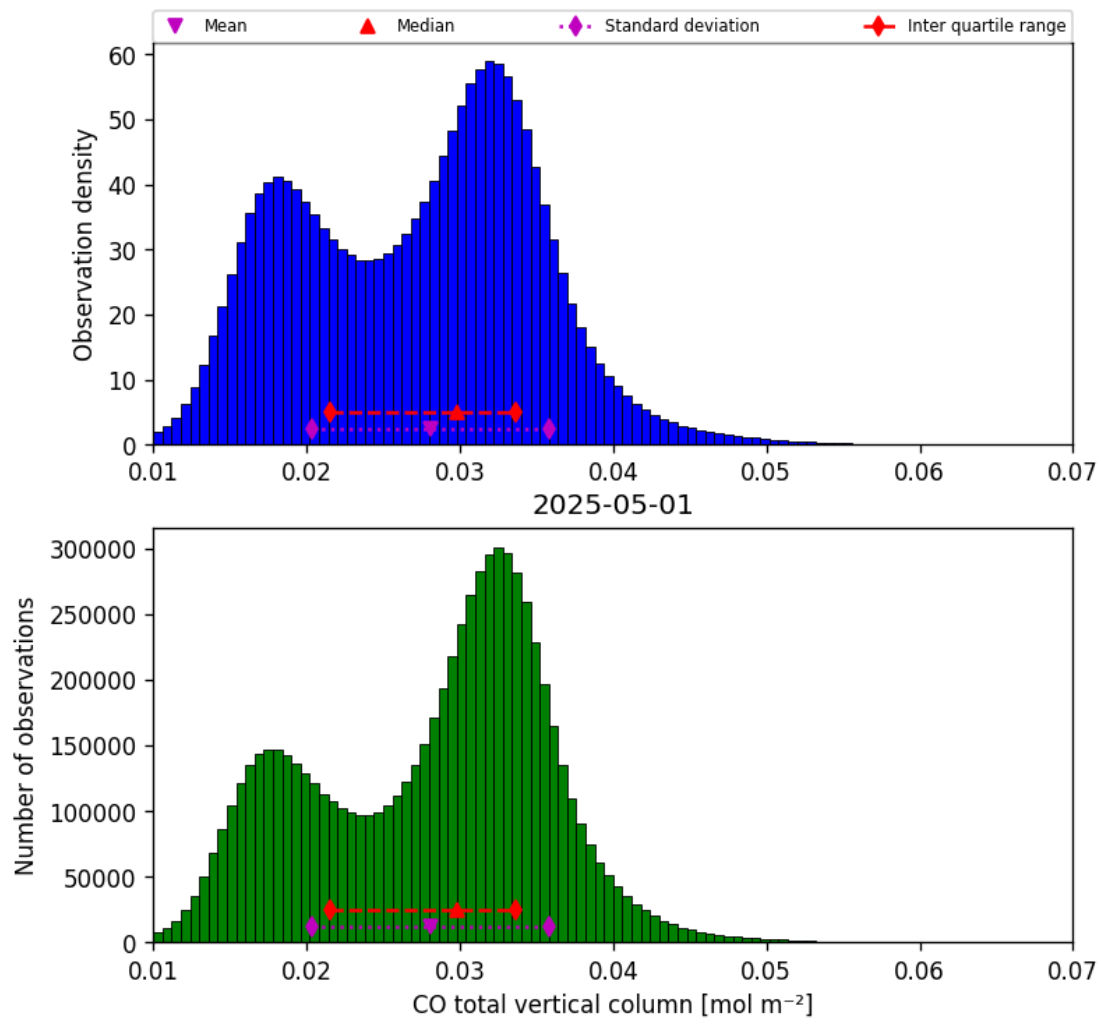


Figure 14: Histogram of “CO total vertical column” for 2025-05-01 to 2025-05-02

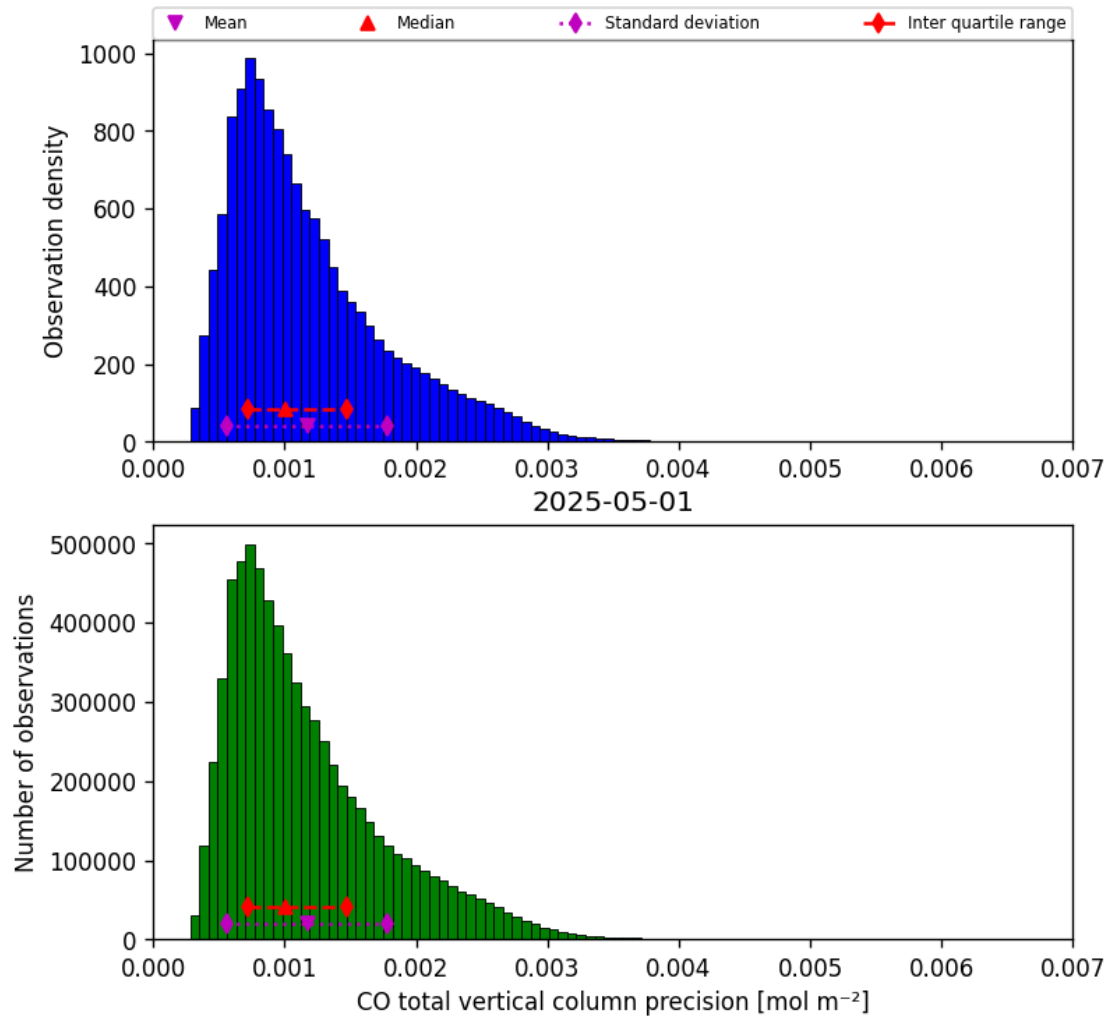


Figure 15: Histogram of “CO total vertical column precision” for 2025-05-01 to 2025-05-02

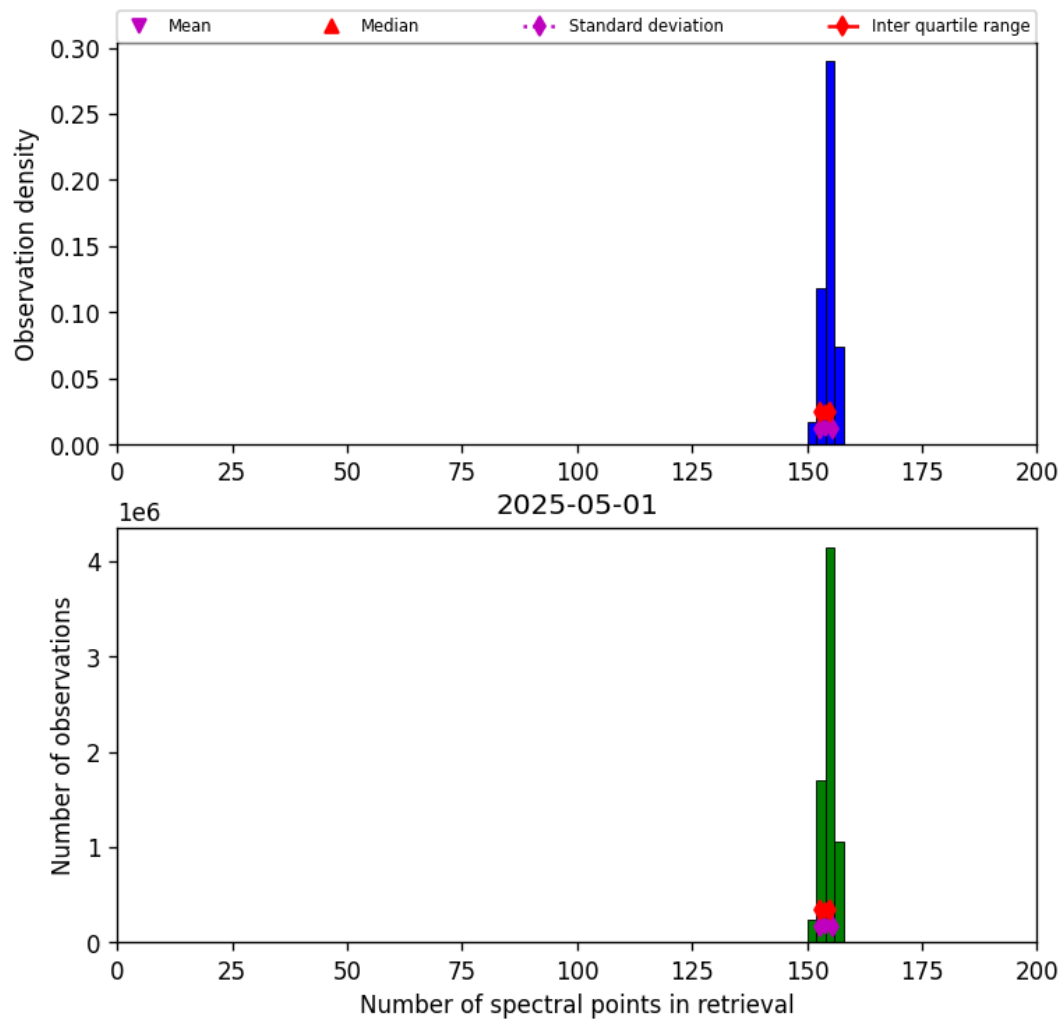


Figure 16: Histogram of “Number of spectral points in retrieval” for 2025-05-01 to 2025-05-02

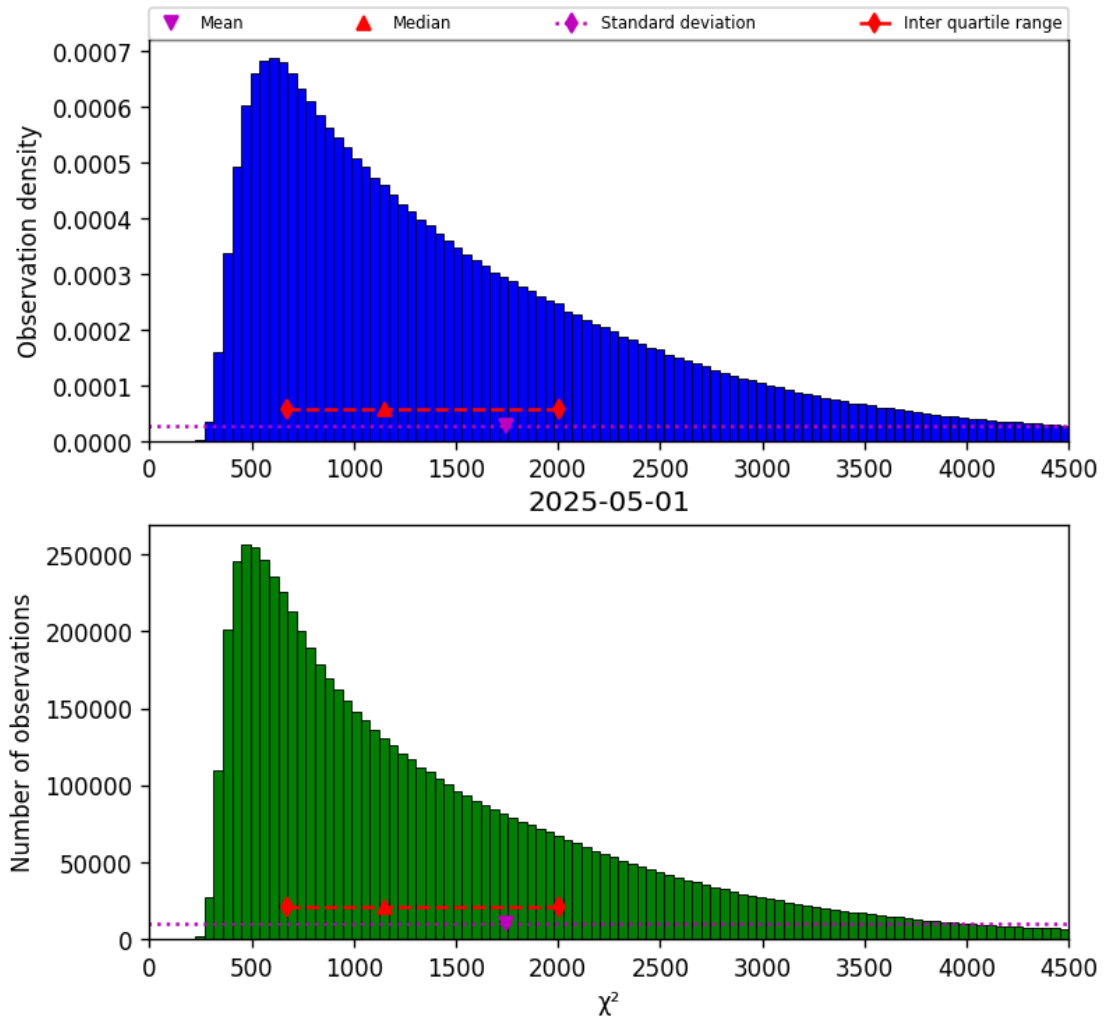


Figure 17: Histogram of “ χ^2 ” for 2025-05-01 to 2025-05-02

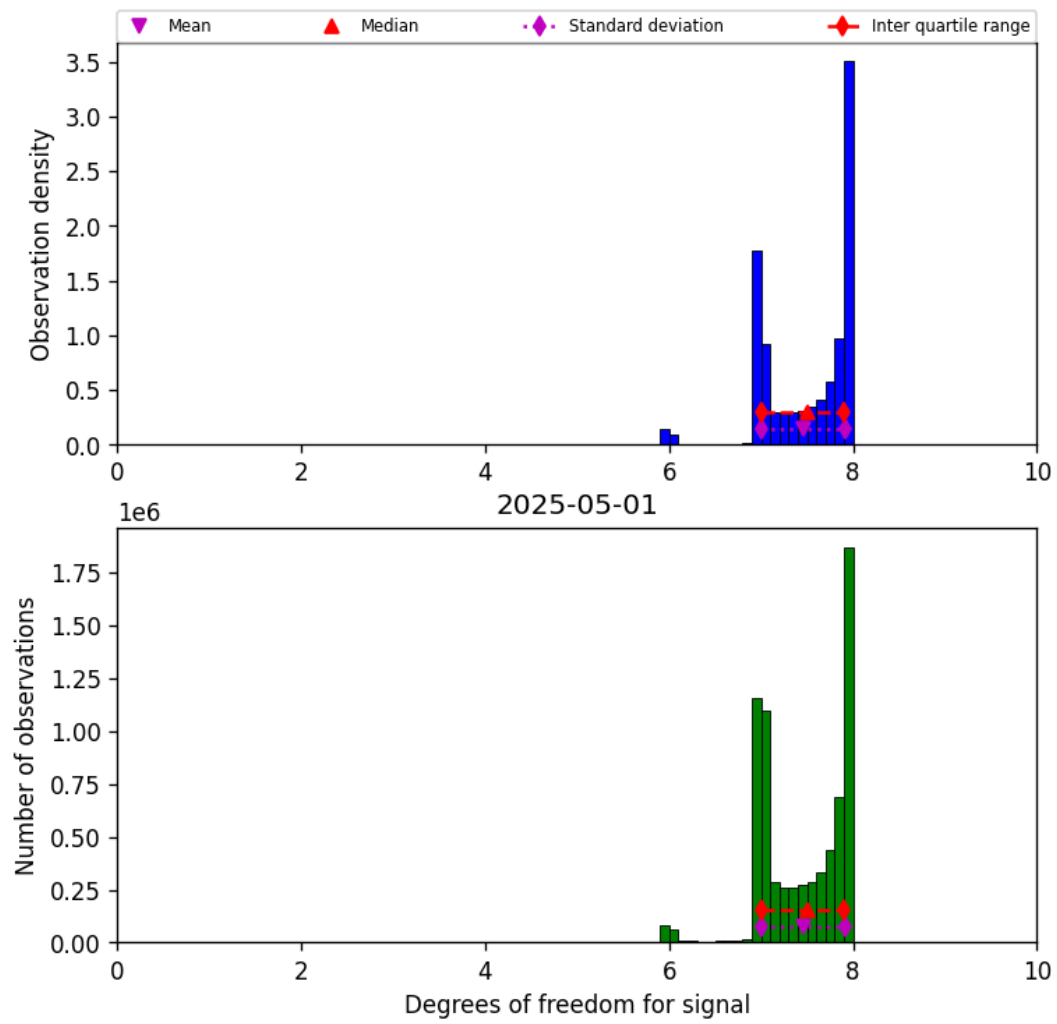


Figure 18: Histogram of “Degrees of freedom for signal” for 2025-05-01 to 2025-05-02

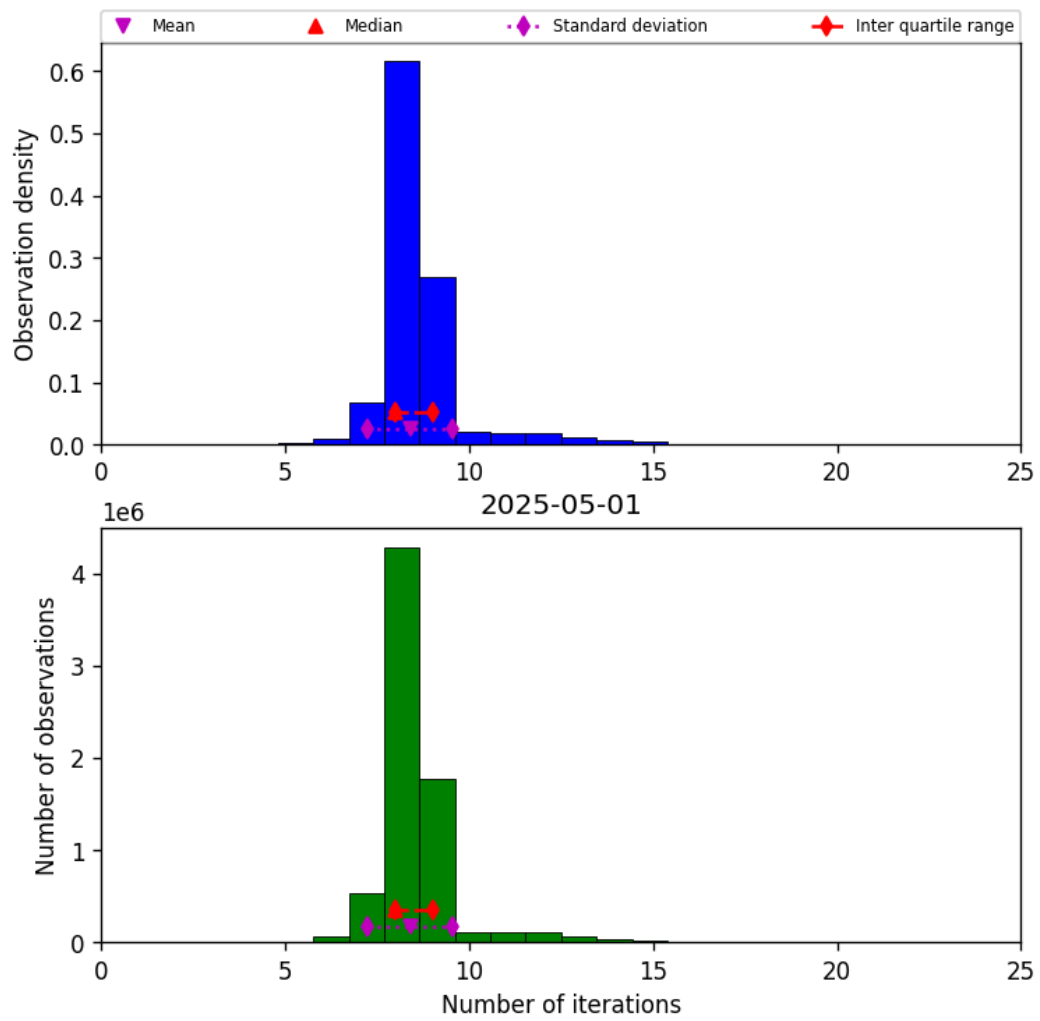


Figure 19: Histogram of “Number of iterations” for 2025-05-01 to 2025-05-02

9 Along track statistics

The TROPOMI instrument uses different binned detector rows for different viewing directions. In this section statistics are presented for each of the binned rows in the instrument.

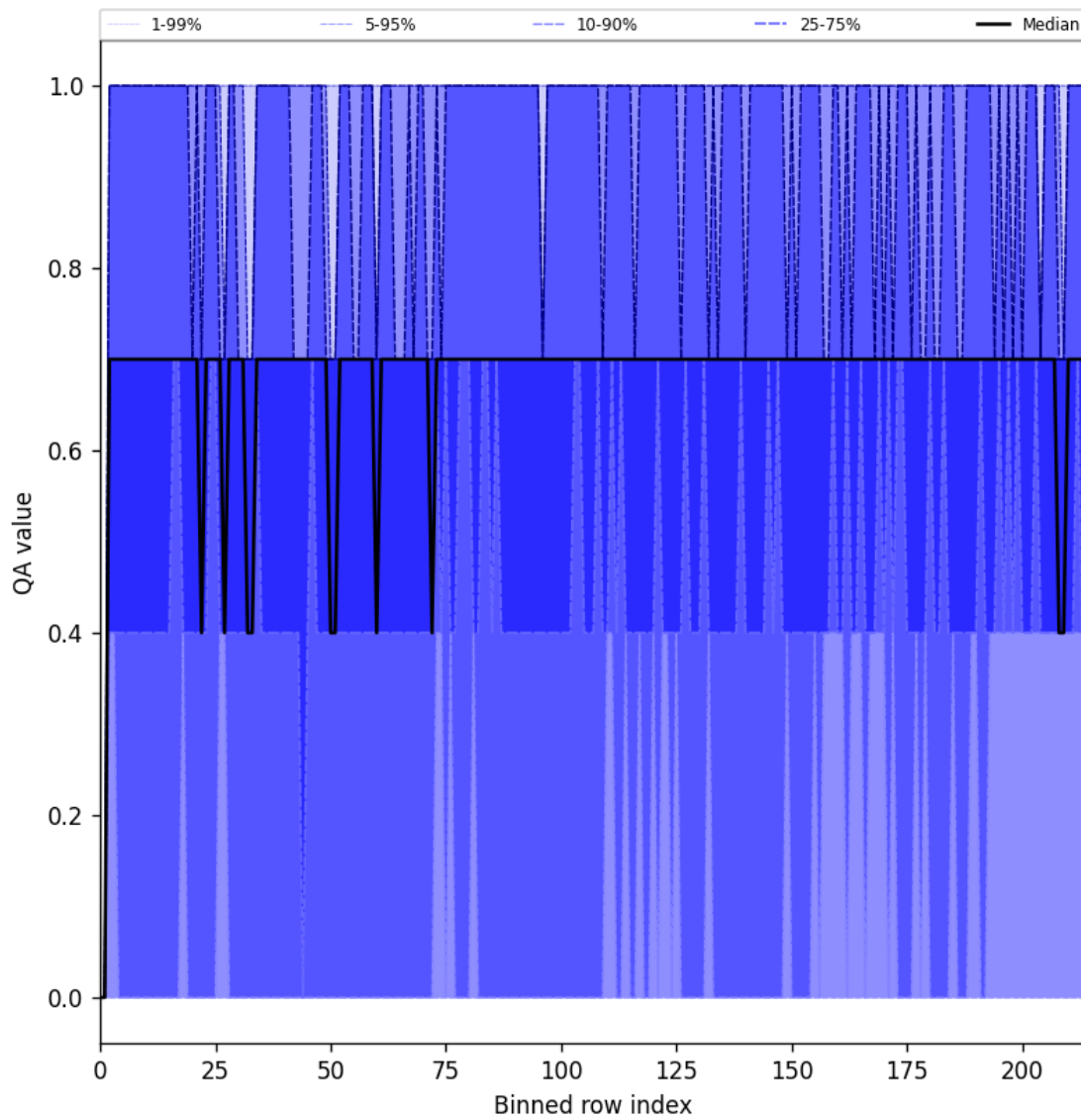


Figure 20: Along track statistics of “QA value” for 2025-05-01 to 2025-05-02

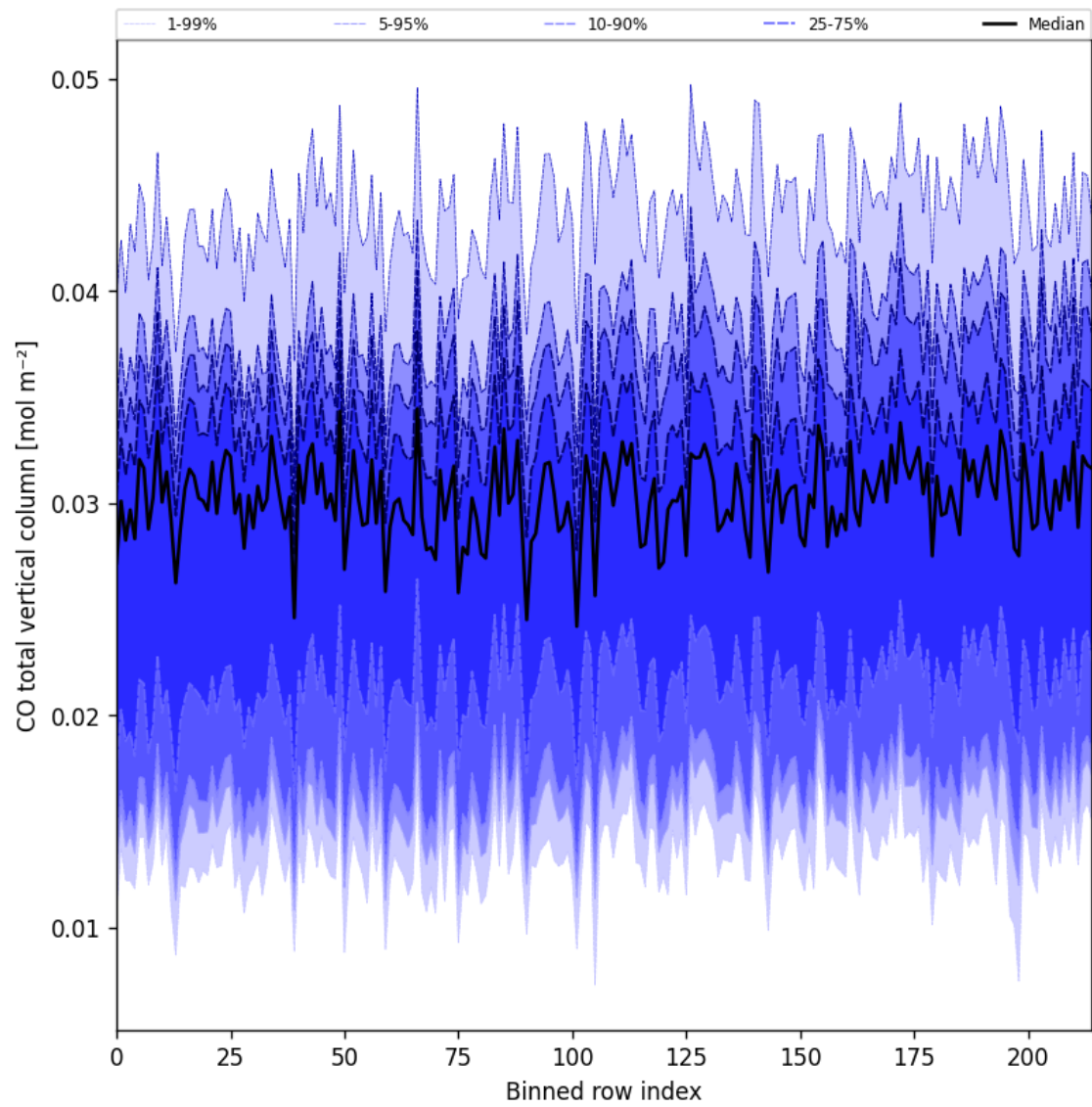


Figure 21: Along track statistics of “CO total vertical column” for 2025-05-01 to 2025-05-02

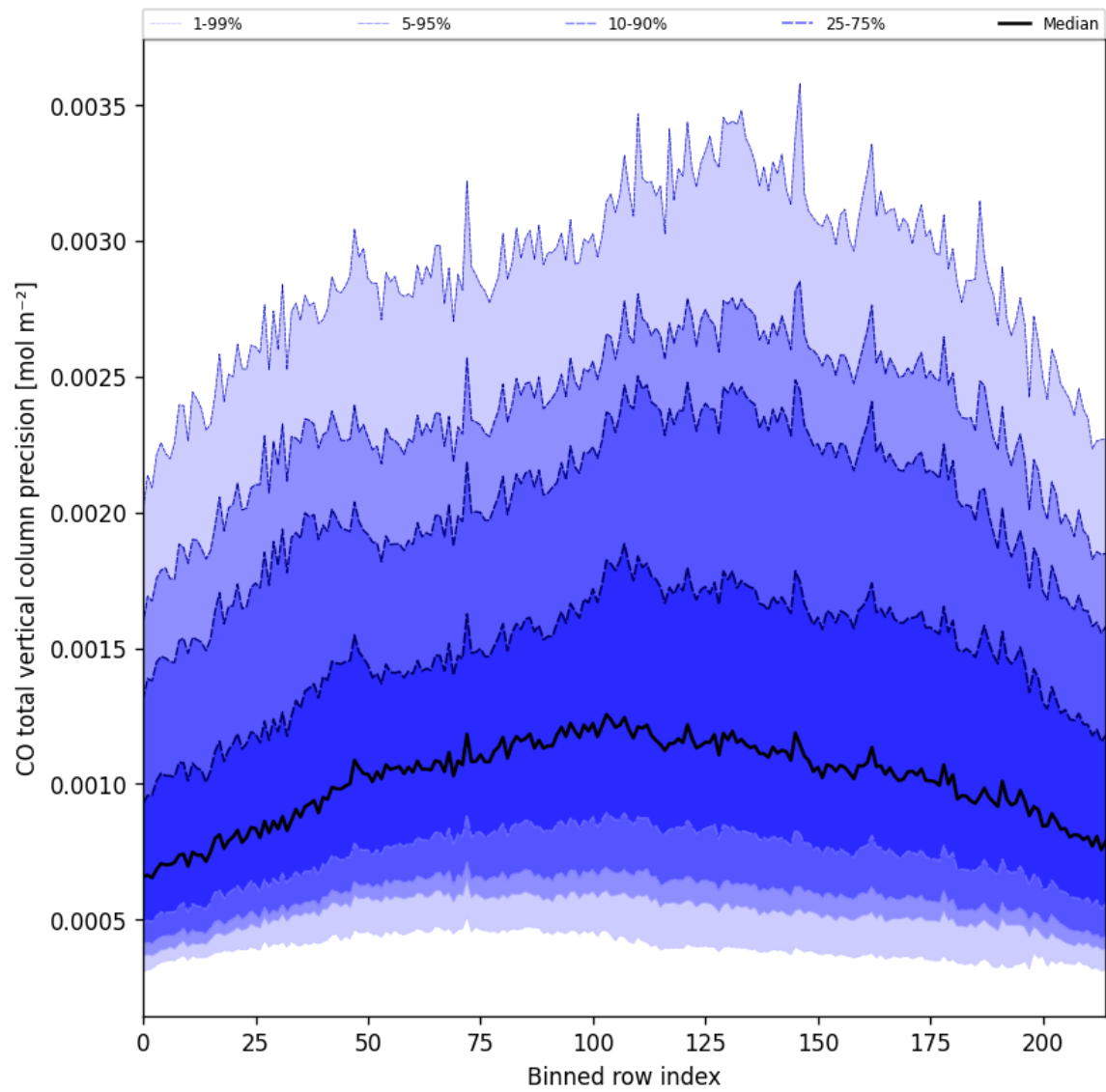


Figure 22: Along track statistics of “CO total vertical column precision” for 2025-05-01 to 2025-05-02



Figure 23: Along track statistics of “Number of spectral points in retrieval” for 2025-05-01 to 2025-05-02

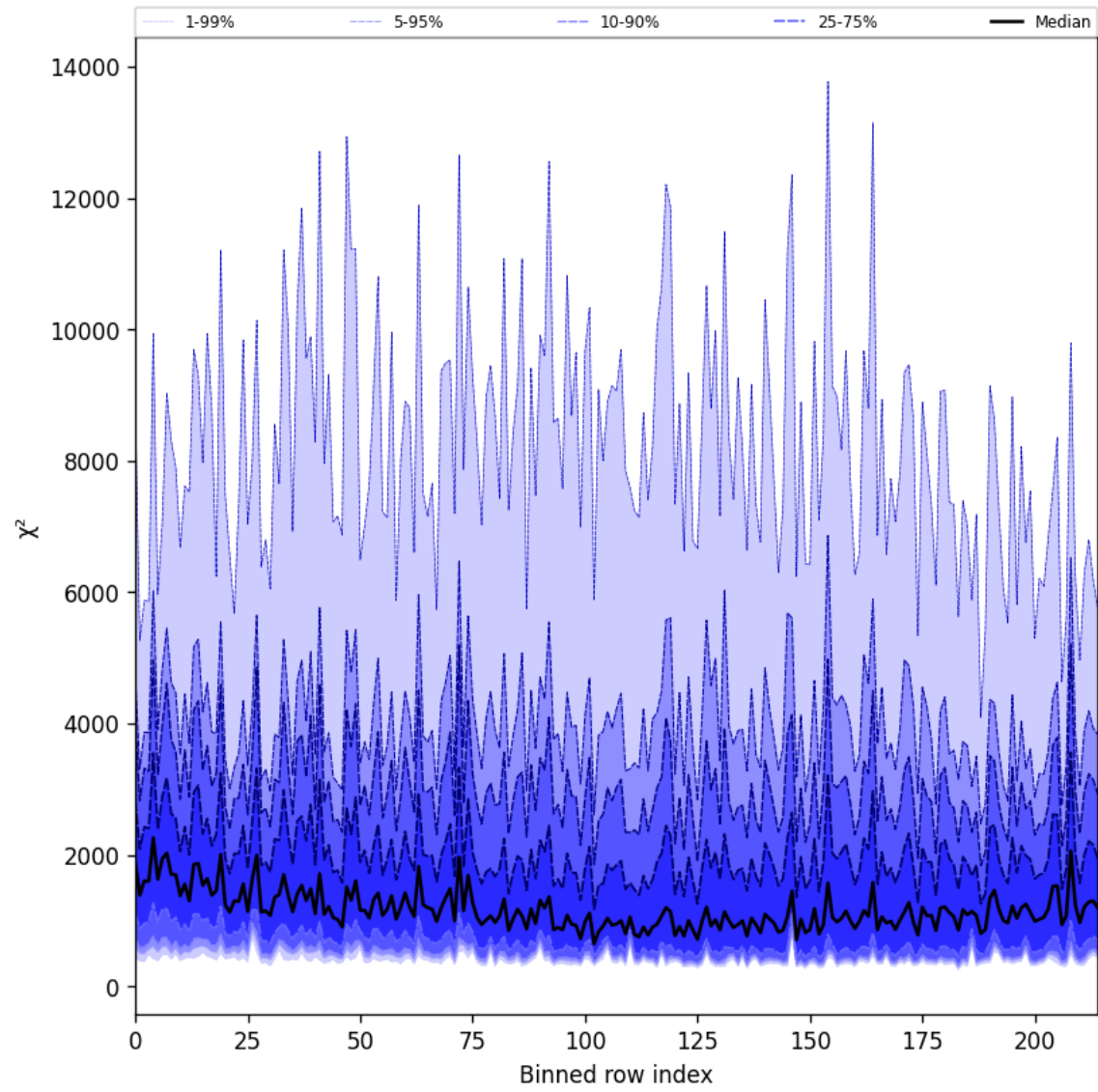


Figure 24: Along track statistics of “ χ^2 ” for 2025-05-01 to 2025-05-02

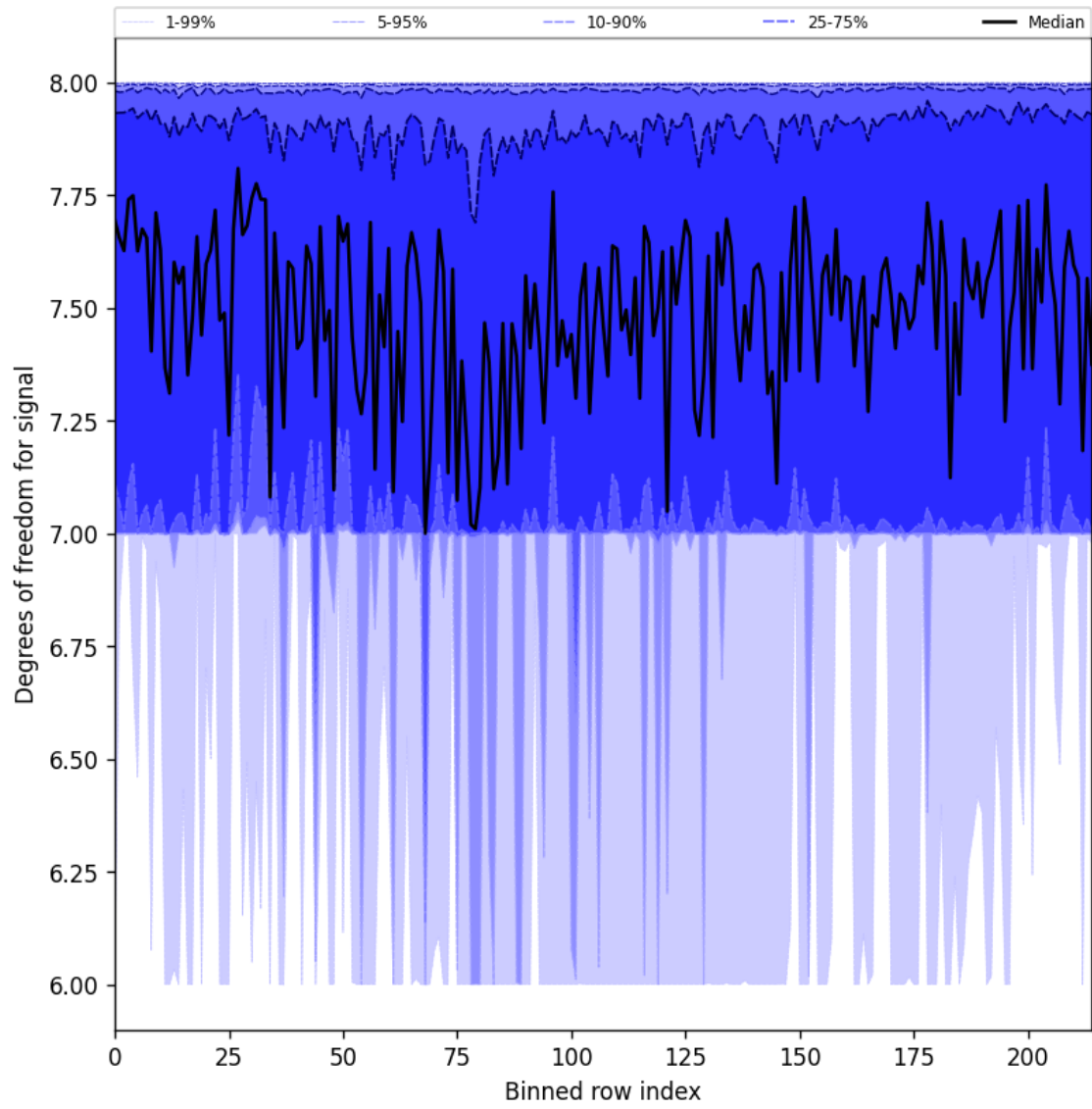


Figure 25: Along track statistics of “Degrees of freedom for signal” for 2025-05-01 to 2025-05-02

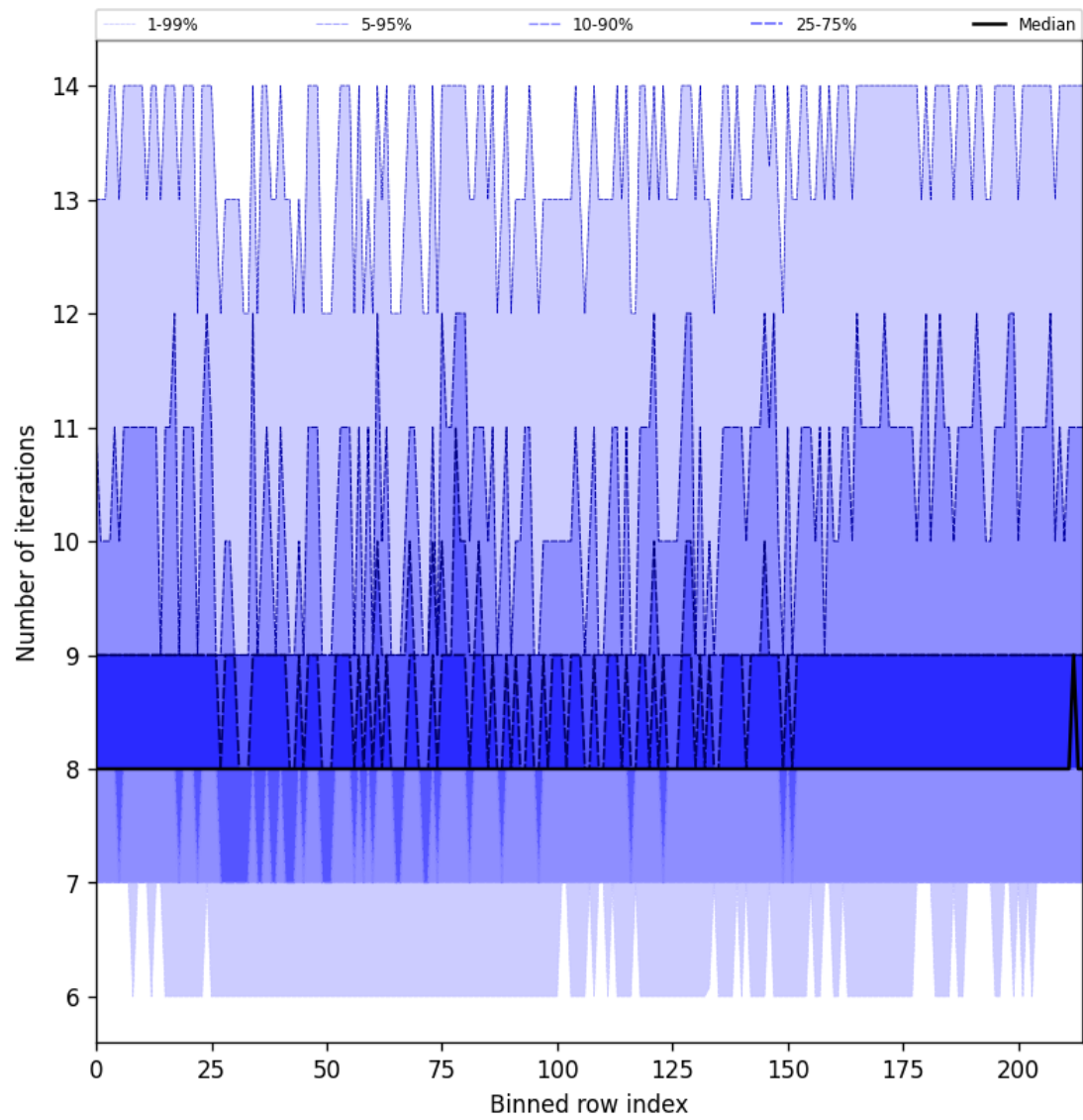


Figure 26: Along track statistics of “Number of iterations” for 2025-05-01 to 2025-05-02

10 Coincidence density

To investigate the relation between parameters scatter density plots are produced. These include some ‘hidden’ parameters, latitude and the solar- and viewing geometries, in addition to all configured parameters. All combinations of pairs of parameters are included *once*, in one direction alone.

Contents

1	Short Introduction	1
1.1	The list of parameters	1
2	Definitions	1
3	Granule outlines	8
4	Input data monitoring	9
5	Warnings and errors	10
6	World maps	11
7	Zonal average	13
8	Histograms	20
9	Along track statistics	27
10	Coincidence density	34
11	Copyright information of ‘PyCAMA’	34

List of Figures

1	Outline of the granules.	8
2	Input data per granule	9
3	Fraction of pixels with specific warnings and errors during processing	10
4	Map of “CO total vertical column” for 2025-05-01 to 2025-05-02	11
5	Map of the number of observations for 2025-05-01 to 2025-05-02	12
6	Zonal average of “QA value” for 2025-05-01 to 2025-05-02.	13
7	Zonal average of “CO total vertical column” for 2025-05-01 to 2025-05-02.	14
8	Zonal average of “CO total vertical column precision” for 2025-05-01 to 2025-05-02.	15
9	Zonal average of “Number of spectral points in retrieval” for 2025-05-01 to 2025-05-02.	16
10	Zonal average of “ χ^2 ” for 2025-05-01 to 2025-05-02.	17
11	Zonal average of “Degrees of freedom for signal” for 2025-05-01 to 2025-05-02.	18
12	Zonal average of “Number of iterations” for 2025-05-01 to 2025-05-02.	19
13	Histogram of “QA value” for 2025-05-01 to 2025-05-02	20
14	Histogram of “CO total vertical column” for 2025-05-01 to 2025-05-02	21
15	Histogram of “CO total vertical column precision” for 2025-05-01 to 2025-05-02	22
16	Histogram of “Number of spectral points in retrieval” for 2025-05-01 to 2025-05-02	23
17	Histogram of “ χ^2 ” for 2025-05-01 to 2025-05-02	24
18	Histogram of “Degrees of freedom for signal” for 2025-05-01 to 2025-05-02	25
19	Histogram of “Number of iterations” for 2025-05-01 to 2025-05-02	26
20	Along track statistics of “QA value” for 2025-05-01 to 2025-05-02	27
21	Along track statistics of “CO total vertical column” for 2025-05-01 to 2025-05-02	28
22	Along track statistics of “CO total vertical column precision” for 2025-05-01 to 2025-05-02	29
23	Along track statistics of “Number of spectral points in retrieval” for 2025-05-01 to 2025-05-02	30
24	Along track statistics of “ χ^2 ” for 2025-05-01 to 2025-05-02	31
25	Along track statistics of “Degrees of freedom for signal” for 2025-05-01 to 2025-05-02	32
26	Along track statistics of “Number of iterations” for 2025-05-01 to 2025-05-02	33

List of Tables

1	Parameterlist and basic statistics for the analysis	2
2	Percentile ranges	3
3	Parameterlist and basic statistics for the analysis for observations in the northern hemisphere	4
4	Parameterlist and basic statistics for the analysis for observations in the southern hemisphere	5
5	Parameterlist and basic statistics for the analysis for observations over water	6
6	Parameterlist and basic statistics for the analysis for observations over land	7

11 Copyright information of ‘PyCAMA’

Copyright © 2005 – 2023, Maarten Sneep (KNMI).

All rights reserved.

Redistribution and use in source and binary forms, with or without modification, are permitted provided that the following conditions are met:

1. Redistributions of source code must retain the above copyright notice, this list of conditions and the following disclaimer.
2. Redistributions in binary form must reproduce the above copyright notice, this list of conditions and the following disclaimer in the documentation and/or other materials provided with the distribution.
3. Neither the name of the copyright holder nor the names of its contributors may be used to endorse or promote products derived from this software without specific prior written permission.

This software is provided by the copyright holders and contributors “as is” and any express or implied warranties, including, but not limited to, the implied warranties of merchantability and fitness for a particular purpose are disclaimed. In no event shall the copyright holder or contributors be liable for any direct, indirect, incidental, special, exemplary, or consequential damages (including, but not limited to, procurement of substitute goods or services; loss of use, data, or profits; or business interruption) however caused and on any theory of liability, whether in contract, strict liability, or tort (including negligence or otherwise) arising in any way out of the use of this software, even if advised of the possibility of such damage.

Maarten Sneep (maarten.sneep@knmi.nl).