

# PyCAMA report generated by tropl2-proc

tropl2-proc

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## 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]                    | $0.640 \pm 0.389$                  | 19725984 | 0.995                  | 0.710                  | 0.870                  | 0.0                     | 1.000               |
| cloud fraction [1]              | $0.545 \pm 0.350$                  | 19725984 | 0.995                  | 0.745                  | 0.504                  | $7.528 \times 10^{-3}$  | 1.000               |
| cloud top height [m]            | $(0.411 \pm 0.295) \times 10^4$    | 19725984 | $1.575 \times 10^3$    | $3.884 \times 10^3$    | $3.388 \times 10^3$    | 0.0                     | $2.000 \times 10^4$ |
| cloud optical thickness [1]     | $25.8 \pm 45.6$                    | 19725984 | 10.7                   | 13.6                   | 11.7                   | 1.000                   | 250                 |
| cloud fraction crb [1]          | $0.543 \pm 0.351$                  | 19725984 | 0.995                  | 0.745                  | 0.501                  | $7.525 \times 10^{-3}$  | 1.000               |
| cloud height crb [m]            | $(0.328 \pm 0.245) \times 10^4$    | 19725984 | $1.125 \times 10^3$    | $3.410 \times 10^3$    | $2.709 \times 10^3$    | 0.0                     | $2.000 \times 10^4$ |
| cloud albedo crb [1]            | $0.631 \pm 0.190$                  | 19725984 | 0.995                  | 0.234                  | 0.608                  | 0.0                     | 1.000               |
| surface albedo fitted [1]       | $0.184 \pm 0.244$                  | 19725984 | $2.500 \times 10^{-2}$ | 0.204                  | $5.367 \times 10^{-2}$ | 0.0                     | 1.000               |
| surface albedo fitted crb [1]   | $0.168 \pm 0.228$                  | 19725984 | $1.500 \times 10^{-2}$ | 0.204                  | $3.718 \times 10^{-2}$ | 0.0                     | 1.000               |
| fitted root mean square [1]     | $(5.907 \pm 7.398) \times 10^{-4}$ | 19725984 | $5.000 \times 10^{-5}$ | $6.783 \times 10^{-4}$ | $3.585 \times 10^{-4}$ | $1.726 \times 10^{-6}$  | 0.526               |
| fitted root mean square crb [1] | $(5.159 \pm 6.779) \times 10^{-4}$ | 19725984 | $5.000 \times 10^{-5}$ | $5.833 \times 10^{-4}$ | $2.799 \times 10^{-4}$ | $1.224 \times 10^{-6}$  | 0.343               |
| wavelength shift [nm]           | $(8.616 \pm 7.101) \times 10^{-3}$ | 19725984 | $5.700 \times 10^{-3}$ | $9.765 \times 10^{-3}$ | $8.108 \times 10^{-3}$ | $-5.041 \times 10^{-2}$ | 0.121               |
| cloud fraction apriori [1]      | $0.546 \pm 0.357$                  | 19725984 | 0.995                  | 0.797                  | 0.506                  | 0.0                     | 1.000               |
| reflectance blue ocra [1]       | $0.541 \pm 0.217$                  | 19725984 | 0.295                  | 0.357                  | 0.506                  | 0.126                   | 1.99                |
| reflectance green ocra [1]      | $0.489 \pm 0.244$                  | 19725984 | 0.195                  | 0.423                  | 0.455                  | $8.199 \times 10^{-2}$  | 1.90                |
| reflectance continuum aband [1] | $0.445 \pm 0.268$                  | 19725984 | $4.500 \times 10^{-2}$ | 0.436                  | 0.426                  | $9.311 \times 10^{-3}$  | 3.75                |



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                    | 0.0                    | 0.250                  | 0.960                  | 1.000                  | 1.000                  | 1.000                  | 1.000                  |
| cloud fraction [1]              | $2.383 \times 10^{-2}$  | $5.961 \times 10^{-2}$  | $9.414 \times 10^{-2}$ | 0.136                  | 0.211                  | 0.956                  | 1.000                  | 1.000                  | 1.000                  | 1.000                  |
| cloud top height [m]            | 265                     | 742                     | $1.089 \times 10^3$    | $1.396 \times 10^3$    | $1.837 \times 10^3$    | $5.721 \times 10^3$    | $7.052 \times 10^3$    | $8.275 \times 10^3$    | $9.860 \times 10^3$    | $1.312 \times 10^4$    |
| cloud optical thickness [1]     | 1.56                    | 3.67                    | 4.82                   | 5.74                   | 7.38                   | 21.0                   | 32.3                   | 50.4                   | 102                    | 250                    |
| cloud fraction crb [1]          | $2.358 \times 10^{-2}$  | $5.882 \times 10^{-2}$  | $9.343 \times 10^{-2}$ | 0.135                  | 0.209                  | 0.955                  | 1.000                  | 1.000                  | 1.000                  | 1.000                  |
| cloud height crb [m]            | 14.1                    | 399                     | 668                    | 936                    | $1.312 \times 10^3$    | $4.721 \times 10^3$    | $5.879 \times 10^3$    | $6.881 \times 10^3$    | $8.157 \times 10^3$    | $1.020 \times 10^4$    |
| cloud albedo crb [1]            | 0.146                   | 0.346                   | 0.426                  | 0.468                  | 0.511                  | 0.745                  | 0.833                  | 0.925                  | 1.000                  | 1.000                  |
| surface albedo fitted [1]       | 0.0                     | $1.026 \times 10^{-2}$  | $1.487 \times 10^{-2}$ | $1.894 \times 10^{-2}$ | $2.506 \times 10^{-2}$ | 0.229                  | 0.439                  | 0.647                  | 0.757                  | 0.912                  |
| surface albedo fitted crb [1]   | $1.318 \times 10^{-3}$  | $7.614 \times 10^{-3}$  | $1.079 \times 10^{-2}$ | $1.379 \times 10^{-2}$ | $1.815 \times 10^{-2}$ | 0.222                  | 0.423                  | 0.602                  | 0.686                  | 0.844                  |
| fitted root mean square [1]     | $1.768 \times 10^{-5}$  | $3.611 \times 10^{-5}$  | $5.785 \times 10^{-5}$ | $8.599 \times 10^{-5}$ | $1.358 \times 10^{-4}$ | $8.141 \times 10^{-4}$ | $1.112 \times 10^{-3}$ | $1.415 \times 10^{-3}$ | $1.880 \times 10^{-3}$ | $3.054 \times 10^{-3}$ |
| fitted root mean square crb [1] | $1.030 \times 10^{-5}$  | $2.425 \times 10^{-5}$  | $4.040 \times 10^{-5}$ | $6.068 \times 10^{-5}$ | $9.913 \times 10^{-5}$ | $6.824 \times 10^{-4}$ | $9.891 \times 10^{-4}$ | $1.318 \times 10^{-3}$ | $1.808 \times 10^{-3}$ | $2.950 \times 10^{-3}$ |
| wavelength shift [nm]           | $-7.526 \times 10^{-3}$ | $-5.938 \times 10^{-4}$ | $5.017 \times 10^{-4}$ | $1.632 \times 10^{-3}$ | $3.444 \times 10^{-3}$ | $1.321 \times 10^{-2}$ | $1.565 \times 10^{-2}$ | $1.780 \times 10^{-2}$ | $2.069 \times 10^{-2}$ | $2.698 \times 10^{-2}$ |
| cloud fraction apriori [1]      | $1.102 \times 10^{-2}$  | $5.603 \times 10^{-2}$  | $8.646 \times 10^{-2}$ | 0.127                  | 0.203                  | 1.000                  | 1.000                  | 1.000                  | 1.000                  | 1.000                  |
| reflectance blue ocra [1]       | 0.229                   | 0.257                   | 0.282                  | 0.309                  | 0.354                  | 0.711                  | 0.784                  | 0.833                  | 0.901                  | 1.08                   |
| reflectance green ocra [1]      | 0.151                   | 0.175                   | 0.195                  | 0.220                  | 0.266                  | 0.688                  | 0.771                  | 0.827                  | 0.895                  | 1.05                   |
| reflectance continuum aband [1] | $3.188 \times 10^{-2}$  | $5.948 \times 10^{-2}$  | $9.511 \times 10^{-2}$ | 0.141                  | 0.218                  | 0.654                  | 0.744                  | 0.810                  | 0.885                  | 1.04                   |

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]                    | $0.679 \pm 0.370$                  | 10328603 | 0.570                  | 0.900                  | 0.0                     | 1.000               | 0.400                  | 0.970                  |
| cloud fraction [1]              | $0.581 \pm 0.357$                  | 10328603 | 0.773                  | 0.586                  | $7.528 \times 10^{-3}$  | 1.000               | 0.226                  | 0.999                  |
| cloud top height [m]            | $(0.424 \pm 0.264) \times 10^4$    | 10328603 | $3.651 \times 10^3$    | $3.749 \times 10^3$    | 0.0                     | $2.000 \times 10^4$ | $2.150 \times 10^3$    | $5.800 \times 10^3$    |
| cloud optical thickness [1]     | $23.7 \pm 36.0$                    | 10328603 | 15.4                   | 12.2                   | 1.000                   | 250                 | 7.74                   | 23.1                   |
| cloud fraction crb [1]          | $0.580 \pm 0.358$                  | 10328603 | 0.774                  | 0.583                  | $7.525 \times 10^{-3}$  | 1.000               | 0.224                  | 0.998                  |
| cloud height crb [m]            | $(0.346 \pm 0.229) \times 10^4$    | 10328603 | $3.216 \times 10^3$    | $3.060 \times 10^3$    | 0.0                     | $2.000 \times 10^4$ | $1.609 \times 10^3$    | $4.824 \times 10^3$    |
| cloud albedo crb [1]            | $0.620 \pm 0.171$                  | 10328603 | 0.216                  | 0.609                  | 0.0                     | 1.000               | 0.512                  | 0.729                  |
| surface albedo fitted [1]       | $0.148 \pm 0.178$                  | 10328603 | 0.176                  | $7.096 \times 10^{-2}$ | 0.0                     | 1.000               | $2.811 \times 10^{-2}$ | 0.204                  |
| surface albedo fitted crb [1]   | $0.138 \pm 0.175$                  | 10328603 | 0.178                  | $4.899 \times 10^{-2}$ | 0.0                     | 1.000               | $2.027 \times 10^{-2}$ | 0.198                  |
| fitted root mean square [1]     | $(5.764 \pm 8.120) \times 10^{-4}$ | 10328603 | $6.354 \times 10^{-4}$ | $3.131 \times 10^{-4}$ | $1.726 \times 10^{-6}$  | 0.526               | $1.286 \times 10^{-4}$ | $7.639 \times 10^{-4}$ |
| fitted root mean square crb [1] | $(5.457 \pm 7.623) \times 10^{-4}$ | 10328603 | $6.496 \times 10^{-4}$ | $2.721 \times 10^{-4}$ | $1.224 \times 10^{-6}$  | 0.343               | $8.988 \times 10^{-5}$ | $7.395 \times 10^{-4}$ |
| wavelength shift [nm]           | $(8.196 \pm 6.902) \times 10^{-3}$ | 10328603 | $9.302 \times 10^{-3}$ | $7.611 \times 10^{-3}$ | $-4.659 \times 10^{-2}$ | 0.121               | $3.242 \times 10^{-3}$ | $1.254 \times 10^{-2}$ |
| cloud fraction apriori [1]      | $0.582 \pm 0.364$                  | 10328603 | 0.783                  | 0.590                  | 0.0                     | 1.000               | 0.217                  | 1.000                  |
| reflectance blue ocra [1]       | $0.520 \pm 0.204$                  | 10328603 | 0.323                  | 0.489                  | 0.126                   | 1.92                | 0.347                  | 0.670                  |
| reflectance green ocra [1]      | $0.468 \pm 0.229$                  | 10328603 | 0.386                  | 0.437                  | $8.199 \times 10^{-2}$  | 1.86                | 0.261                  | 0.647                  |
| reflectance continuum aband [1] | $0.437 \pm 0.253$                  | 10328603 | 0.395                  | 0.415                  | $9.311 \times 10^{-3}$  | 3.75                | 0.230                  | 0.626                  |

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]                    | $0.597 \pm 0.404$                  | 9397381 | 0.800                  | 0.850                  | 0.0                     | 1.000                  | 0.150                  | 0.950                  |
| cloud fraction [1]              | $0.504 \pm 0.338$                  | 9397381 | 0.655                  | 0.437                  | $7.531 \times 10^{-3}$  | 1.000                  | 0.197                  | 0.852                  |
| cloud top height [m]            | $(0.398 \pm 0.324) \times 10^4$    | 9397381 | $4.000 \times 10^3$    | $2.916 \times 10^3$    | 0.0                     | $2.000 \times 10^4$    | $1.598 \times 10^3$    | $5.598 \times 10^3$    |
| cloud optical thickness [1]     | $28.1 \pm 54.0$                    | 9397381 | 11.8                   | 11.2                   | 1.000                   | 250                    | 6.98                   | 18.7                   |
| cloud fraction crb [1]          | $0.503 \pm 0.338$                  | 9397381 | 0.653                  | 0.434                  | $8.572 \times 10^{-3}$  | 1.000                  | 0.197                  | 0.850                  |
| cloud height crb [m]            | $(0.309 \pm 0.260) \times 10^4$    | 9397381 | $3.484 \times 10^3$    | $2.245 \times 10^3$    | 0.0                     | $2.000 \times 10^4$    | $1.086 \times 10^3$    | $4.570 \times 10^3$    |
| cloud albedo crb [1]            | $0.643 \pm 0.207$                  | 9397381 | 0.264                  | 0.606                  | 0.0                     | 1.000                  | 0.509                  | 0.774                  |
| surface albedo fitted [1]       | $0.223 \pm 0.296$                  | 9397381 | 0.439                  | $4.231 \times 10^{-2}$ | 0.0                     | 1.000                  | $2.293 \times 10^{-2}$ | 0.462                  |
| surface albedo fitted crb [1]   | $0.200 \pm 0.272$                  | 9397381 | 0.423                  | $2.994 \times 10^{-2}$ | 0.0                     | 1.000                  | $1.657 \times 10^{-2}$ | 0.440                  |
| fitted root mean square [1]     | $(6.063 \pm 6.510) \times 10^{-4}$ | 9397381 | $7.081 \times 10^{-4}$ | $4.138 \times 10^{-4}$ | $2.476 \times 10^{-6}$  | $5.004 \times 10^{-2}$ | $1.484 \times 10^{-4}$ | $8.566 \times 10^{-4}$ |
| fitted root mean square crb [1] | $(4.832 \pm 5.690) \times 10^{-4}$ | 9397381 | $5.237 \times 10^{-4}$ | $2.868 \times 10^{-4}$ | $2.934 \times 10^{-6}$  | $2.976 \times 10^{-2}$ | $1.099 \times 10^{-4}$ | $6.336 \times 10^{-4}$ |
| wavelength shift [nm]           | $(9.079 \pm 7.286) \times 10^{-3}$ | 9397381 | $1.020 \times 10^{-2}$ | $8.717 \times 10^{-3}$ | $-5.041 \times 10^{-2}$ | $6.147 \times 10^{-2}$ | $3.694 \times 10^{-3}$ | $1.390 \times 10^{-2}$ |
| cloud fraction apriori [1]      | $0.506 \pm 0.345$                  | 9397381 | 0.684                  | 0.438                  | 0.0                     | 1.000                  | 0.190                  | 0.874                  |
| reflectance blue ocrs [1]       | $0.563 \pm 0.229$                  | 9397381 | 0.393                  | 0.528                  | 0.152                   | 1.99                   | 0.363                  | 0.757                  |
| reflectance green ocrs [1]      | $0.511 \pm 0.259$                  | 9397381 | 0.465                  | 0.478                  | $8.604 \times 10^{-2}$  | 1.90                   | 0.271                  | 0.736                  |
| reflectance continuum aband [1] | $0.454 \pm 0.284$                  | 9397381 | 0.480                  | 0.441                  | $1.322 \times 10^{-2}$  | 3.49                   | 0.204                  | 0.684                  |

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]                    | $0.678 \pm 0.363$                   | 13670746 | 0.560                  | 0.900                  | 0.0                     | 1.000               | 0.400                  | 0.960                  |
| cloud fraction [1]              | $0.548 \pm 0.348$                   | 13670746 | 0.730                  | 0.518                  | $7.531 \times 10^{-3}$  | 1.000               | 0.216                  | 0.946                  |
| cloud top height [m]            | $(0.383 \pm 0.279) \times 10^4$     | 13670746 | $3.578 \times 10^3$    | $3.053 \times 10^3$    | 0.0                     | $2.000 \times 10^4$ | $1.711 \times 10^3$    | $5.288 \times 10^3$    |
| cloud optical thickness [1]     | $25.6 \pm 43.5$                     | 13670746 | 12.9                   | 12.3                   | 1.000                   | 250                 | 8.40                   | 21.3                   |
| cloud fraction crb [1]          | $0.546 \pm 0.348$                   | 13670746 | 0.731                  | 0.515                  | $8.619 \times 10^{-3}$  | 1.000               | 0.213                  | 0.945                  |
| cloud height crb [m]            | $(0.304 \pm 0.238) \times 10^4$     | 13670746 | $3.188 \times 10^3$    | $2.391 \times 10^3$    | 0.0                     | $2.000 \times 10^4$ | $1.170 \times 10^3$    | $4.358 \times 10^3$    |
| cloud albedo crb [1]            | $0.612 \pm 0.173$                   | 13670746 | 0.205                  | 0.593                  | 0.0                     | 1.000               | 0.505                  | 0.710                  |
| surface albedo fitted [1]       | $0.111 \pm 0.202$                   | 13670746 | $4.037 \times 10^{-2}$ | $3.291 \times 10^{-2}$ | 0.0                     | 1.000               | $1.997 \times 10^{-2}$ | $6.035 \times 10^{-2}$ |
| surface albedo fitted crb [1]   | $(9.603 \pm 18.815) \times 10^{-2}$ | 13670746 | $2.693 \times 10^{-2}$ | $2.349 \times 10^{-2}$ | 0.0                     | 1.000               | $1.452 \times 10^{-2}$ | $4.145 \times 10^{-2}$ |
| fitted root mean square [1]     | $(5.194 \pm 7.005) \times 10^{-4}$  | 13670746 | $6.126 \times 10^{-4}$ | $2.728 \times 10^{-4}$ | $1.726 \times 10^{-6}$  | 0.526               | $1.042 \times 10^{-4}$ | $7.168 \times 10^{-4}$ |
| fitted root mean square crb [1] | $(4.716 \pm 6.644) \times 10^{-4}$  | 13670746 | $5.414 \times 10^{-4}$ | $2.234 \times 10^{-4}$ | $1.224 \times 10^{-6}$  | 0.343               | $7.995 \times 10^{-5}$ | $6.214 \times 10^{-4}$ |
| wavelength shift [nm]           | $(8.377 \pm 7.383) \times 10^{-3}$  | 13670746 | $1.019 \times 10^{-2}$ | $7.695 \times 10^{-3}$ | $-5.041 \times 10^{-2}$ | 0.121               | $2.991 \times 10^{-3}$ | $1.318 \times 10^{-2}$ |
| cloud fraction apriori [1]      | $0.548 \pm 0.355$                   | 13670746 | 0.778                  | 0.520                  | 0.0                     | 1.000               | 0.206                  | 0.984                  |
| reflectance blue ocr [1]        | $0.520 \pm 0.198$                   | 13670746 | 0.314                  | 0.486                  | 0.156                   | 1.97                | 0.354                  | 0.668                  |
| reflectance green ocr [1]       | $0.462 \pm 0.224$                   | 13670746 | 0.377                  | 0.428                  | $8.402 \times 10^{-2}$  | 1.87                | 0.262                  | 0.639                  |
| reflectance continuum aband [1] | $0.395 \pm 0.258$                   | 13670746 | 0.439                  | 0.372                  | $1.186 \times 10^{-2}$  | 3.75                | 0.159                  | 0.598                  |

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]                    | $0.494 \pm 0.441$                  | 4371390 | 0.950                  | 0.570                  | 0.0                     | 1.000                  | 0.0                    | 0.950                  |
| cloud fraction [1]              | $0.494 \pm 0.348$                  | 4371390 | 0.711                  | 0.395                  | $7.528 \times 10^{-3}$  | 1.000                  | 0.182                  | 0.893                  |
| cloud top height [m]            | $(0.512 \pm 0.337) \times 10^4$    | 4371390 | $4.435 \times 10^3$    | $4.598 \times 10^3$    | 0.0                     | $2.000 \times 10^4$    | $2.538 \times 10^3$    | $6.973 \times 10^3$    |
| cloud optical thickness [1]     | $25.1 \pm 51.0$                    | 4371390 | 11.5                   | 8.66                   | 1.000                   | 250                    | 5.40                   | 16.9                   |
| cloud fraction crb [1]          | $0.494 \pm 0.347$                  | 4371390 | 0.709                  | 0.394                  | $7.525 \times 10^{-3}$  | 1.000                  | 0.183                  | 0.892                  |
| cloud height crb [m]            | $(0.408 \pm 0.263) \times 10^4$    | 4371390 | $3.789 \times 10^3$    | $3.649 \times 10^3$    | 0.0                     | $2.000 \times 10^4$    | $1.966 \times 10^3$    | $5.755 \times 10^3$    |
| cloud albedo crb [1]            | $0.693 \pm 0.224$                  | 4371390 | 0.357                  | 0.678                  | 0.0                     | 1.000                  | 0.537                  | 0.894                  |
| surface albedo fitted [1]       | $0.409 \pm 0.261$                  | 4371390 | 0.472                  | 0.279                  | $1.370 \times 10^{-3}$  | 1.000                  | 0.198                  | 0.671                  |
| surface albedo fitted crb [1]   | $0.385 \pm 0.234$                  | 4371390 | 0.437                  | 0.273                  | $6.084 \times 10^{-3}$  | 1.000                  | 0.193                  | 0.630                  |
| fitted root mean square [1]     | $(8.229 \pm 7.905) \times 10^{-4}$ | 4371390 | $7.397 \times 10^{-4}$ | $6.224 \times 10^{-4}$ | $4.208 \times 10^{-6}$  | 0.222                  | $3.337 \times 10^{-4}$ | $1.073 \times 10^{-3}$ |
| fitted root mean square crb [1] | $(6.534 \pm 7.083) \times 10^{-4}$ | 4371390 | $6.527 \times 10^{-4}$ | $4.337 \times 10^{-4}$ | $2.934 \times 10^{-6}$  | $2.992 \times 10^{-2}$ | $2.012 \times 10^{-4}$ | $8.538 \times 10^{-4}$ |
| wavelength shift [nm]           | $(9.125 \pm 6.384) \times 10^{-3}$ | 4371390 | $8.761 \times 10^{-3}$ | $8.816 \times 10^{-3}$ | $-4.659 \times 10^{-2}$ | $6.149 \times 10^{-2}$ | $4.499 \times 10^{-3}$ | $1.326 \times 10^{-2}$ |
| cloud fraction apriori [1]      | $0.499 \pm 0.354$                  | 4371390 | 0.758                  | 0.398                  | 0.0                     | 1.000                  | 0.179                  | 0.937                  |
| reflectance blue ocra [1]       | $0.603 \pm 0.263$                  | 4371390 | 0.465                  | 0.614                  | 0.126                   | 1.99                   | 0.349                  | 0.814                  |
| reflectance green ocra [1]      | $0.567 \pm 0.289$                  | 4371390 | 0.542                  | 0.591                  | $8.425 \times 10^{-2}$  | 1.90                   | 0.272                  | 0.813                  |
| reflectance continuum aband [1] | $0.581 \pm 0.257$                  | 4371390 | 0.433                  | 0.582                  | $1.273 \times 10^{-2}$  | 3.49                   | 0.350                  | 0.784                  |

Table 7: Correlation matrix

| Viewing zenith angle    | Solar zenith angle      | Latitude                | Radiometric cloud fraction | Cloud top height        | Cloud optical thickness | Cloud fraction (CRB)    | Cloud height (CRB)      | Cloud albedo (CRB)     | OCRA cloud fraction     |
|-------------------------|-------------------------|-------------------------|----------------------------|-------------------------|-------------------------|-------------------------|-------------------------|------------------------|-------------------------|
| 1.000                   | $2.023 \times 10^{-2}$  | $-1.056 \times 10^{-2}$ | $4.742 \times 10^{-2}$     | $2.716 \times 10^{-2}$  | $-1.028 \times 10^{-2}$ | $4.687 \times 10^{-2}$  | $6.468 \times 10^{-2}$  | $7.820 \times 10^{-2}$ | $4.549 \times 10^{-2}$  |
| $2.023 \times 10^{-2}$  | 1.000                   | $-1.832 \times 10^{-4}$ | 0.188                      | $5.671 \times 10^{-2}$  | 0.257                   | 0.188                   | $3.881 \times 10^{-2}$  | 0.263                  | 0.188                   |
| $-1.056 \times 10^{-2}$ | $-1.832 \times 10^{-4}$ | 1.000                   | 0.146                      | $-7.572 \times 10^{-2}$ | $-6.913 \times 10^{-2}$ | 0.145                   | $-4.097 \times 10^{-2}$ | -0.142                 | 0.142                   |
| $4.742 \times 10^{-2}$  | 0.188                   | 0.146                   | 1.000                      | $-7.029 \times 10^{-2}$ | 0.226                   | 1.000                   | $7.410 \times 10^{-3}$  | 0.139                  | 0.991                   |
| $2.716 \times 10^{-2}$  | $5.671 \times 10^{-2}$  | $-7.572 \times 10^{-2}$ | $-7.029 \times 10^{-2}$    | 1.000                   | 0.123                   | $-6.986 \times 10^{-2}$ | 0.950                   | 0.251                  | $-7.672 \times 10^{-2}$ |
| $-1.028 \times 10^{-2}$ | 0.257                   | $-6.913 \times 10^{-2}$ | 0.226                      | 0.123                   | 1.000                   | 0.221                   | 0.155                   | 0.483                  | 0.222                   |
| $4.687 \times 10^{-2}$  | 0.188                   | 0.145                   | 1.000                      | $-6.986 \times 10^{-2}$ | 0.221                   | 1.000                   | $7.649 \times 10^{-3}$  | 0.138                  | 0.991                   |
| $6.468 \times 10^{-2}$  | $3.881 \times 10^{-2}$  | $-4.097 \times 10^{-2}$ | $7.410 \times 10^{-3}$     | 0.950                   | 0.155                   | $7.649 \times 10^{-3}$  | 1.000                   | 0.189                  | $7.022 \times 10^{-4}$  |
| $7.820 \times 10^{-2}$  | 0.263                   | -0.142                  | 0.139                      | 0.251                   | 0.483                   | 0.138                   | 0.189                   | 1.000                  | 0.146                   |
| $4.549 \times 10^{-2}$  | 0.188                   | 0.142                   | 0.991                      | $-7.672 \times 10^{-2}$ | 0.222                   | 0.991                   | $7.022 \times 10^{-4}$  | 0.146                  | 1.000                   |

Table 8: Covariance matrix

| Viewing zenith angle | Solar zenith angle  | Latitude             | Radiometric cloud fraction | Cloud top height     | Cloud optical thickness | Cloud fraction (CRB)   | Cloud height (CRB)   | Cloud albedo (CRB)     | OCRA cloud fraction    |
|----------------------|---------------------|----------------------|----------------------------|----------------------|-------------------------|------------------------|----------------------|------------------------|------------------------|
| 384                  | 8.04                | -10.8                | 0.326                      | $1.568 \times 10^3$  | -9.18                   | 0.322                  | $3.106 \times 10^3$  | 0.291                  | 0.318                  |
| 8.04                 | 411                 | -0.193               | 1.33                       | $3.388 \times 10^3$  | 238                     | 1.34                   | $1.928 \times 10^3$  | 1.01                   | 1.36                   |
| -10.8                | -0.193              | $2.702 \times 10^3$  | 2.66                       | $-1.159 \times 10^4$ | -164                    | 2.65                   | $-5.216 \times 10^3$ | -1.40                  | 2.63                   |
| 0.326                | 1.33                | 2.66                 | 0.123                      | -72.6                | 3.61                    | 0.123                  | 6.36                 | $9.223 \times 10^{-3}$ | 0.124                  |
| $1.568 \times 10^3$  | $3.388 \times 10^3$ | $-1.159 \times 10^4$ | -72.6                      | $8.677 \times 10^6$  | $1.644 \times 10^4$     | -72.1                  | $6.856 \times 10^6$  | 140                    | -80.7                  |
| -9.18                | 238                 | -164                 | 3.61                       | $1.644 \times 10^4$  | $2.075 \times 10^3$     | 3.53                   | $1.726 \times 10^4$  | 4.17                   | 3.62                   |
| 0.322                | 1.34                | 2.65                 | 0.123                      | -72.1                | 3.53                    | 0.123                  | 6.57                 | $9.136 \times 10^{-3}$ | 0.124                  |
| $3.106 \times 10^3$  | $1.928 \times 10^3$ | $-5.216 \times 10^3$ | 6.36                       | $6.856 \times 10^6$  | $1.726 \times 10^4$     | 6.57                   | $5.999 \times 10^6$  | 87.6                   | 0.614                  |
| 0.291                | 1.01                | -1.40                | $9.223 \times 10^{-3}$     | 140                  | 4.17                    | $9.136 \times 10^{-3}$ | 87.6                 | $3.591 \times 10^{-2}$ | $9.904 \times 10^{-3}$ |
| 0.318                | 1.36                | 2.63                 | 0.124                      | -80.7                | 3.62                    | 0.124                  | 0.614                | $9.904 \times 10^{-3}$ | 0.128                  |

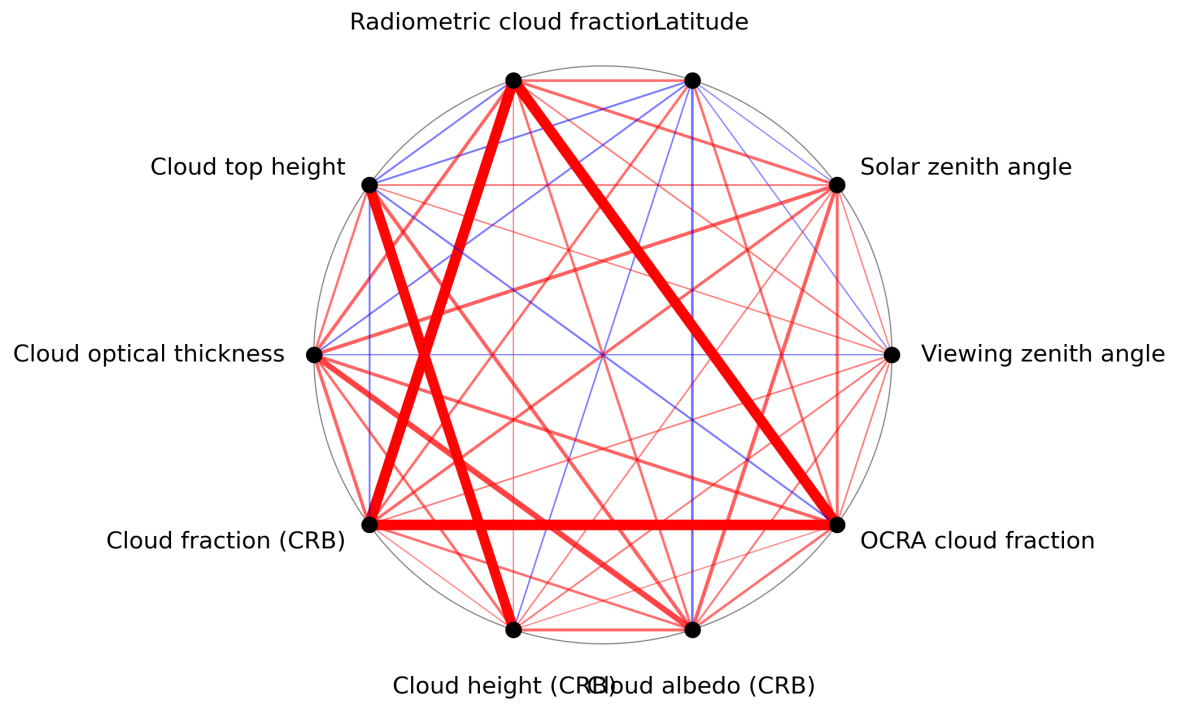


Figure 1: Map of correlation graph for 2023-09-20 to 2023-09-22.



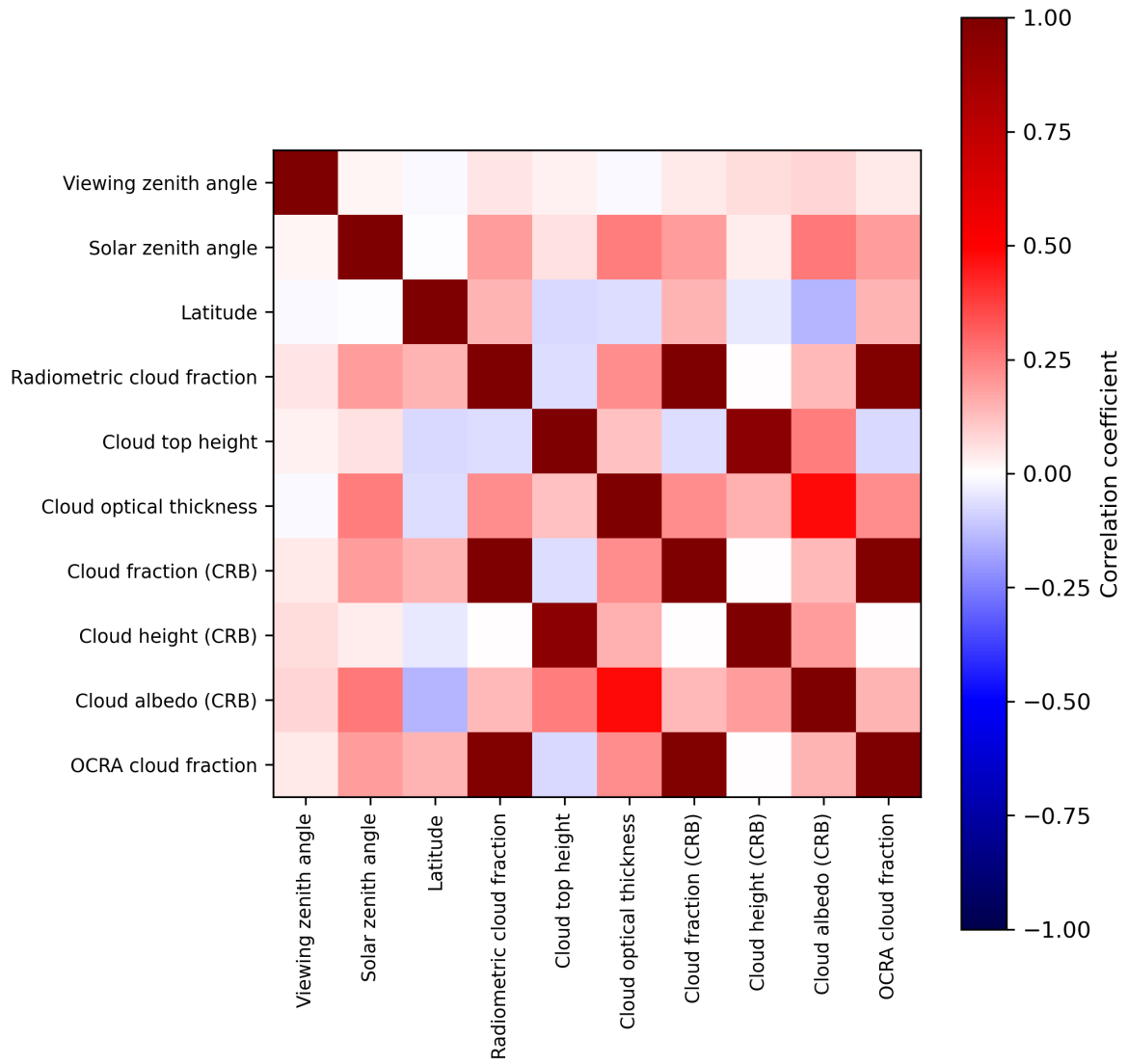


Figure 2: Map of correlation matrix for 2023-09-20 to 2023-09-22.

### 3 Granule outlines

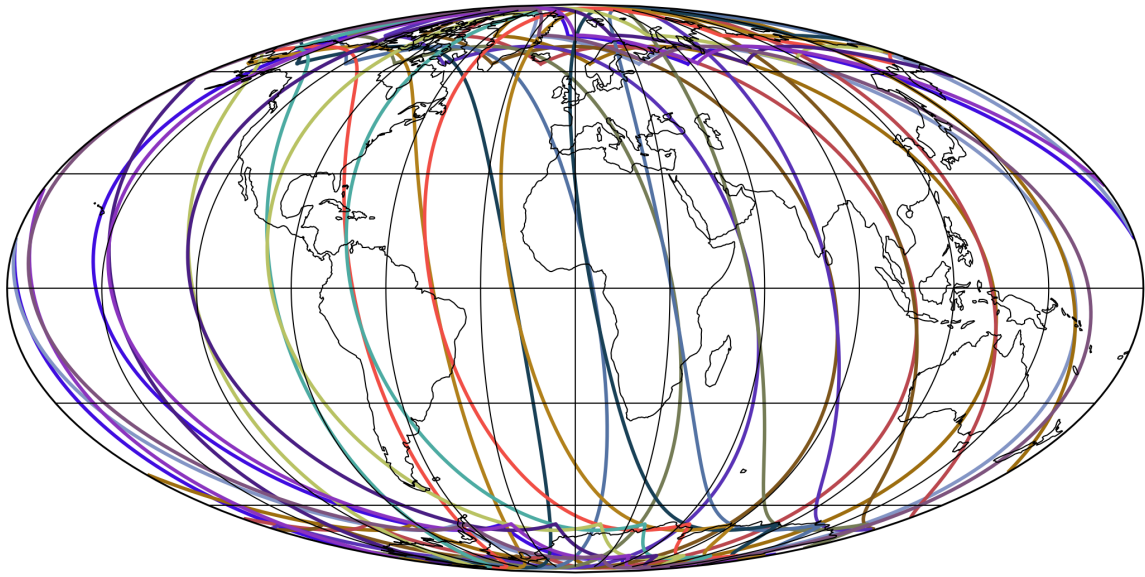


Figure 3: Outline of the granules.

## 4 Input data monitoring

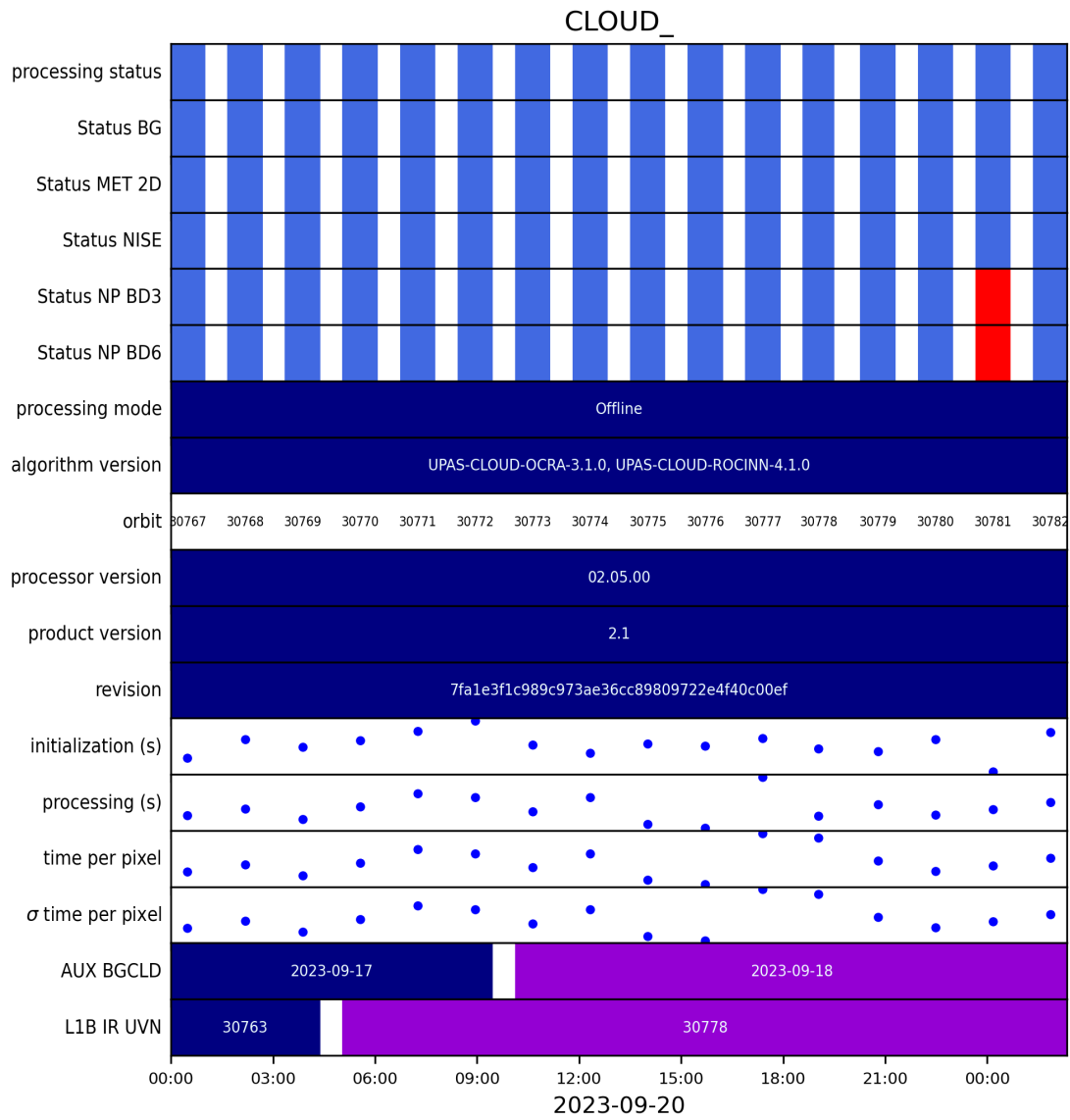


Figure 4: Input data per granule

## 5 Warnings and errors

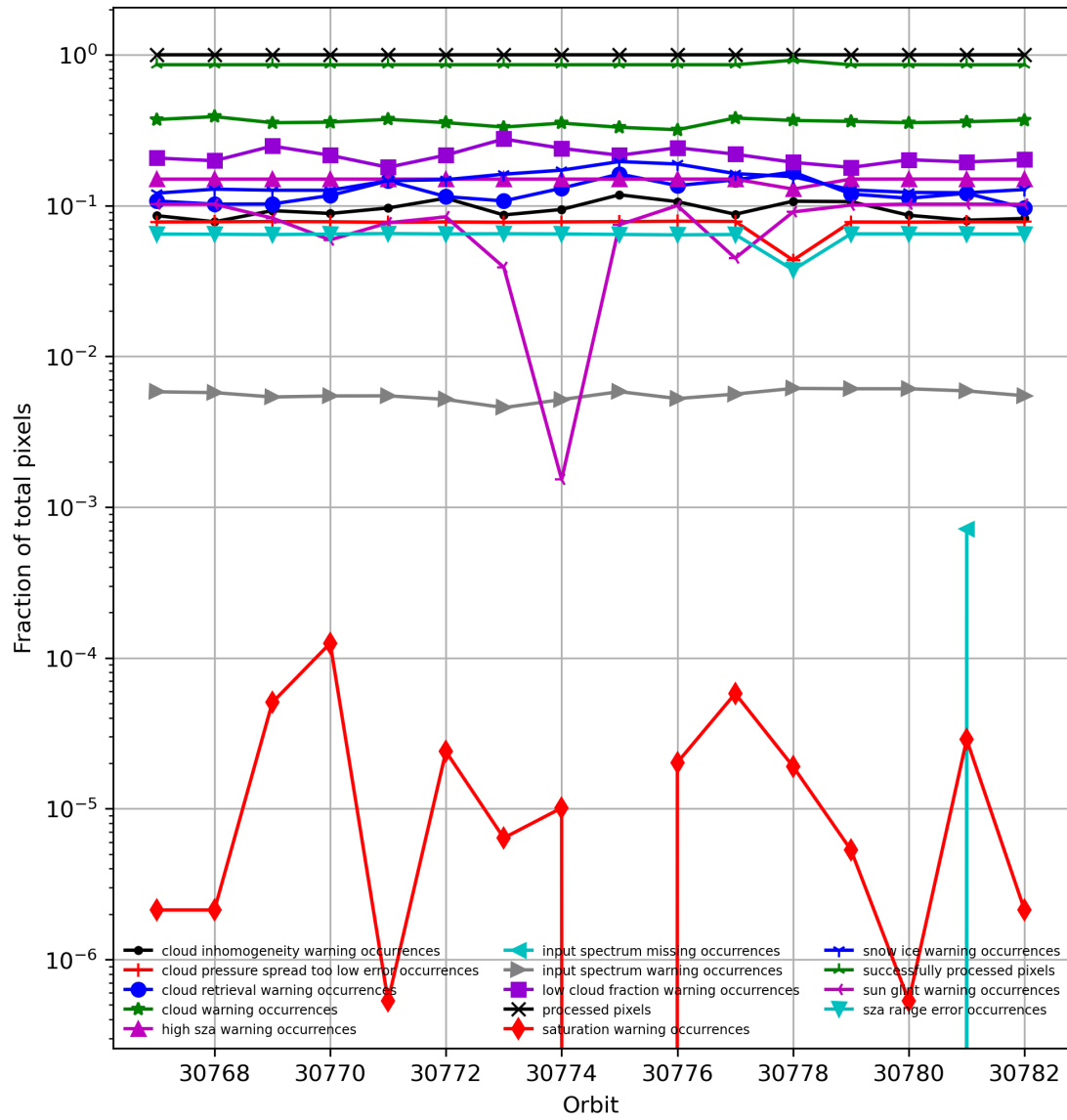


Figure 5: Fraction of pixels with specific warnings and errors during processing

## 6 World maps

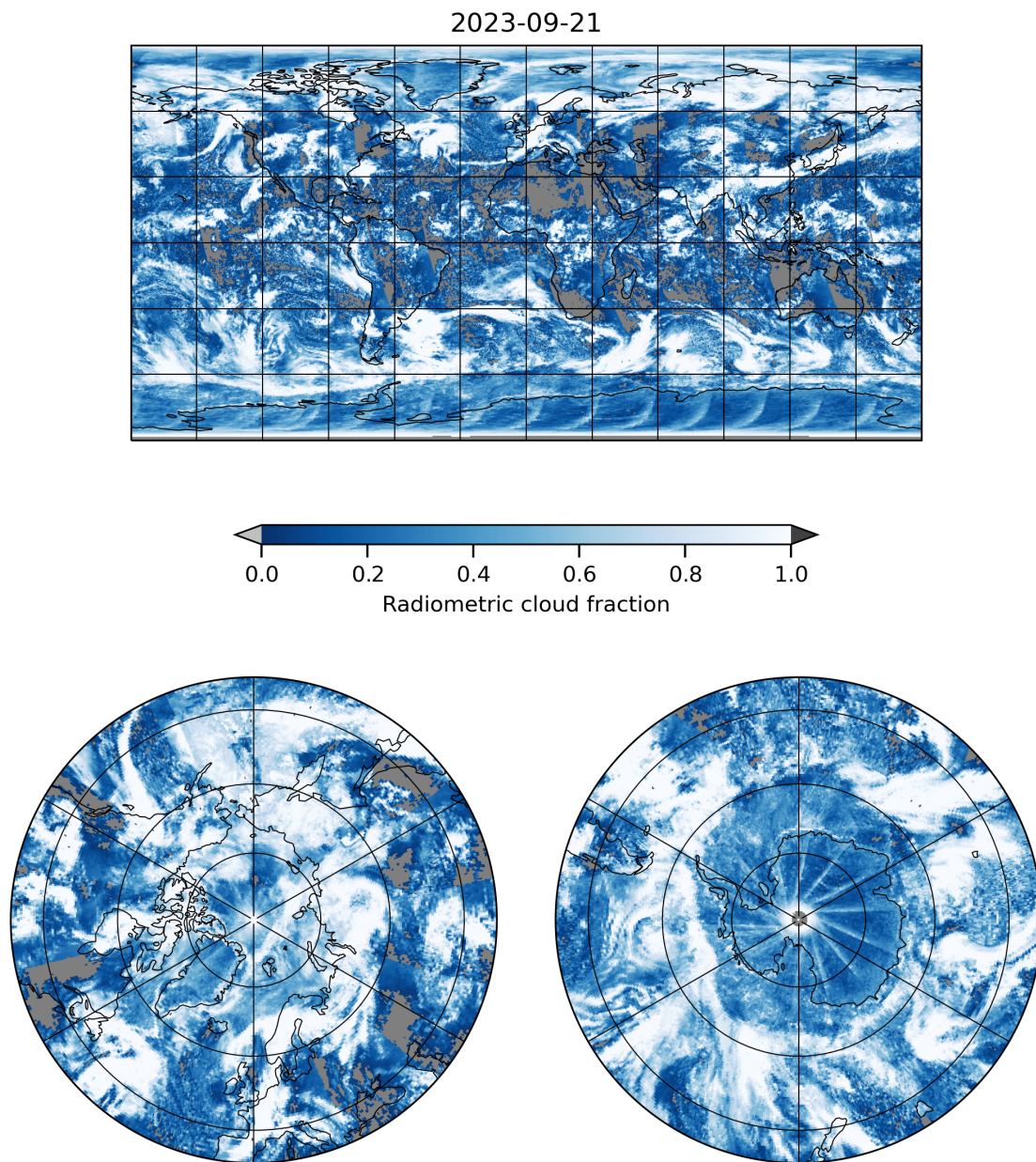


Figure 6: Map of “Radiometric cloud fraction” for 2023-09-20 to 2023-09-22



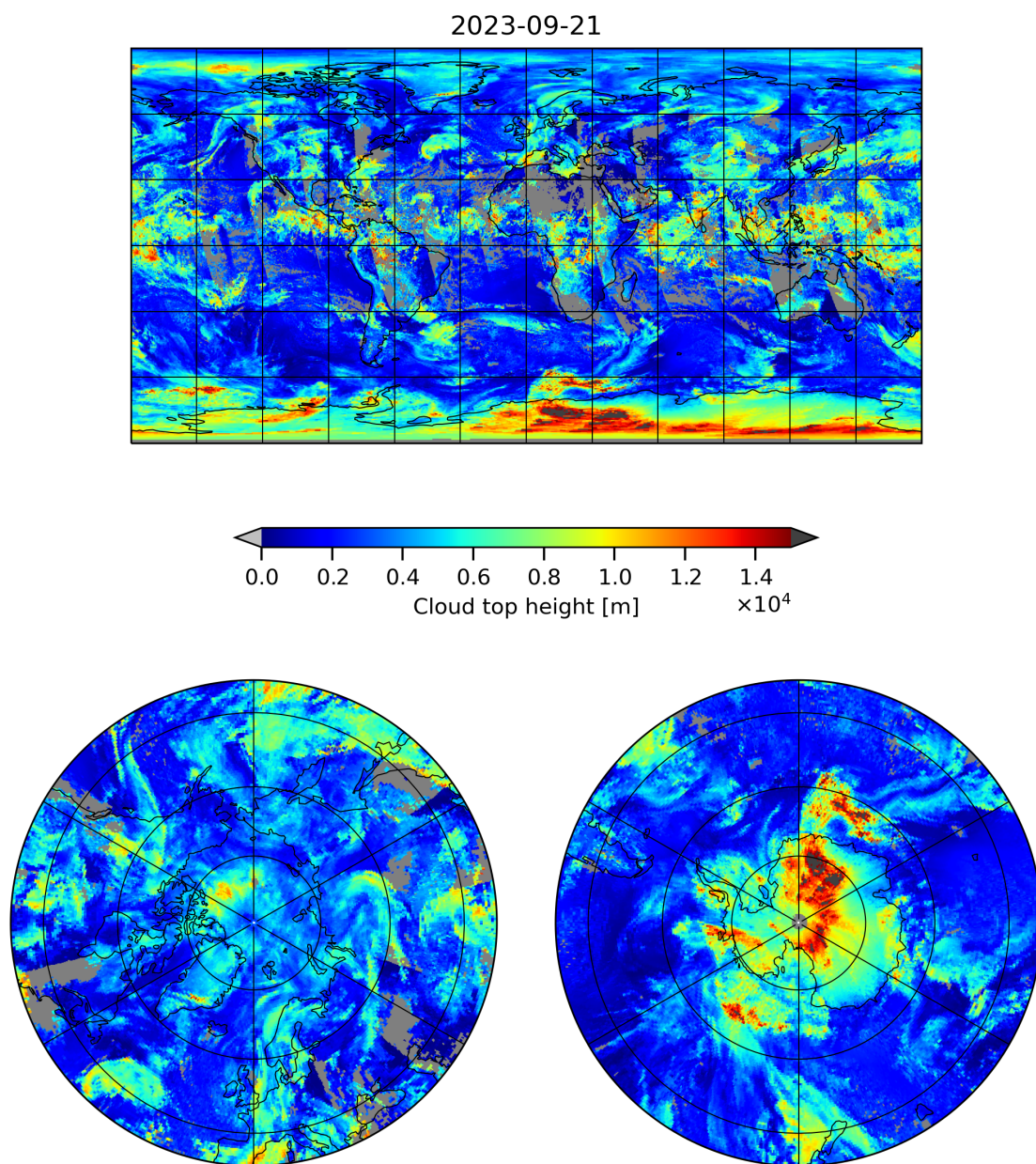


Figure 7: Map of “Cloud top height” for 2023-09-20 to 2023-09-22

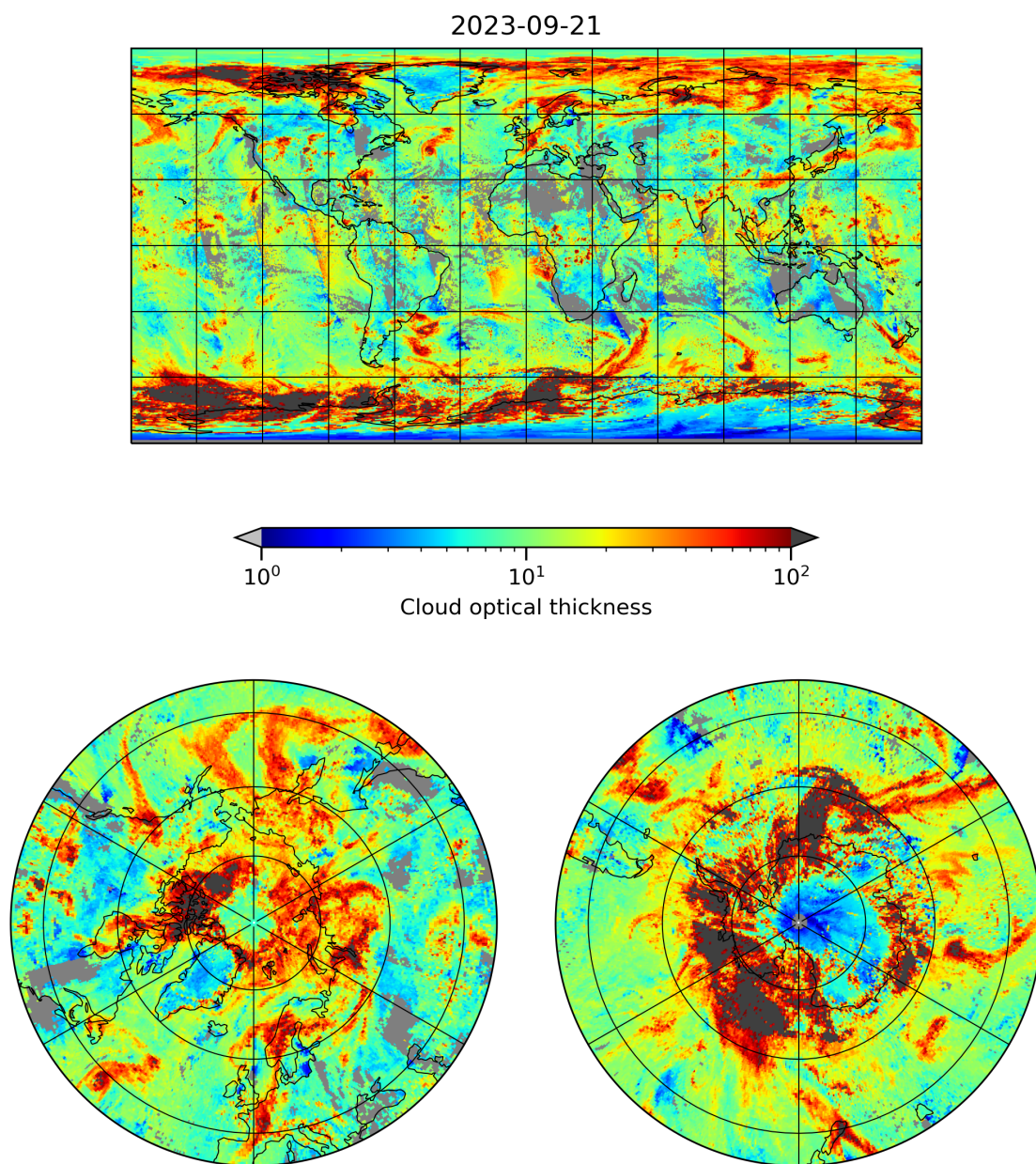


Figure 8: Map of “Cloud optical thickness” for 2023-09-20 to 2023-09-22



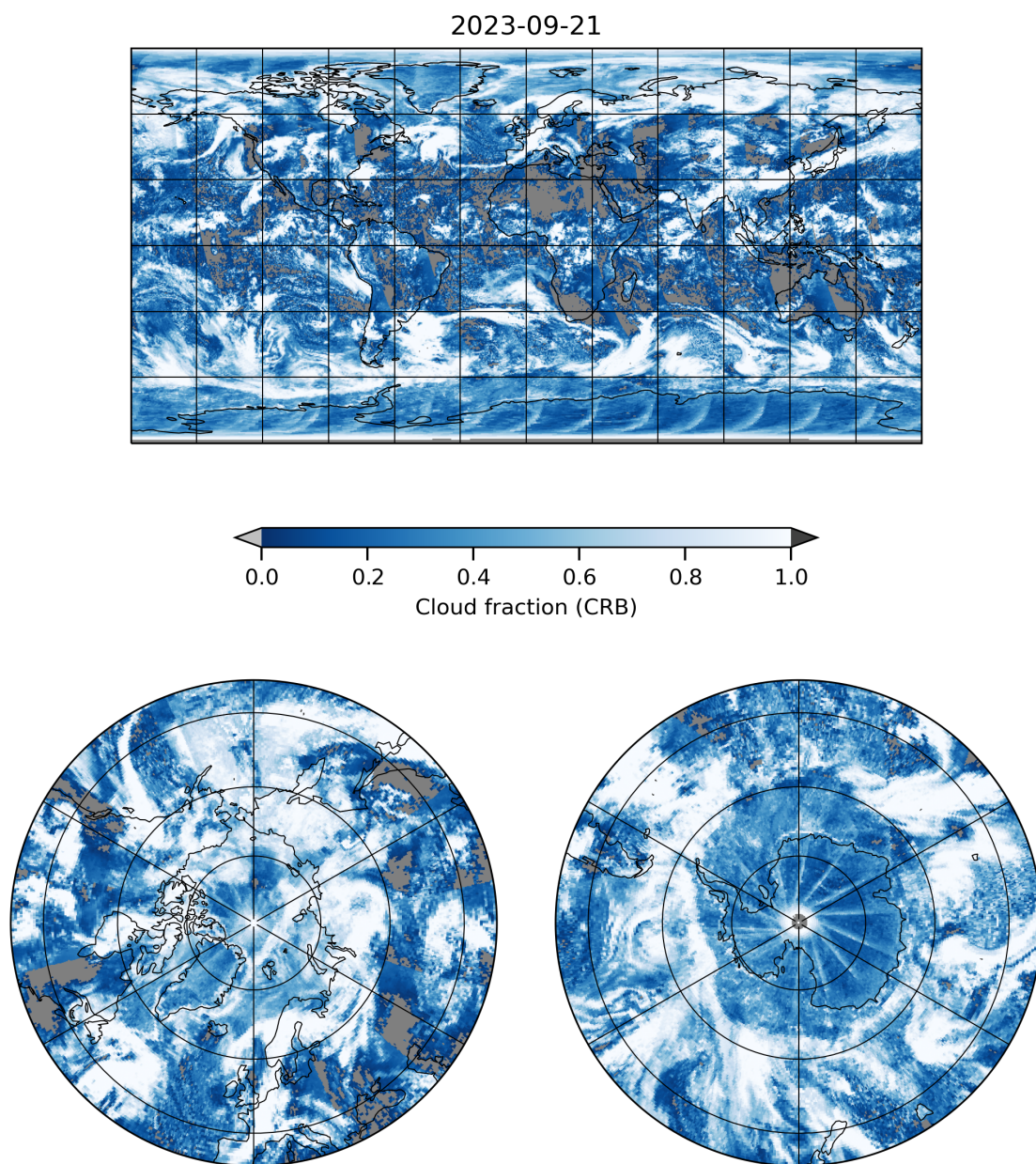


Figure 9: Map of “Cloud fraction (CRB)” for 2023-09-20 to 2023-09-22



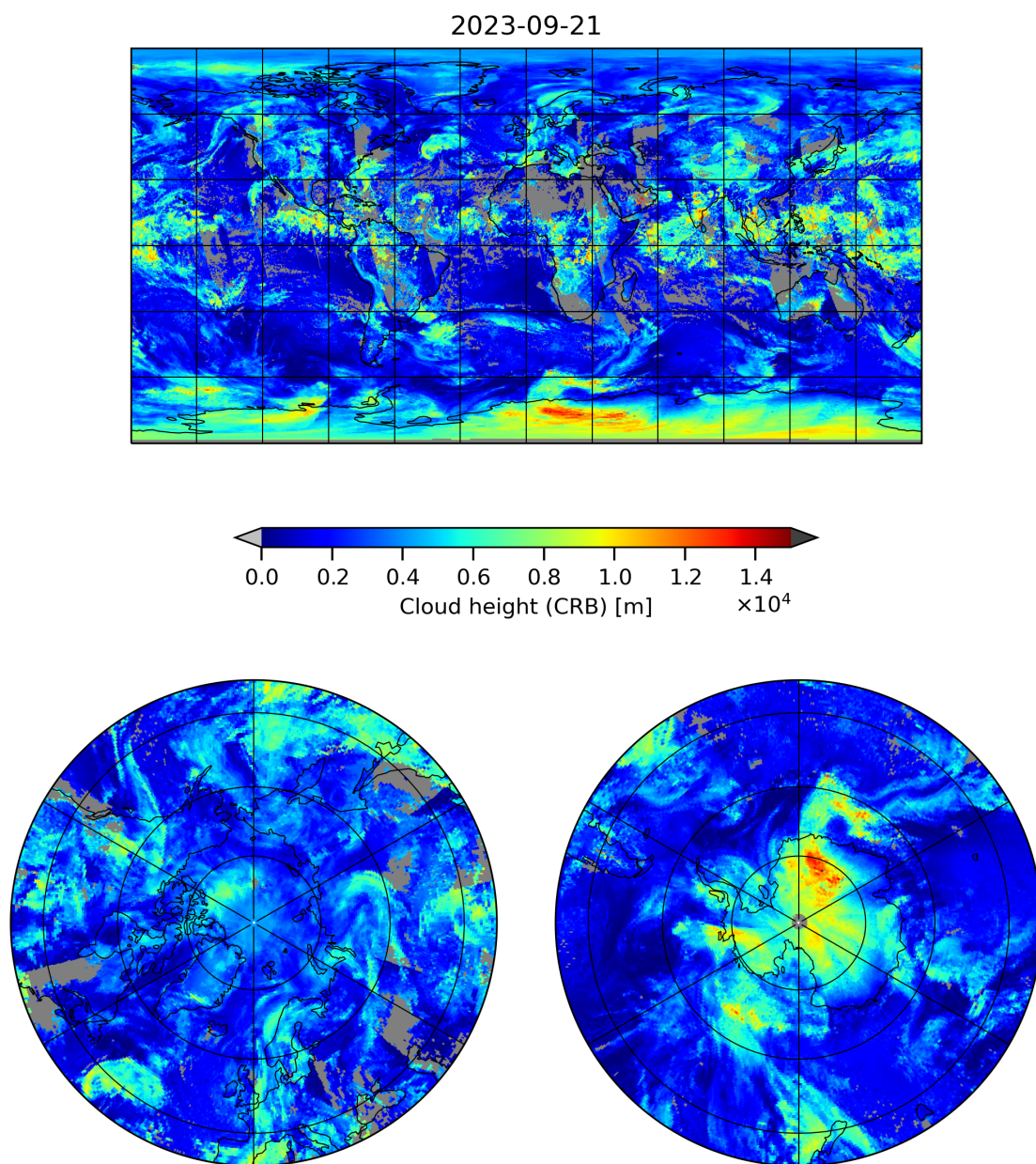


Figure 10: Map of “Cloud height (CRB)” for 2023-09-20 to 2023-09-22

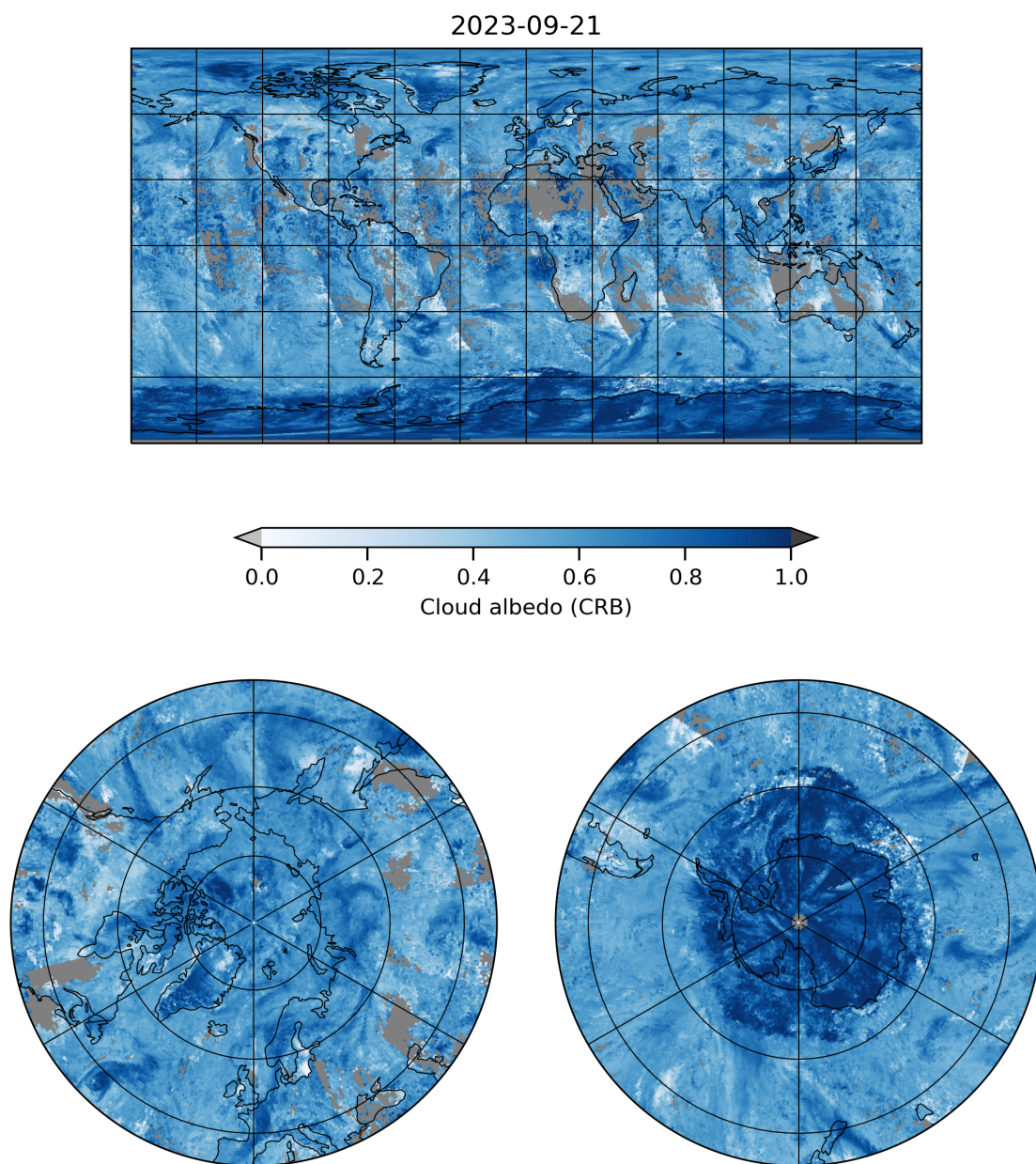


Figure 11: Map of “Cloud albedo (CRB)” for 2023-09-20 to 2023-09-22



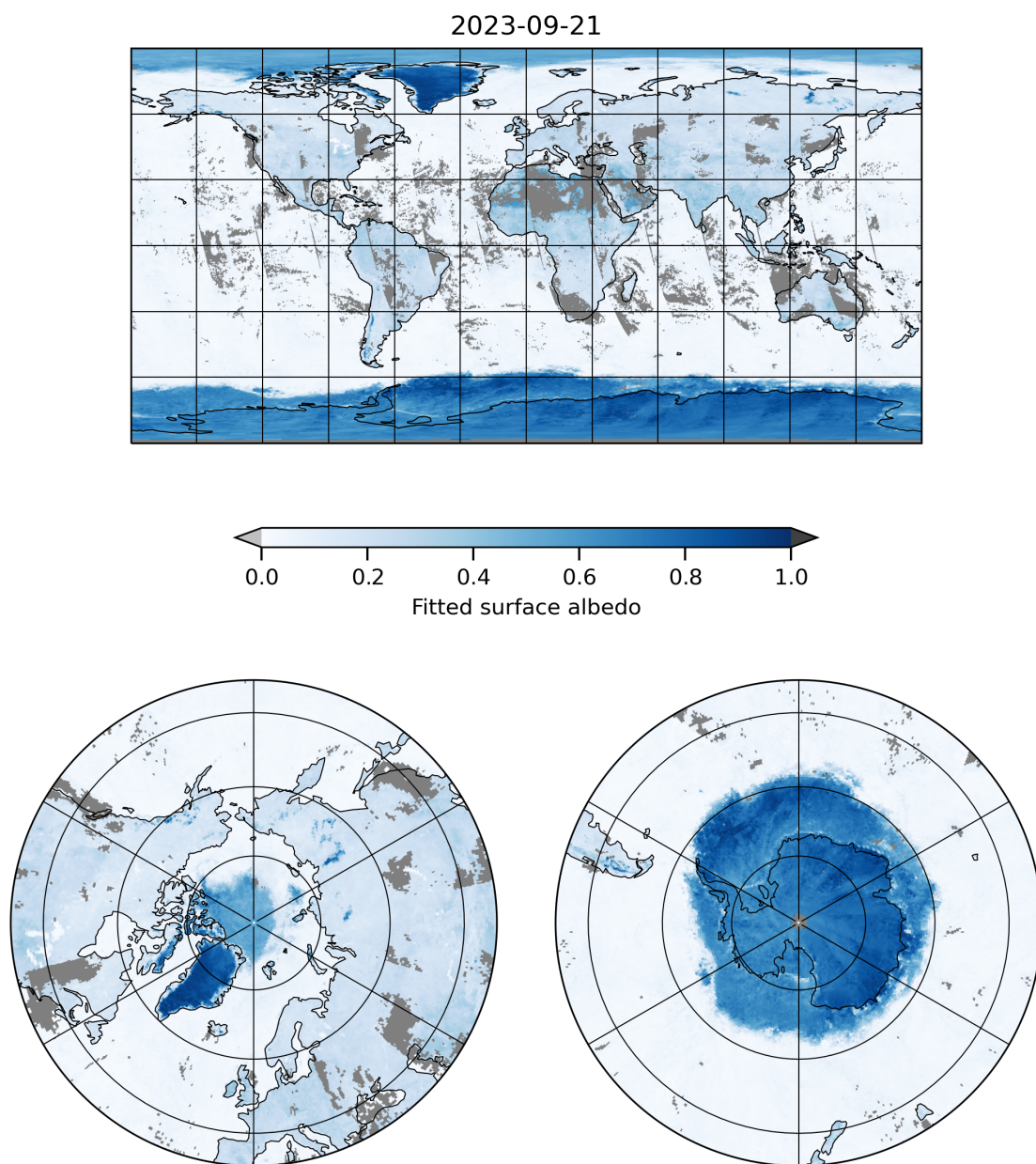


Figure 12: Map of “Fitted surface albedo” for 2023-09-20 to 2023-09-22

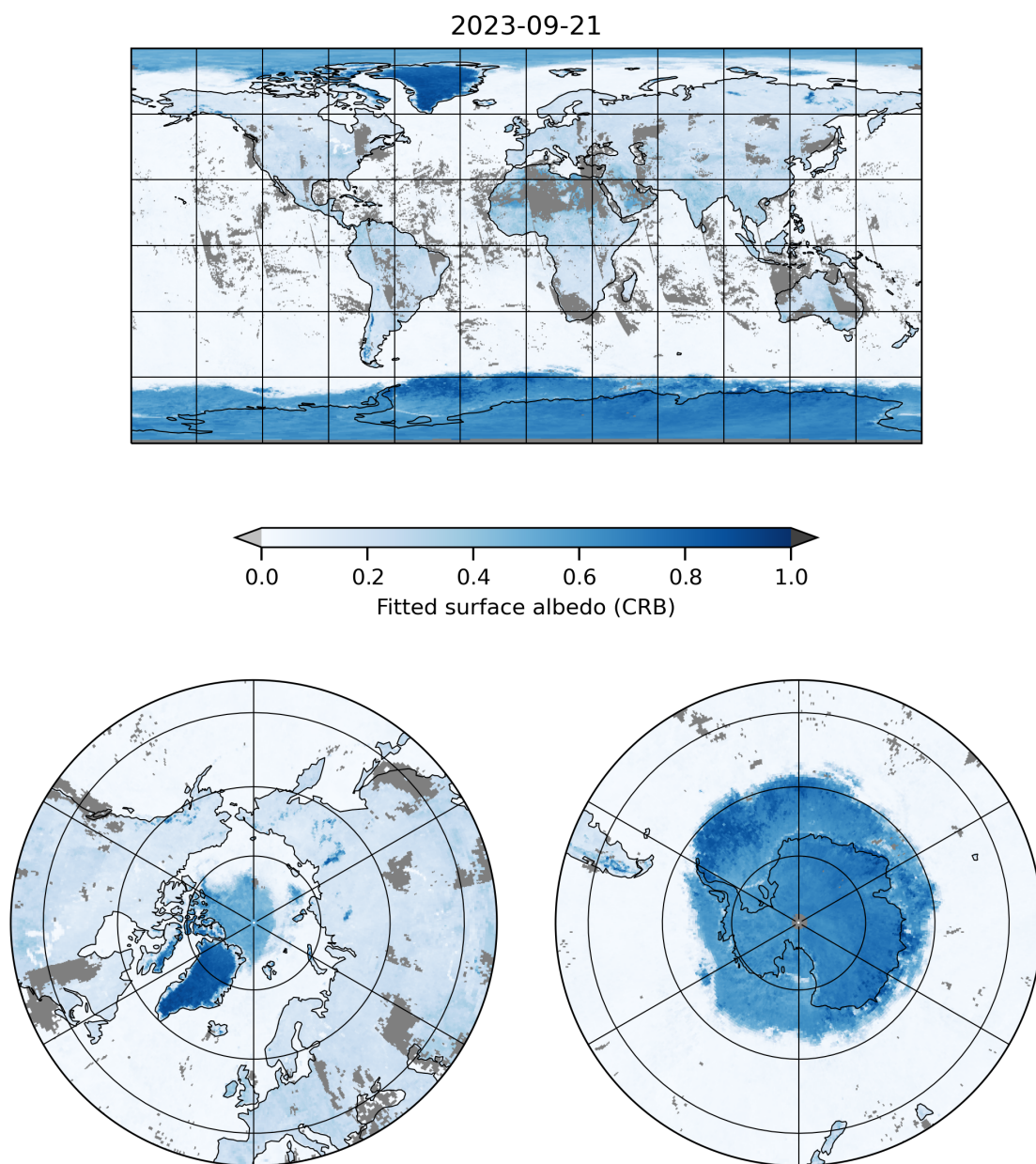


Figure 13: Map of “Fitted surface albedo (CRB)” for 2023-09-20 to 2023-09-22

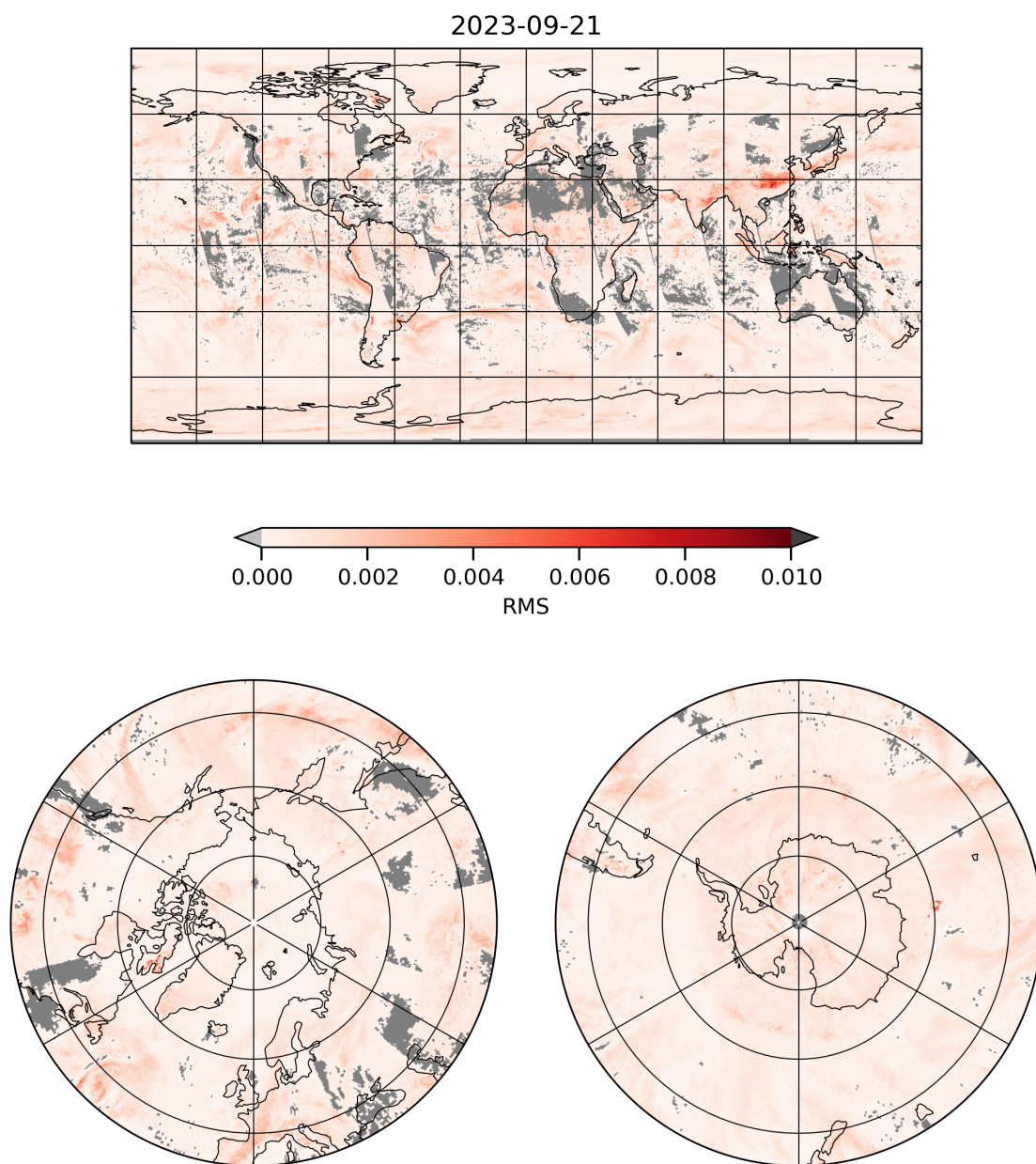


Figure 14: Map of “RMS” for 2023-09-20 to 2023-09-22



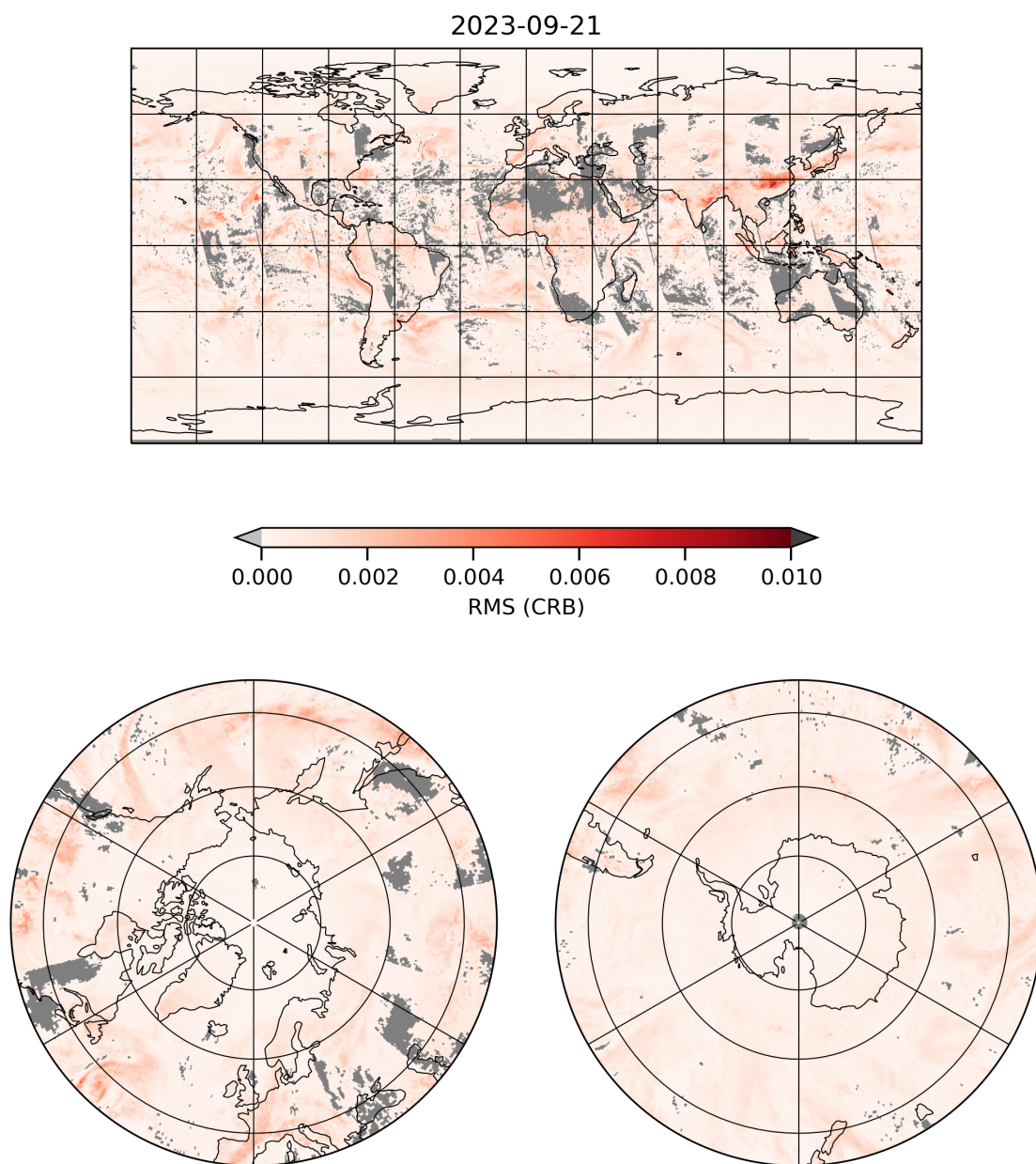


Figure 15: Map of “RMS (CRB)” for 2023-09-20 to 2023-09-22

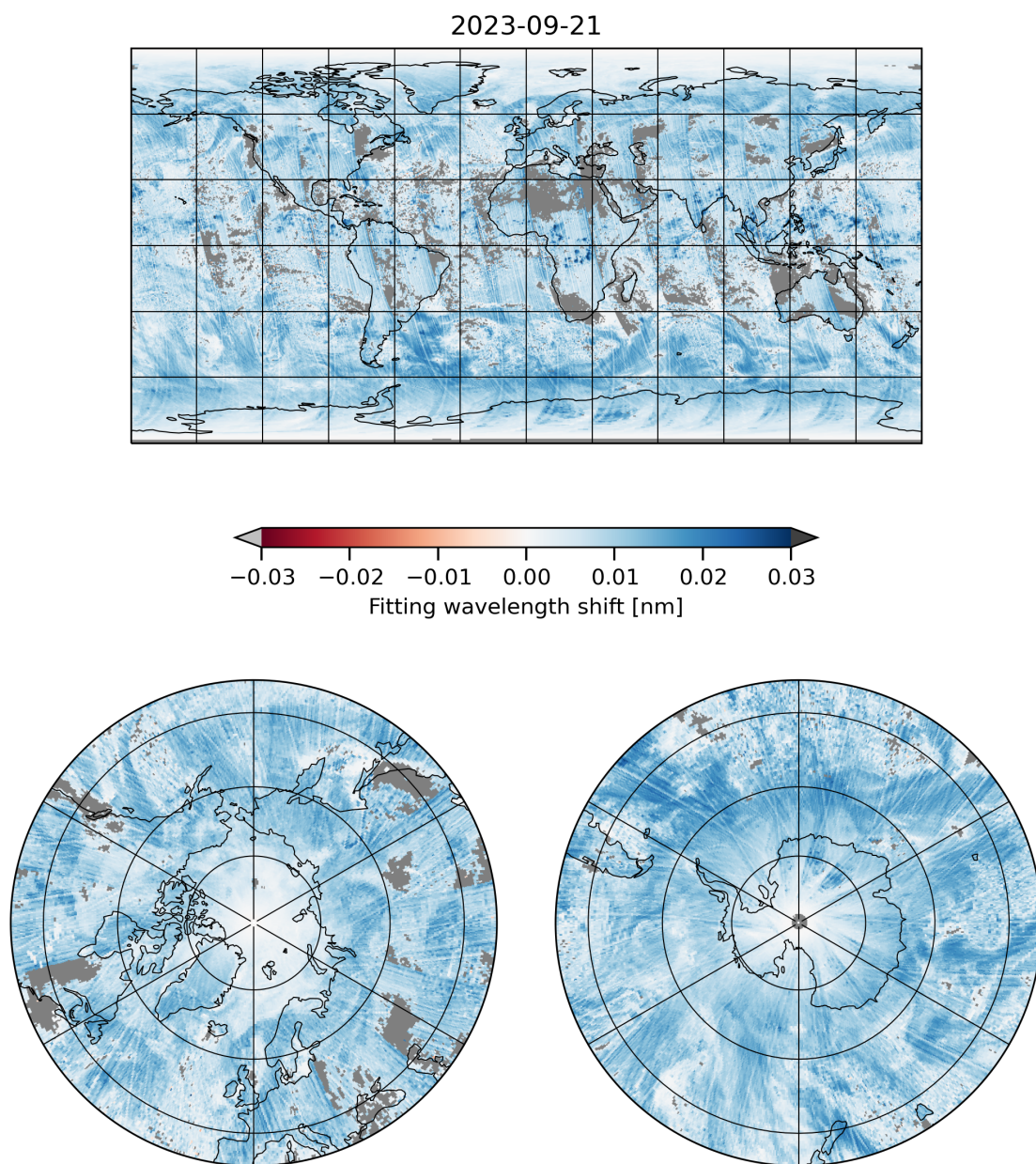


Figure 16: Map of "Fitting wavelength shift" for 2023-09-20 to 2023-09-22



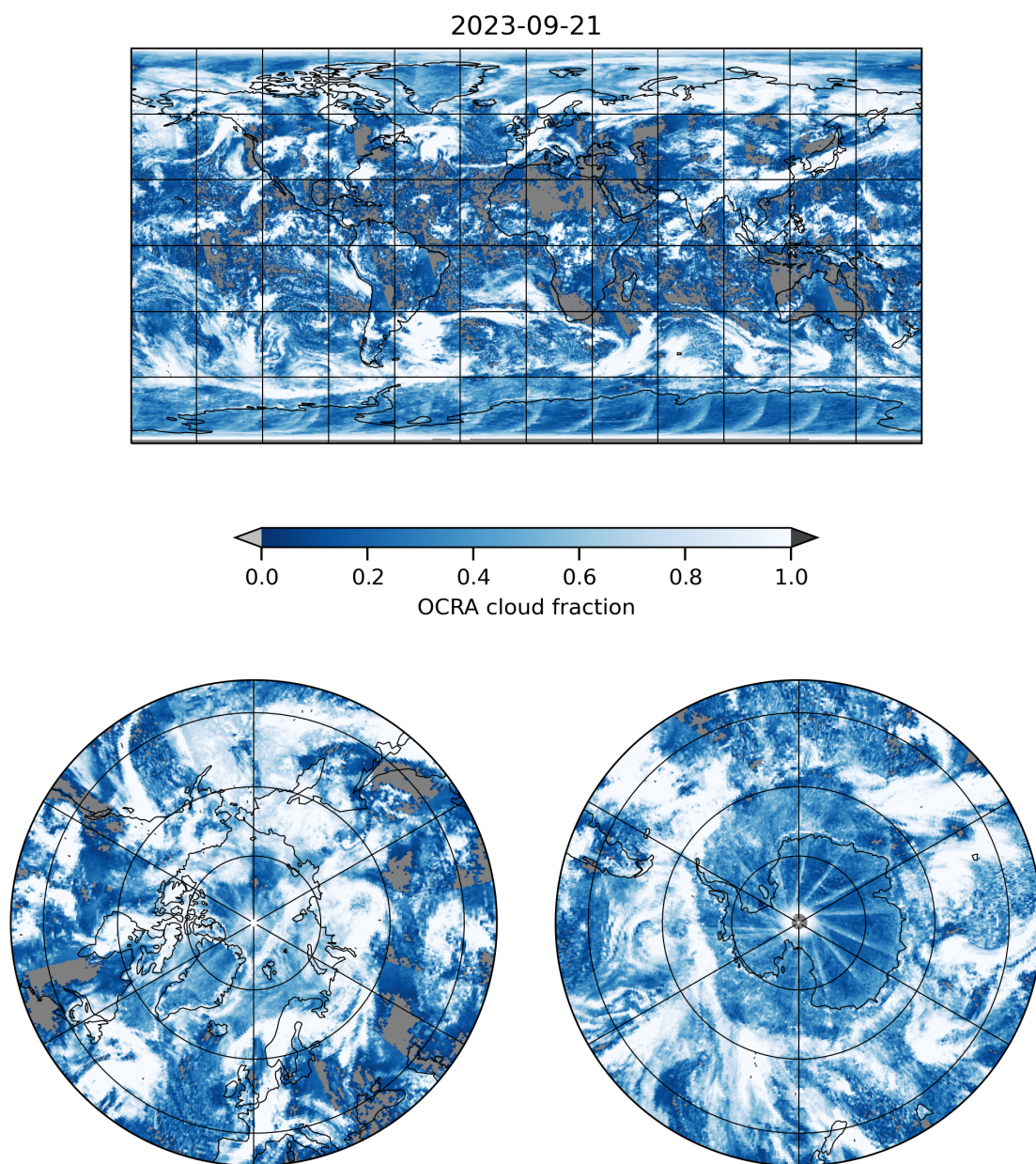


Figure 17: Map of “OCRA cloud fraction” for 2023-09-20 to 2023-09-22



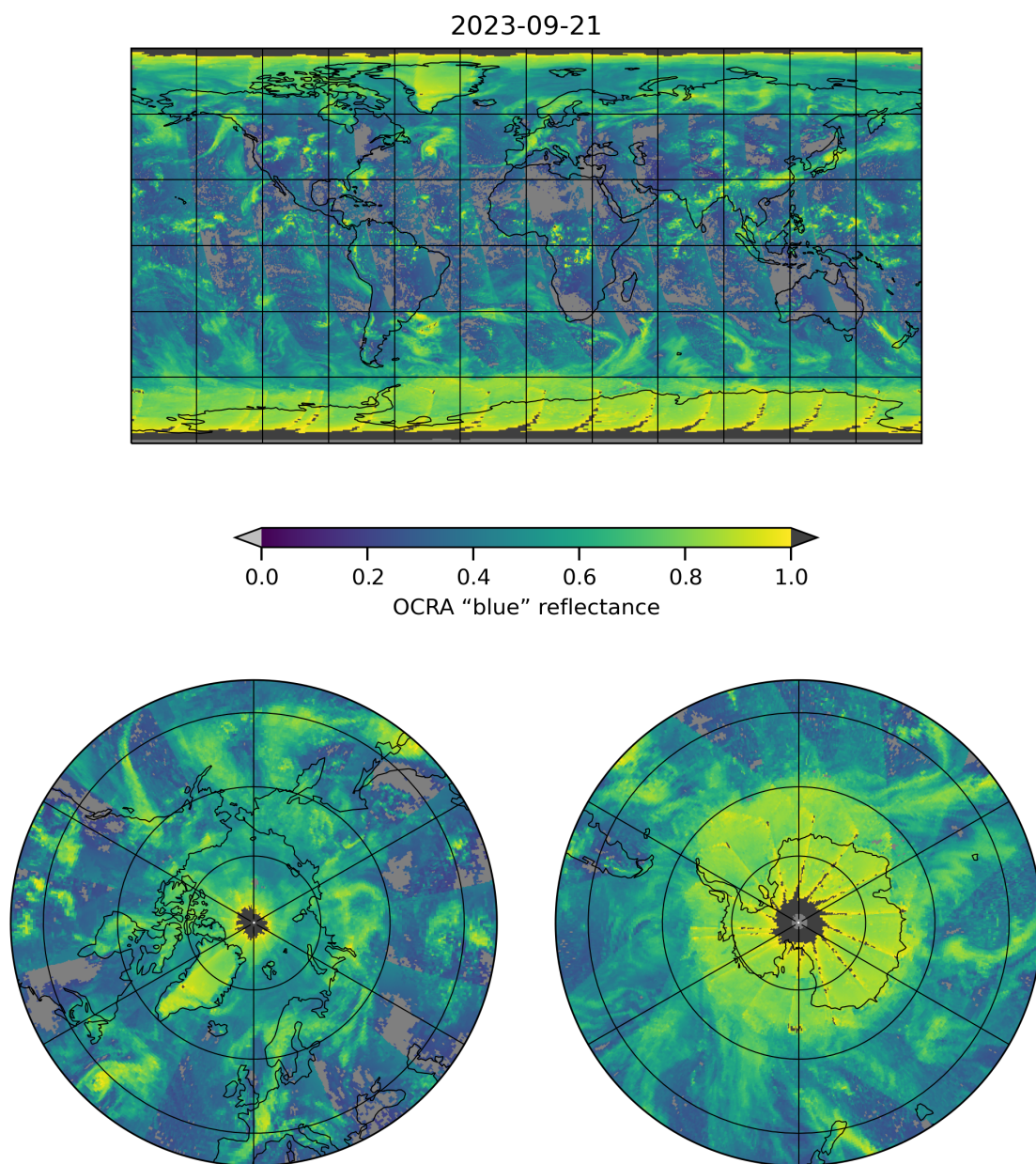


Figure 18: Map of "OCRA "blue" reflectance" for 2023-09-20 to 2023-09-22

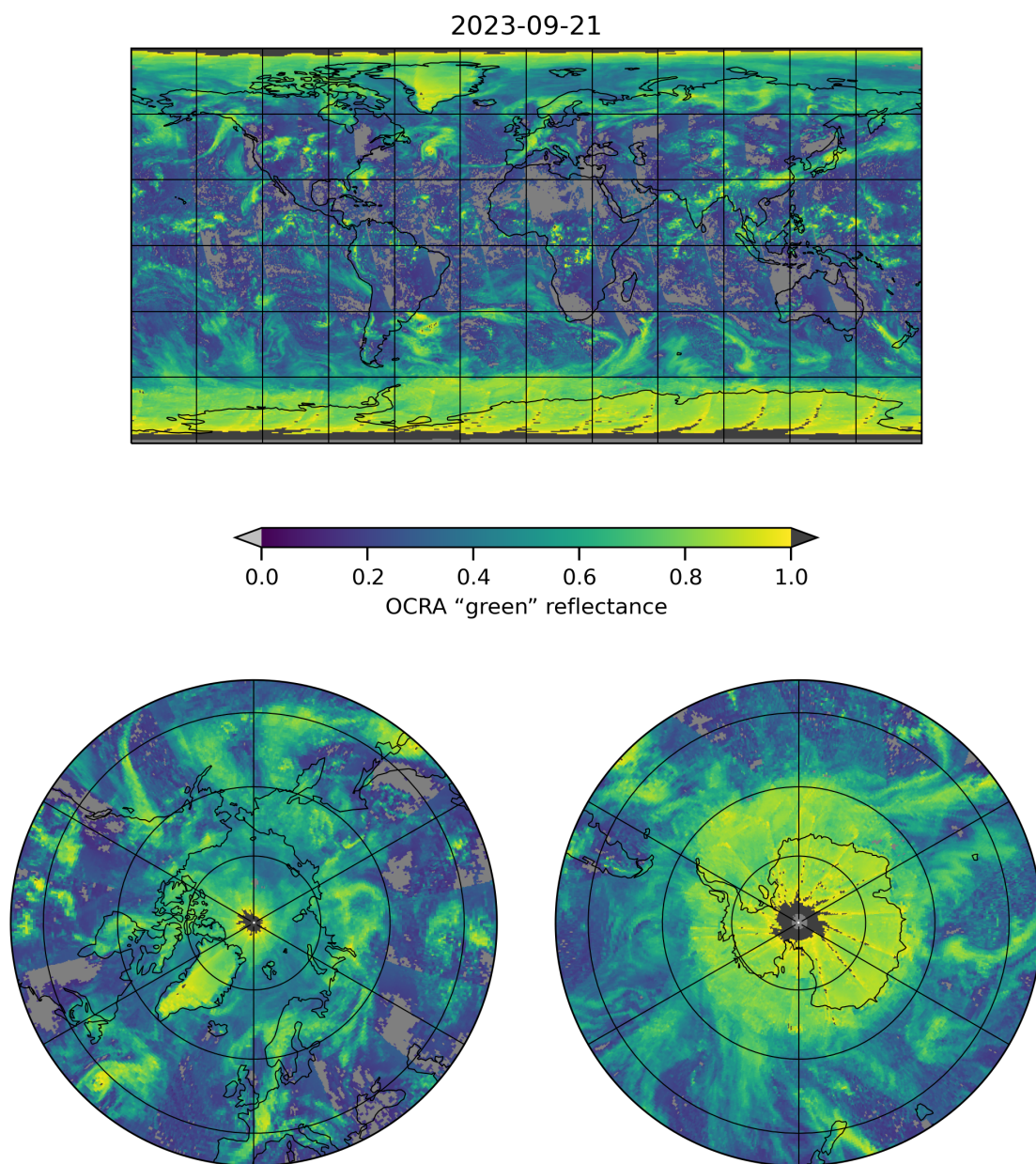


Figure 19: Map of "OCRA "green" reflectance" for 2023-09-20 to 2023-09-22



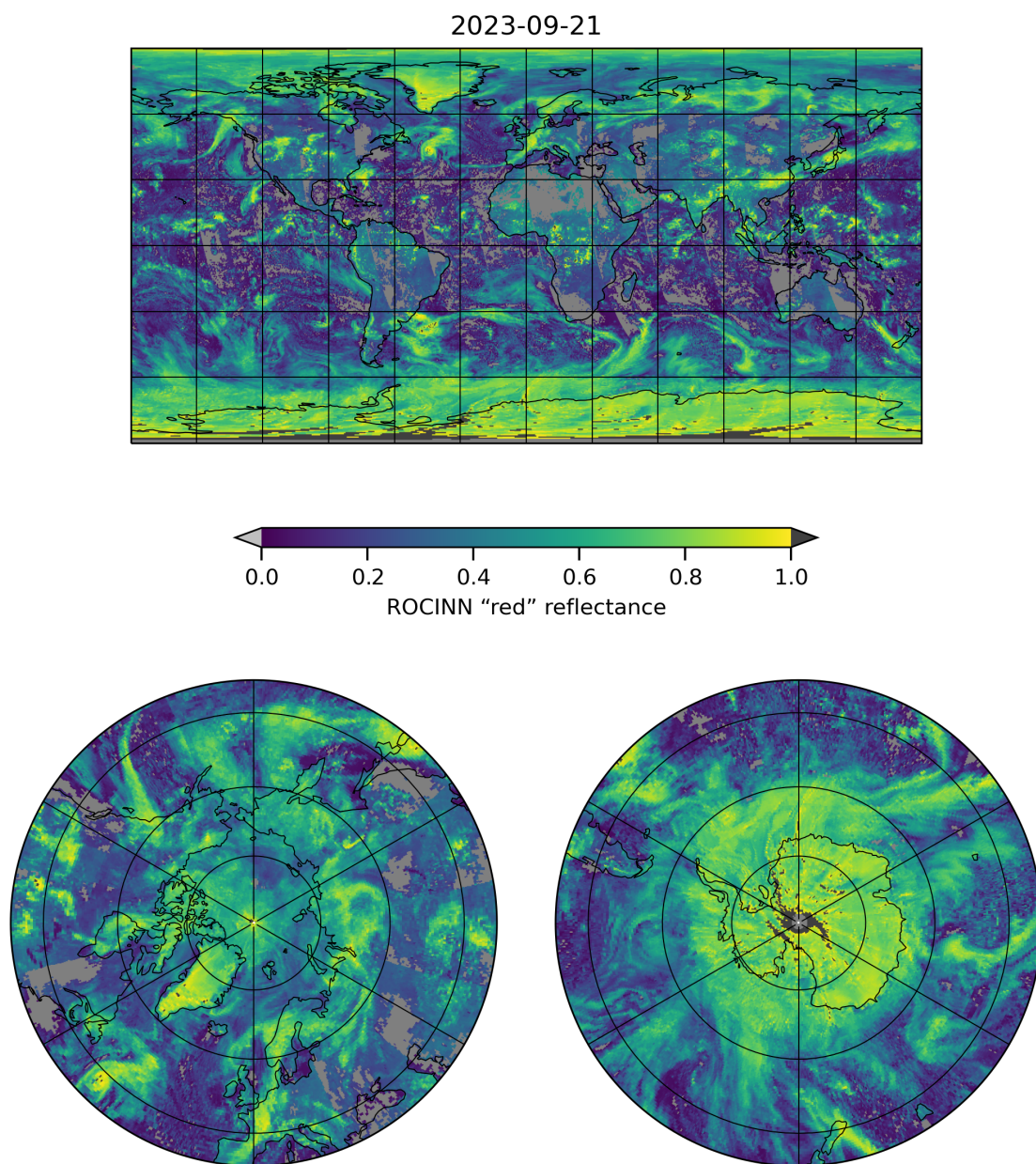


Figure 20: Map of "ROCINN "red" reflectance" for 2023-09-20 to 2023-09-22

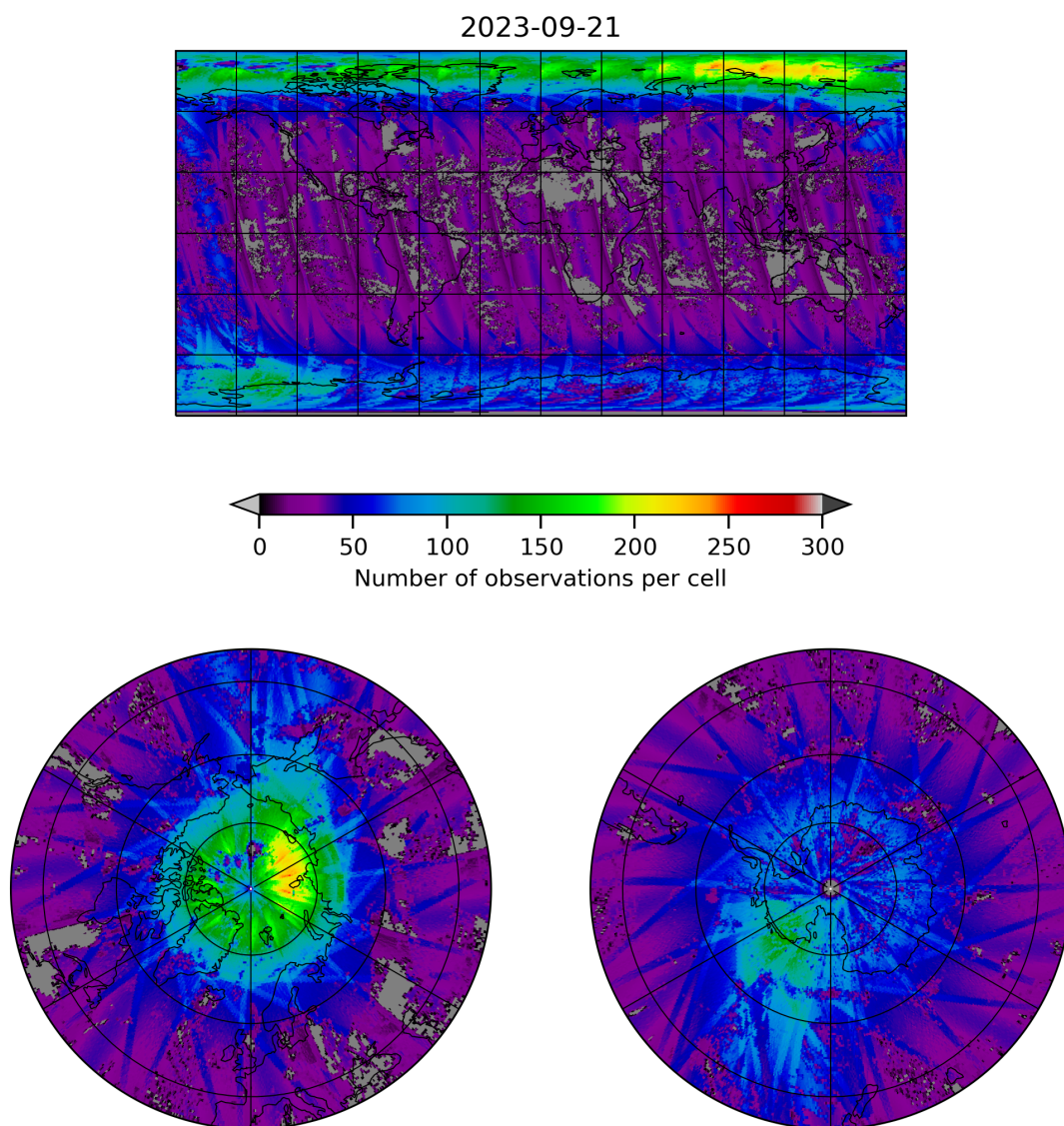


Figure 21: Map of the number of observations for 2023-09-20 to 2023-09-22

## 7 Zonal average

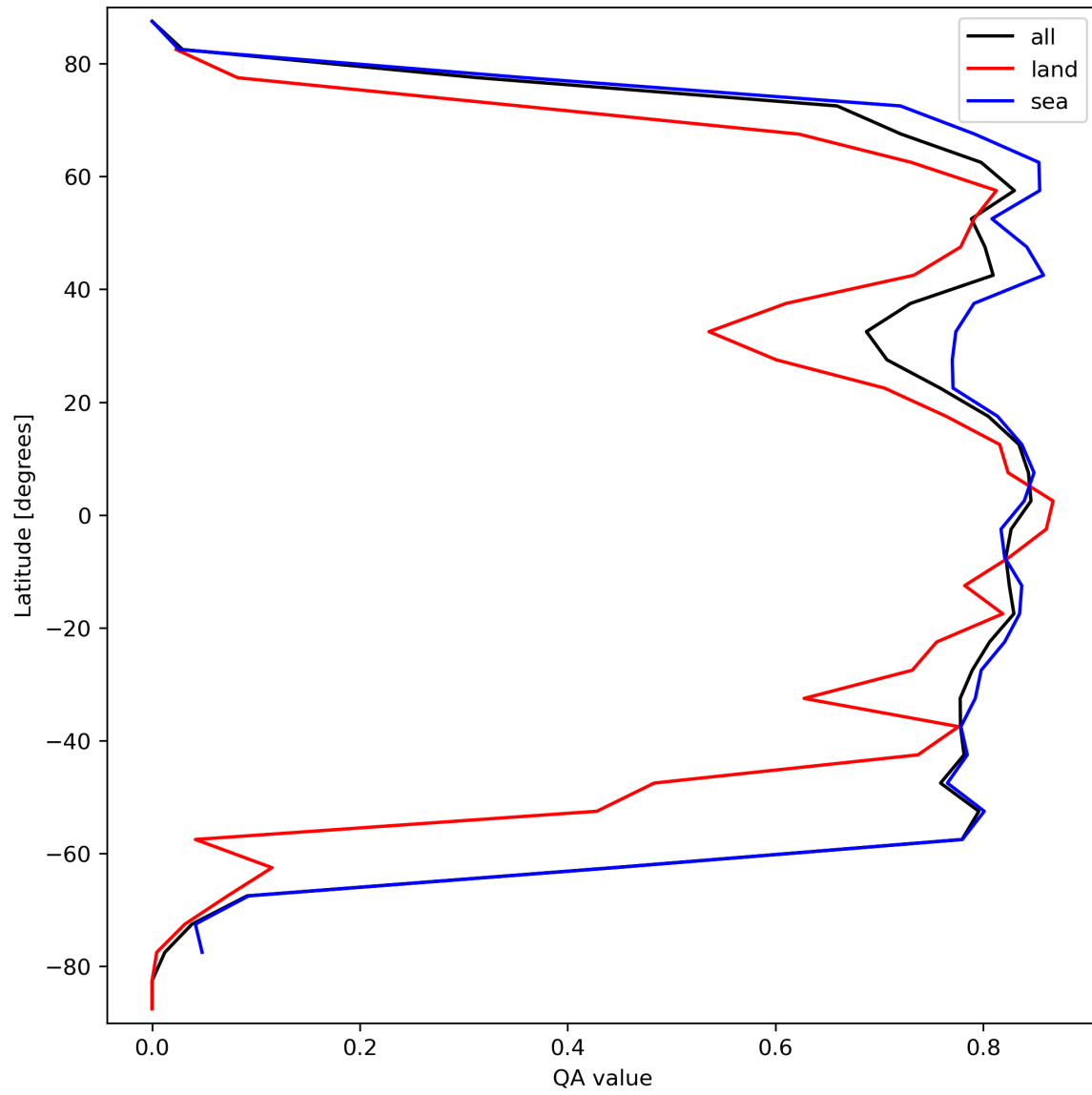


Figure 22: Zonal average of “QA value” for 2023-09-20 to 2023-09-22.



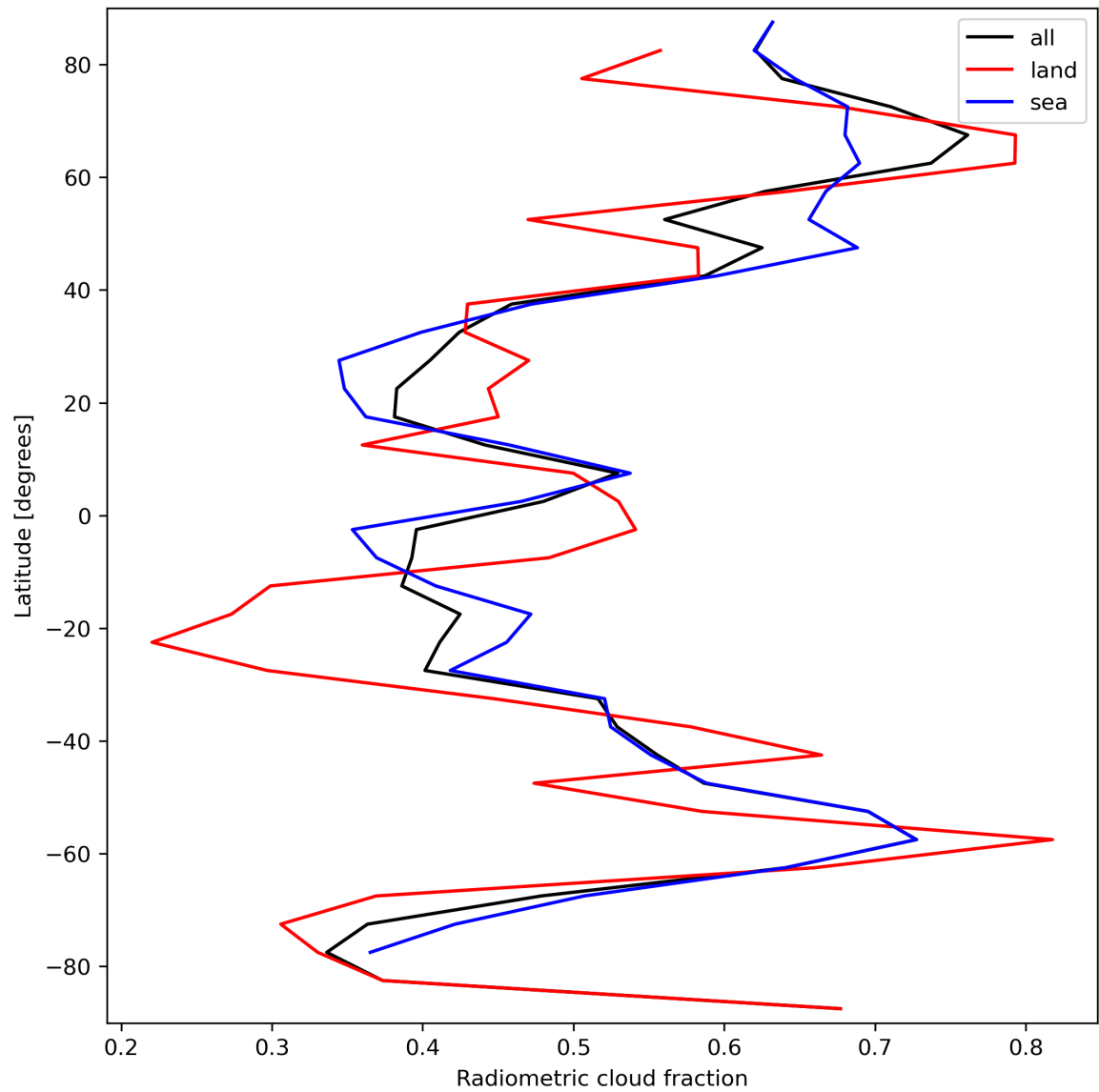


Figure 23: Zonal average of “Radiometric cloud fraction” for 2023-09-20 to 2023-09-22.

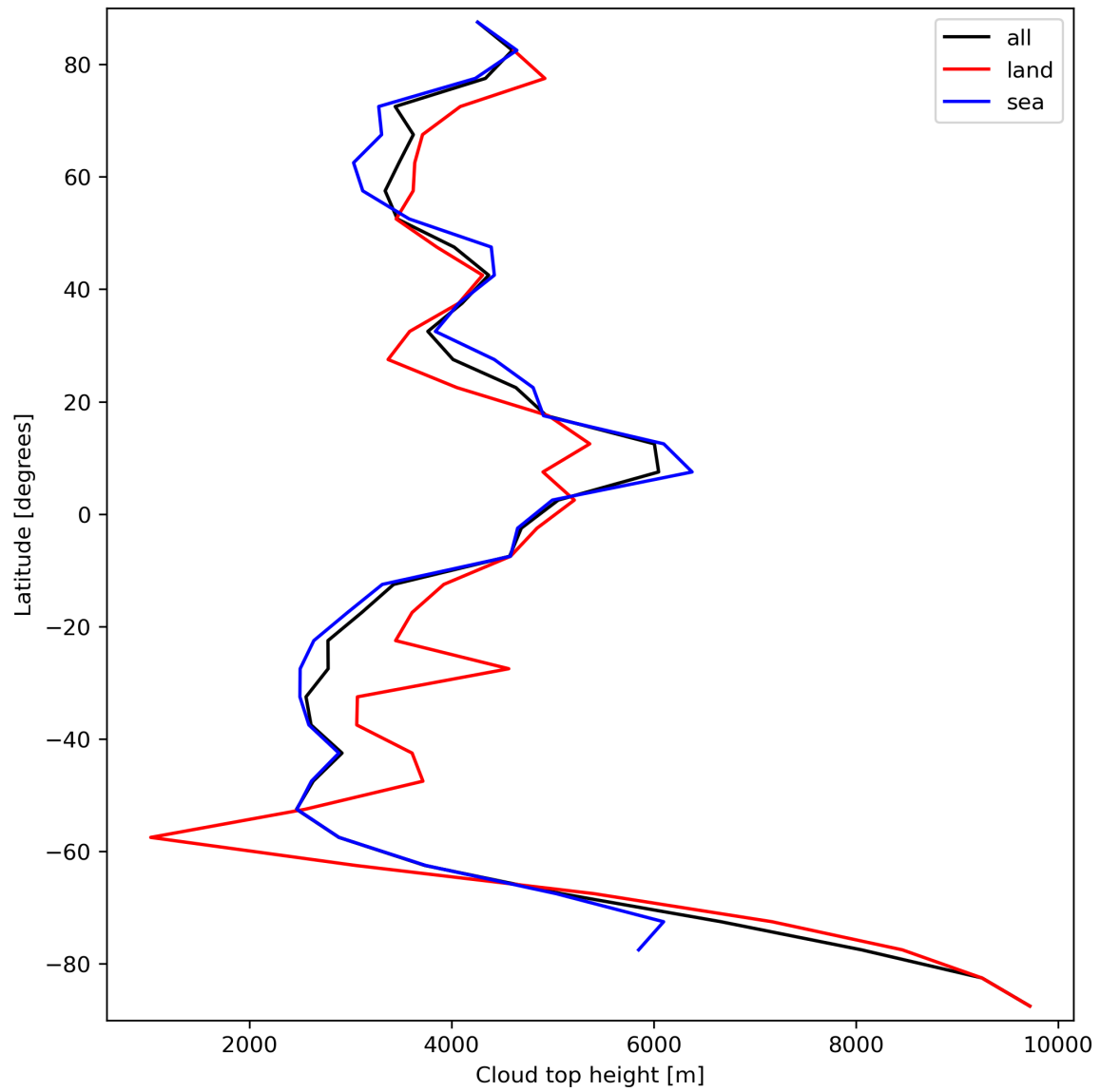


Figure 24: Zonal average of “Cloud top height” for 2023-09-20 to 2023-09-22.

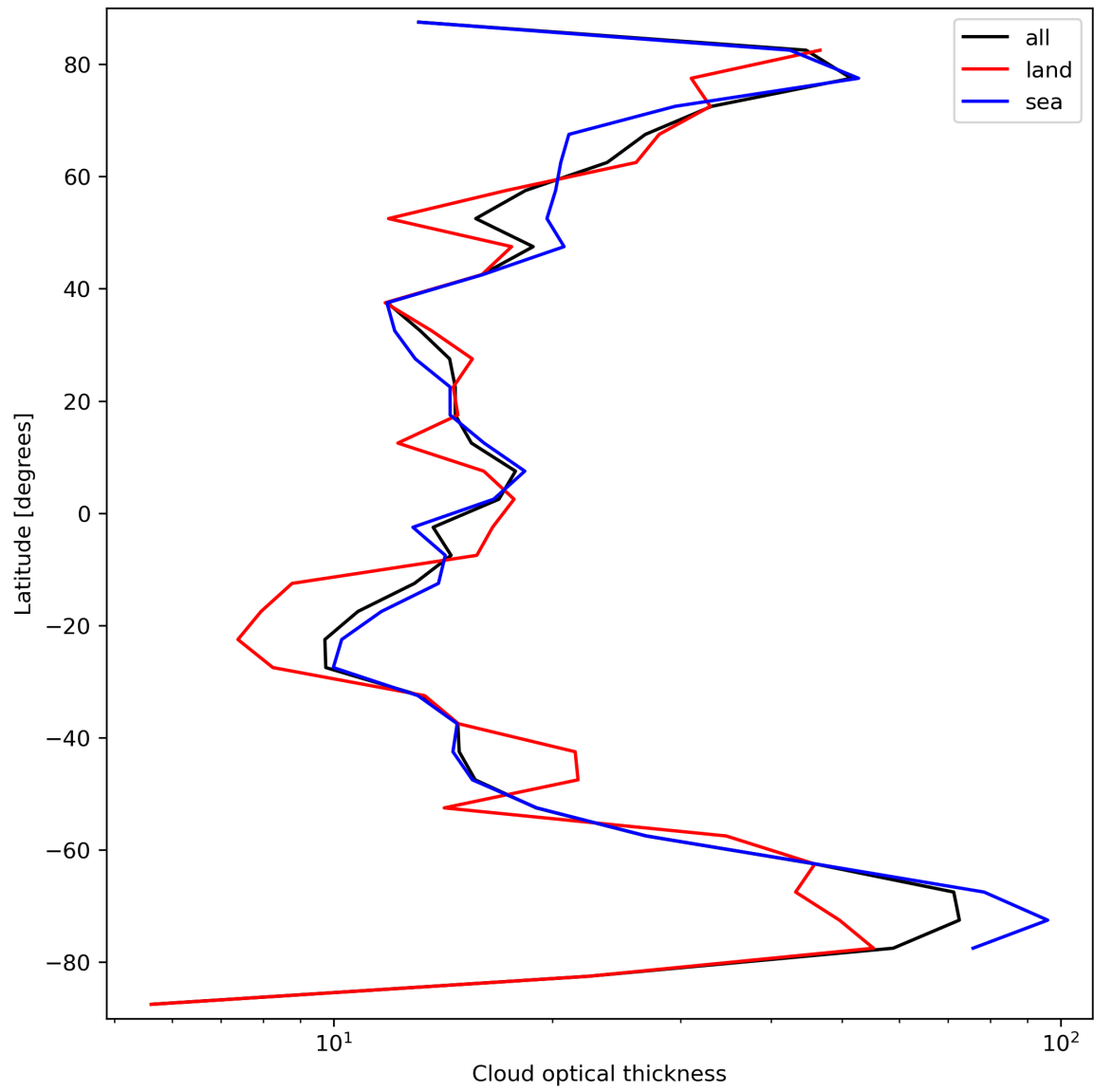


Figure 25: Zonal average of “Cloud optical thickness” for 2023-09-20 to 2023-09-22.

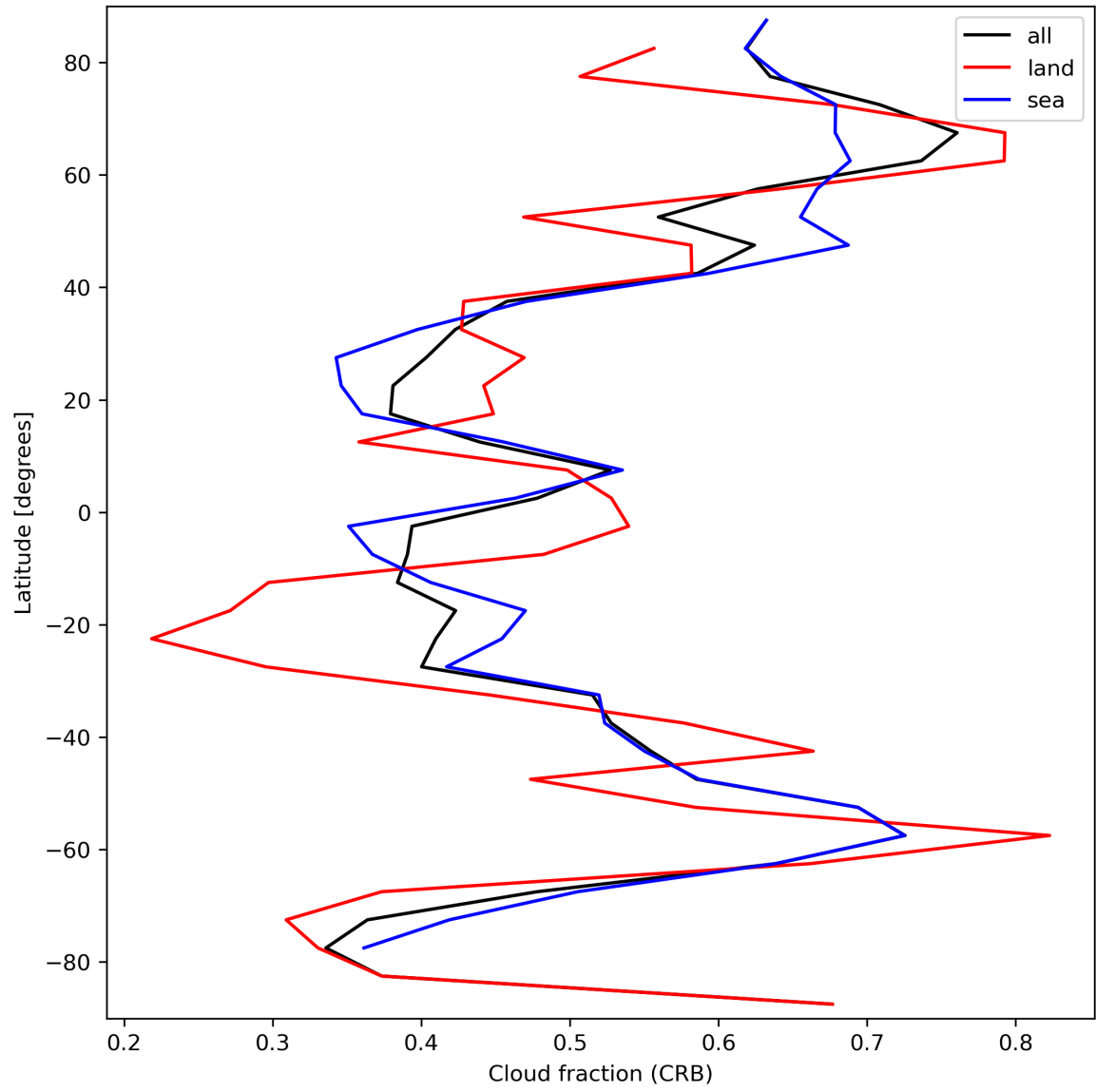


Figure 26: Zonal average of “Cloud fraction (CRB)” for 2023-09-20 to 2023-09-22.



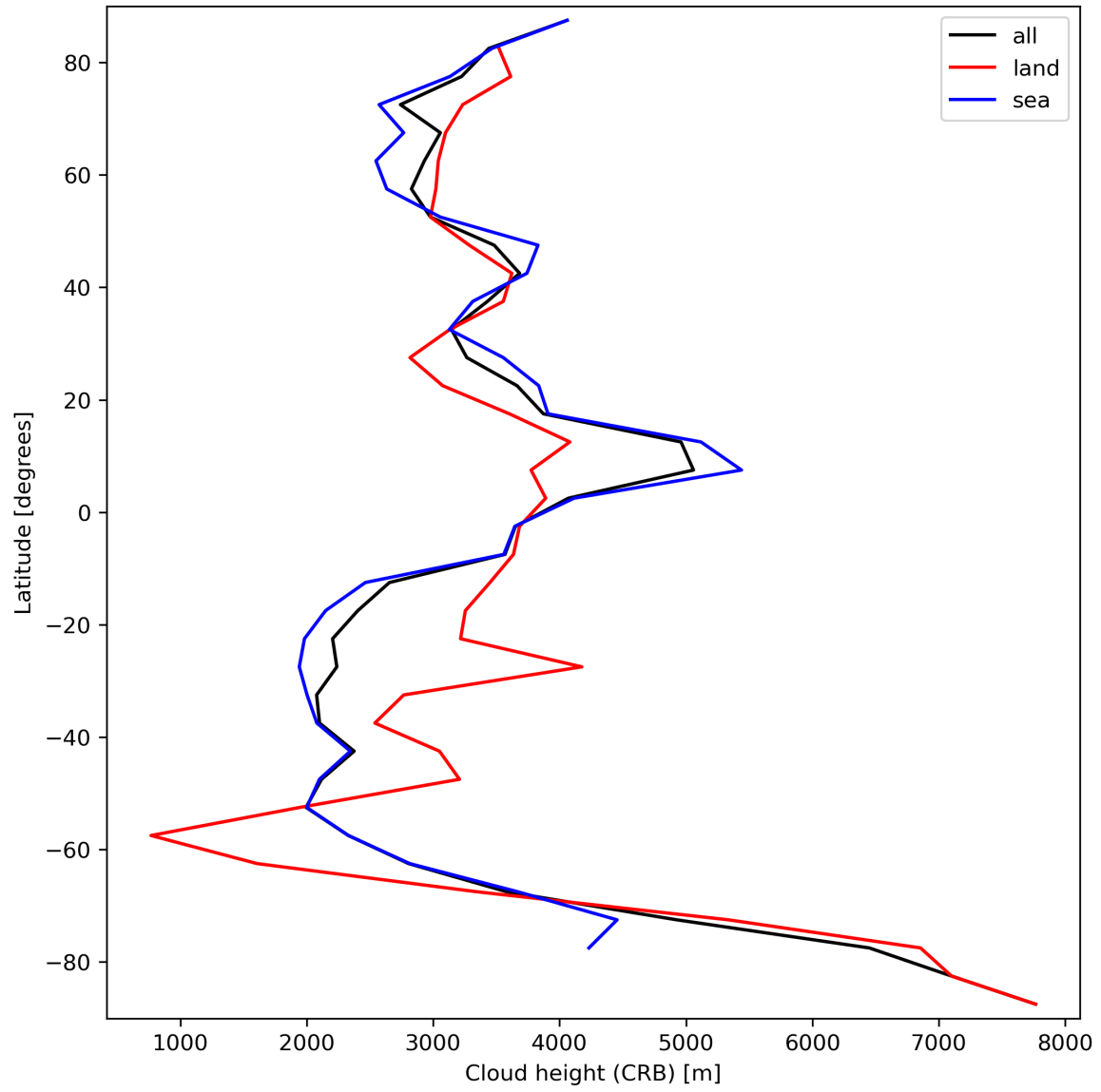


Figure 27: Zonal average of “Cloud height (CRB)” for 2023-09-20 to 2023-09-22.

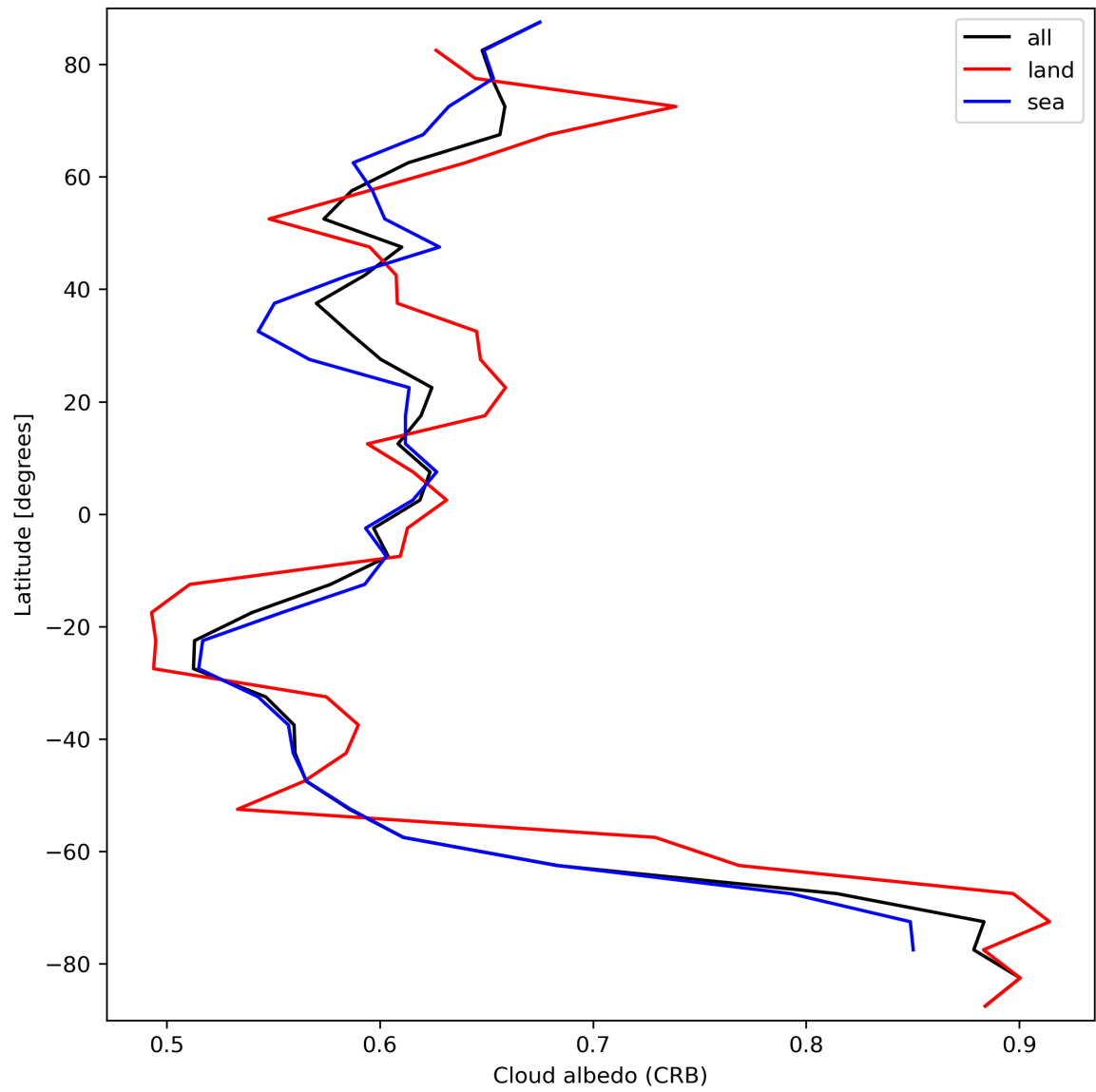


Figure 28: Zonal average of “Cloud albedo (CRB)” for 2023-09-20 to 2023-09-22.

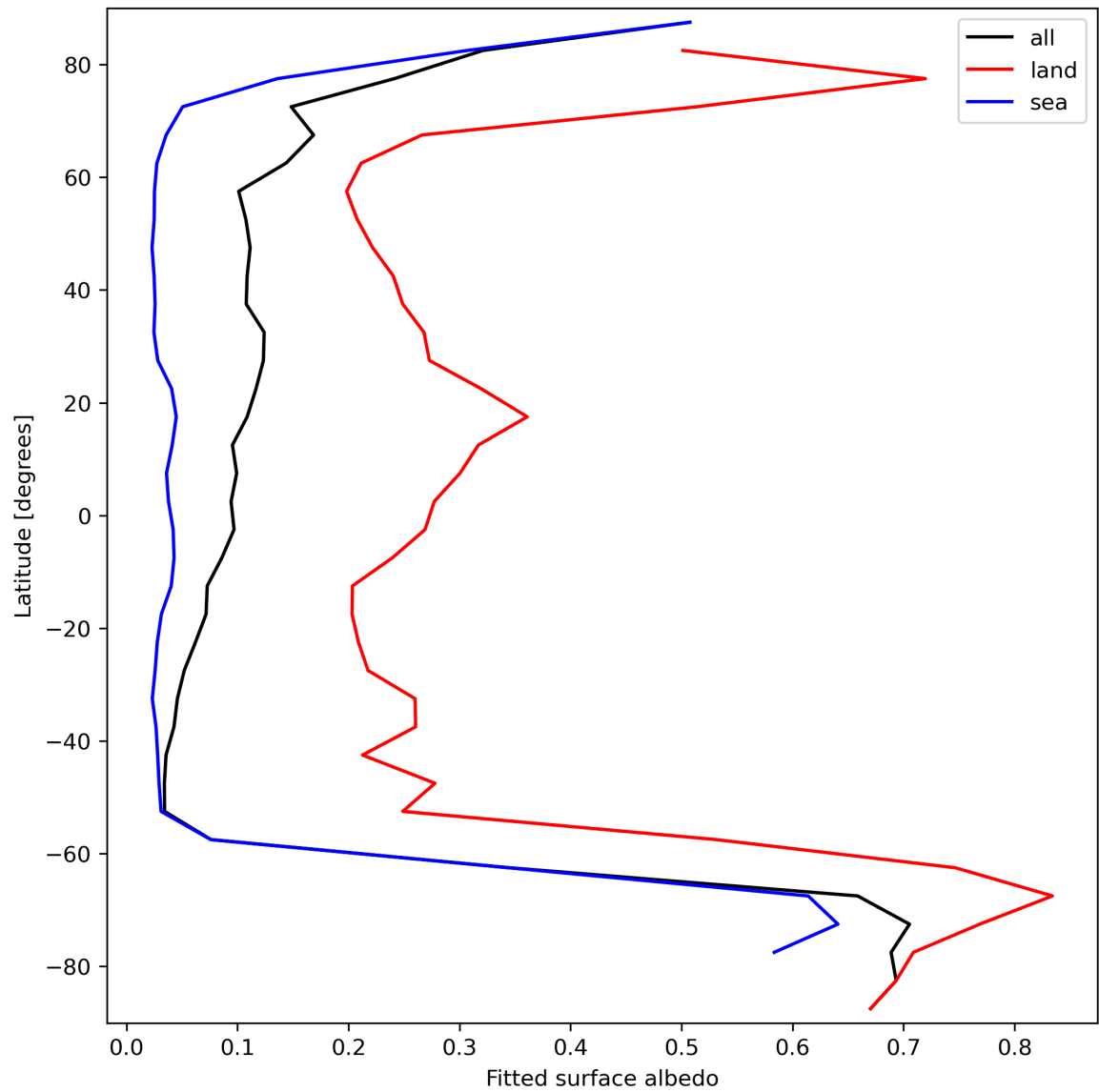


Figure 29: Zonal average of “Fitted surface albedo” for 2023-09-20 to 2023-09-22.

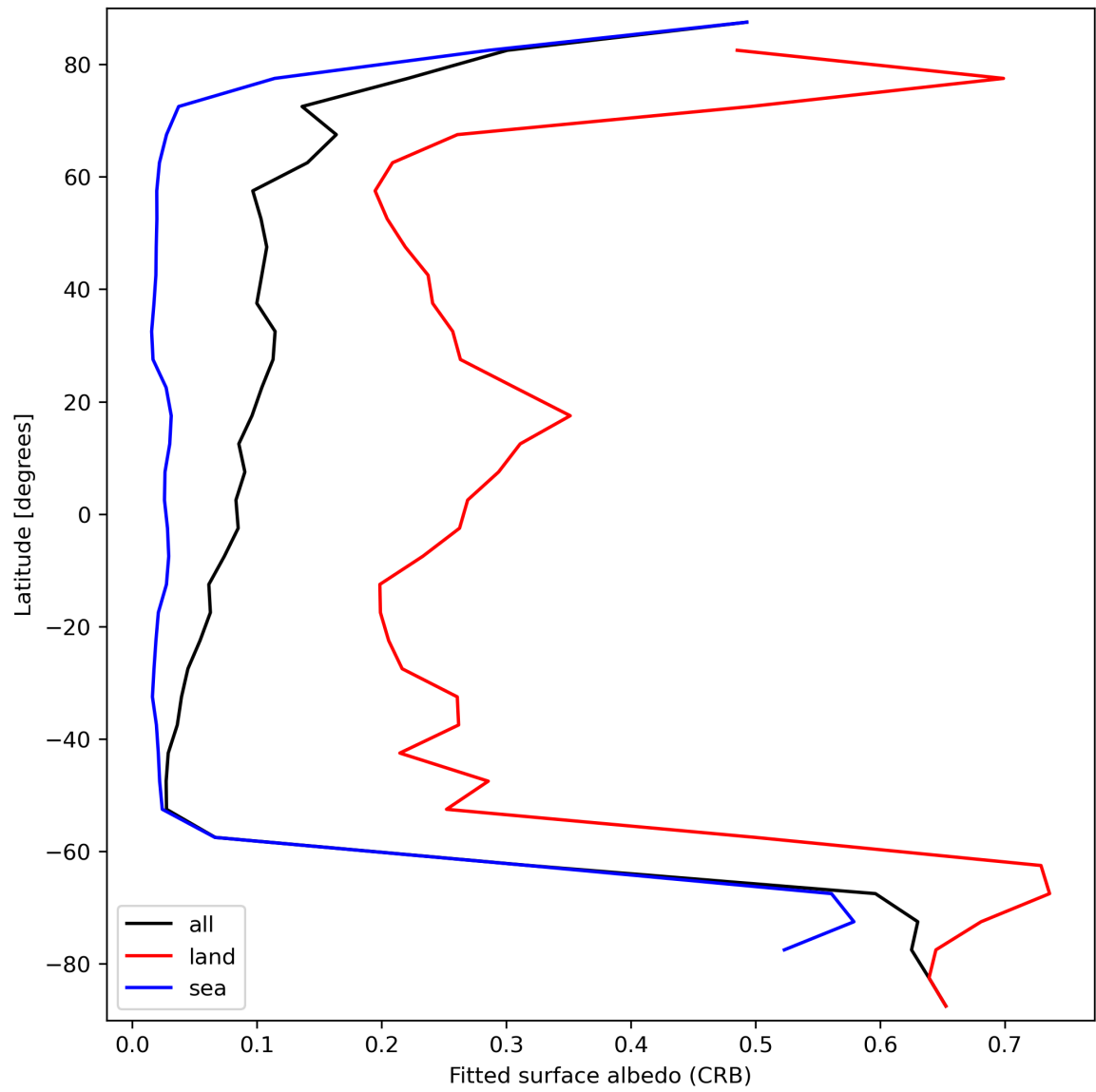


Figure 30: Zonal average of “Fitted surface albedo (CRB)” for 2023-09-20 to 2023-09-22.

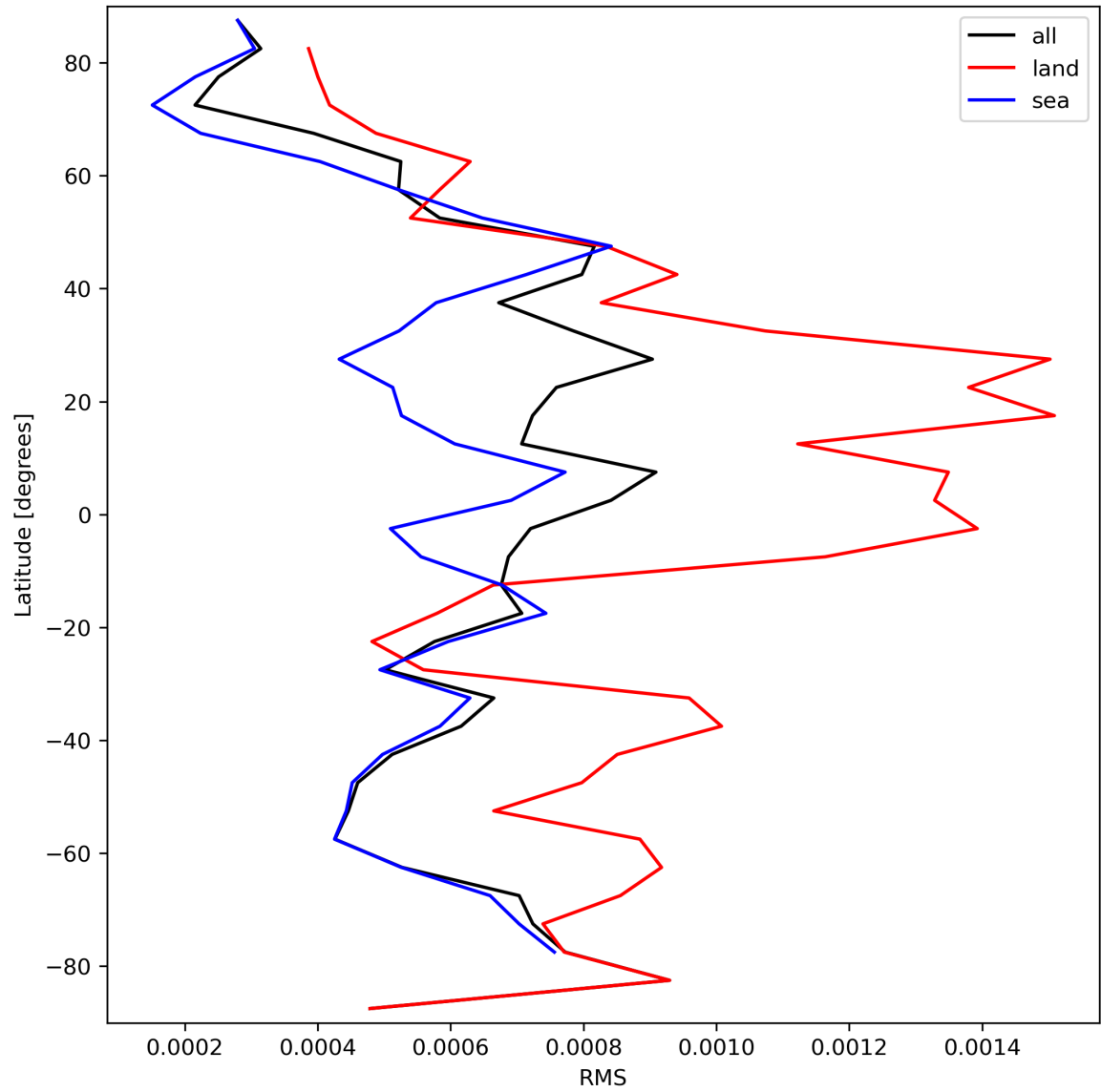


Figure 31: Zonal average of “RMS” for 2023-09-20 to 2023-09-22.



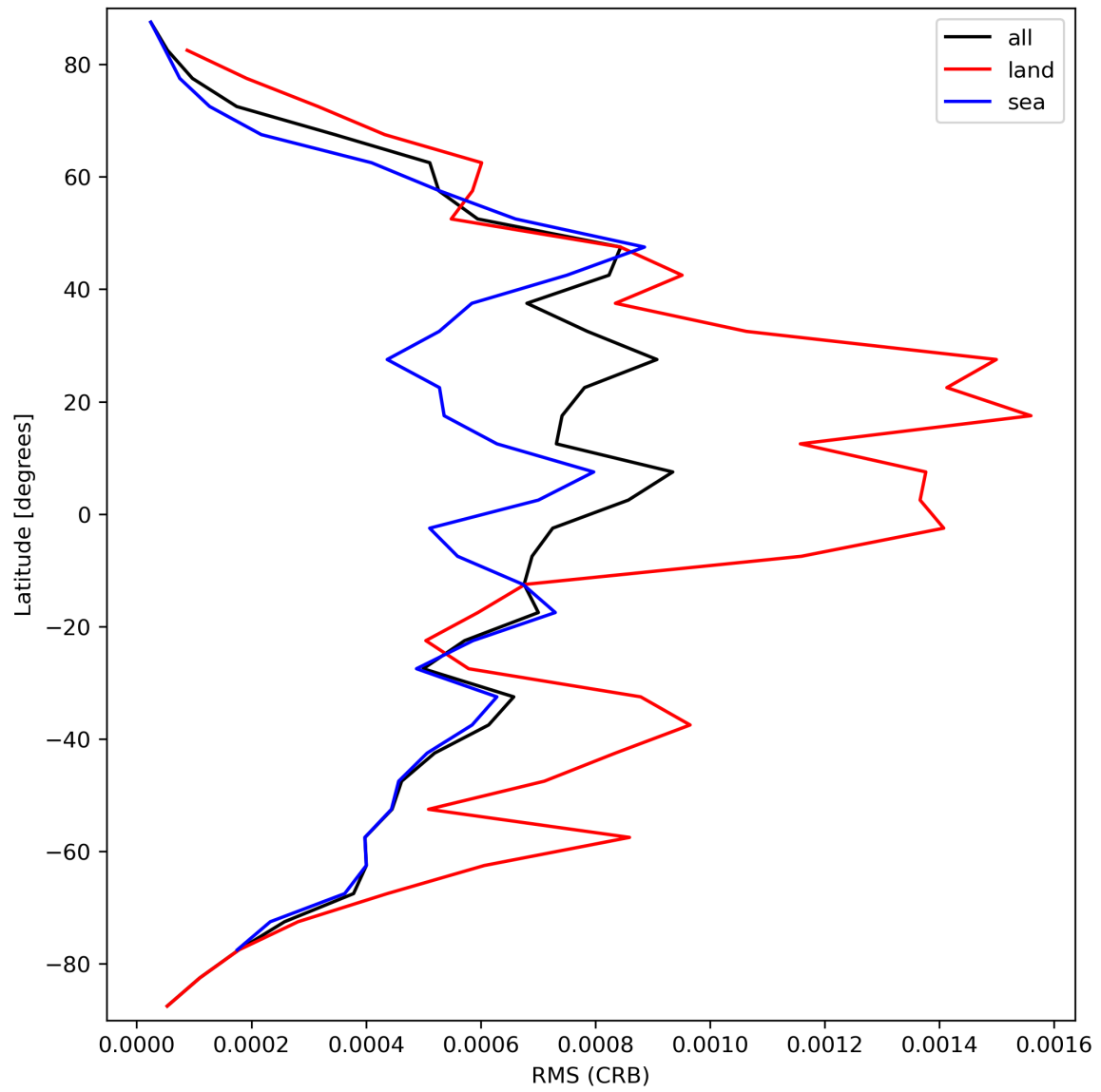


Figure 32: Zonal average of “RMS (CRB)” for 2023-09-20 to 2023-09-22.

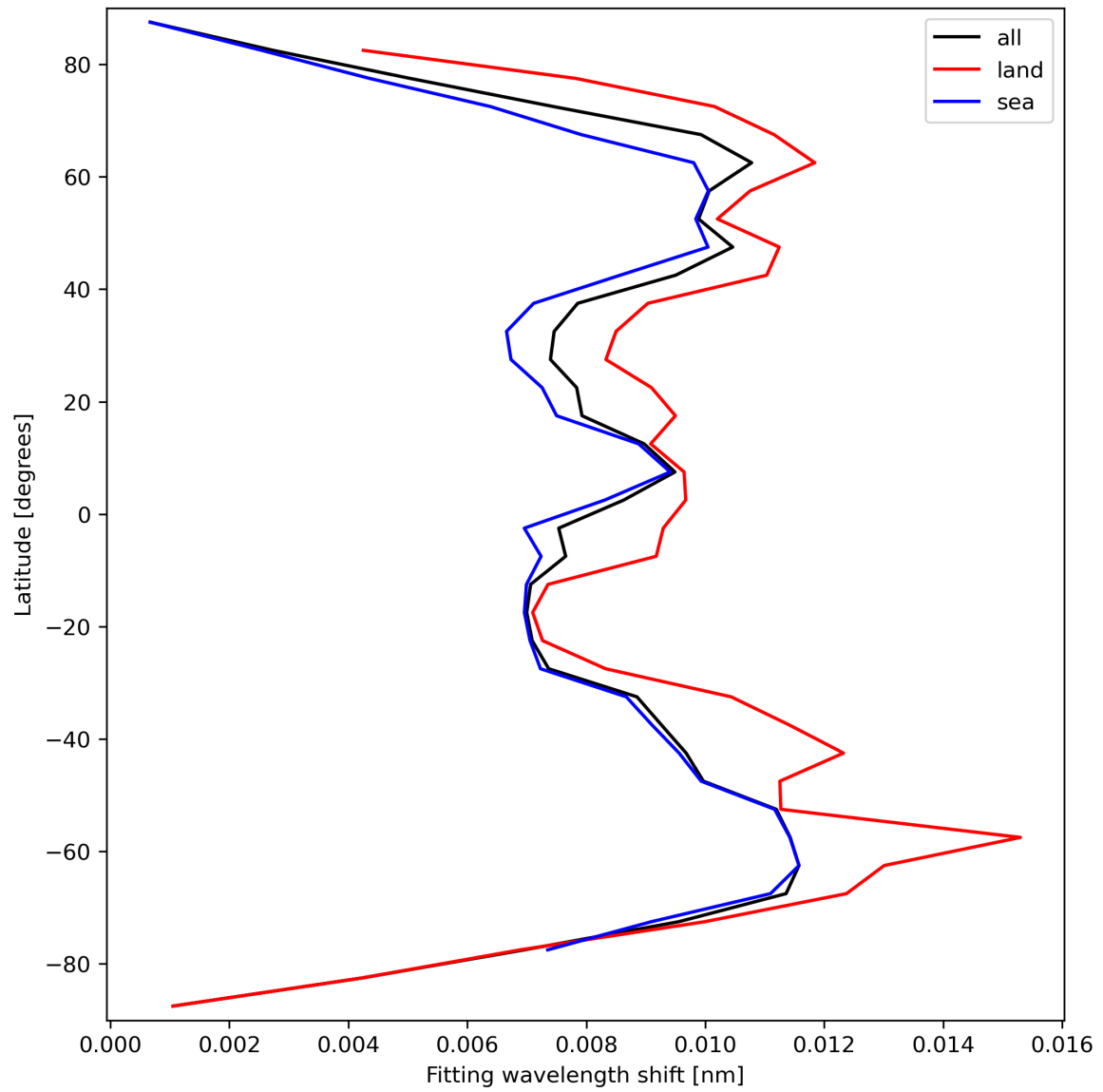


Figure 33: Zonal average of “Fitting wavelength shift” for 2023-09-20 to 2023-09-22.

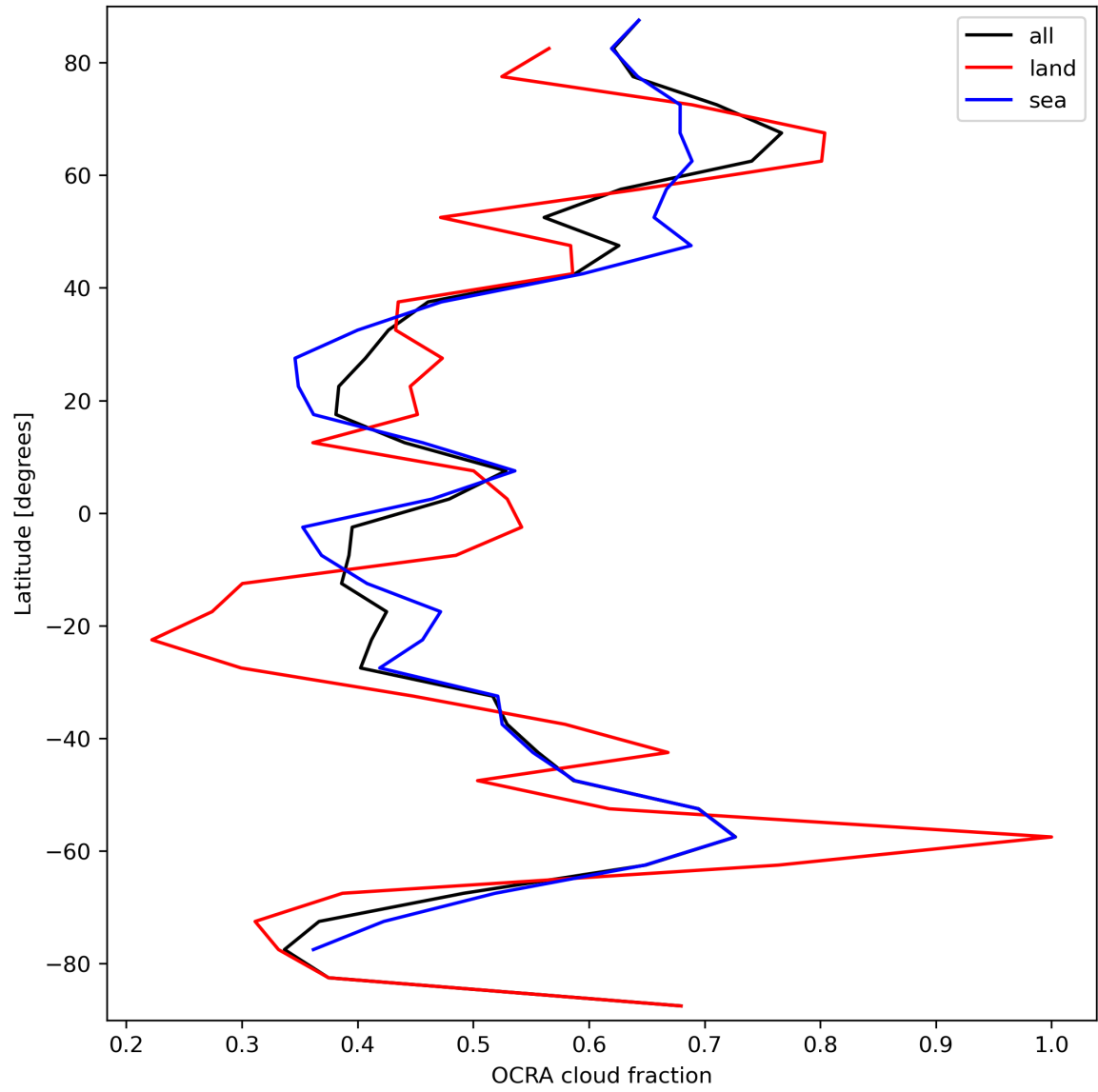


Figure 34: Zonal average of “OCRA cloud fraction” for 2023-09-20 to 2023-09-22.

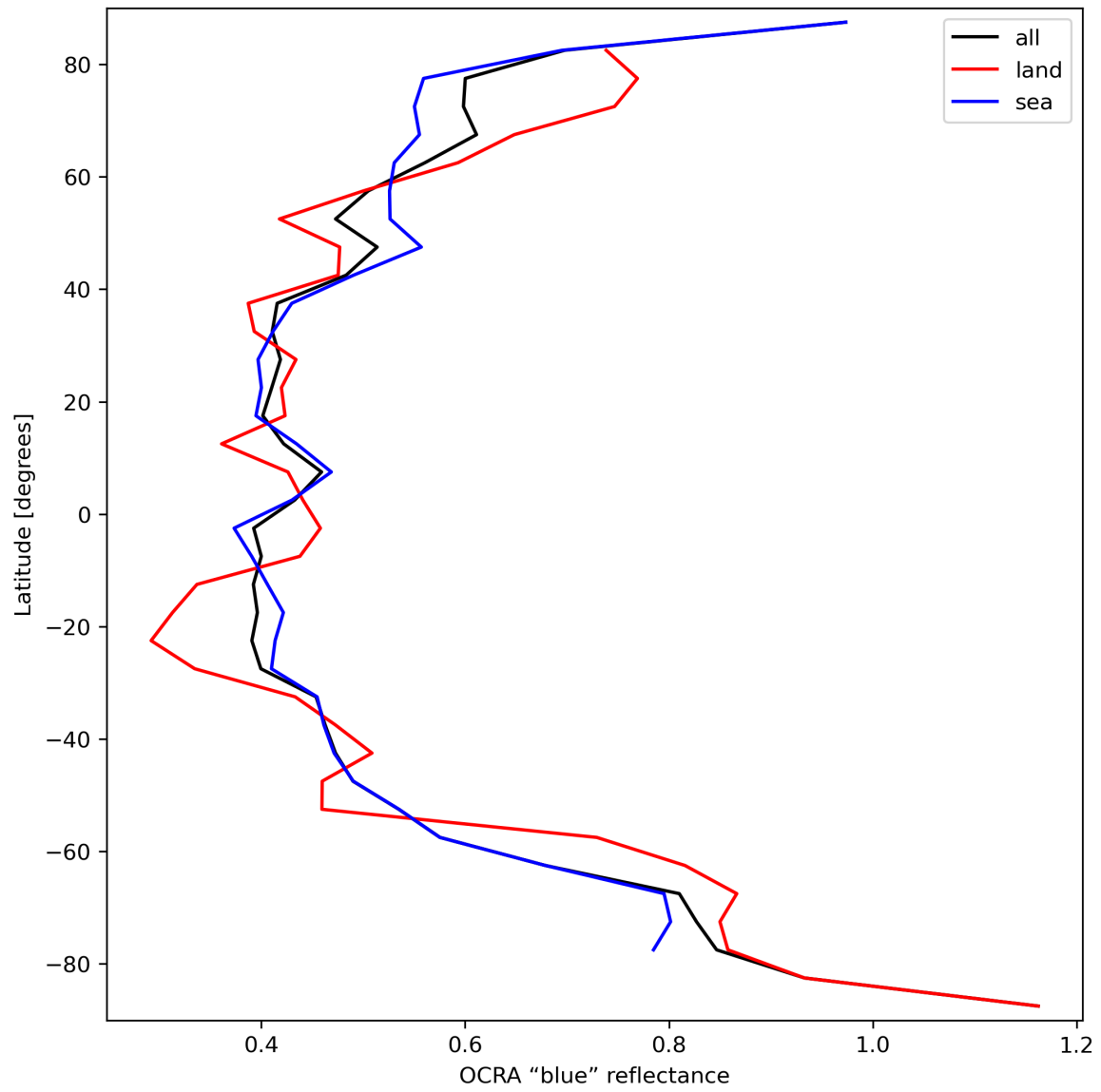


Figure 35: Zonal average of “OCRA “blue” reflectance” for 2023-09-20 to 2023-09-22.

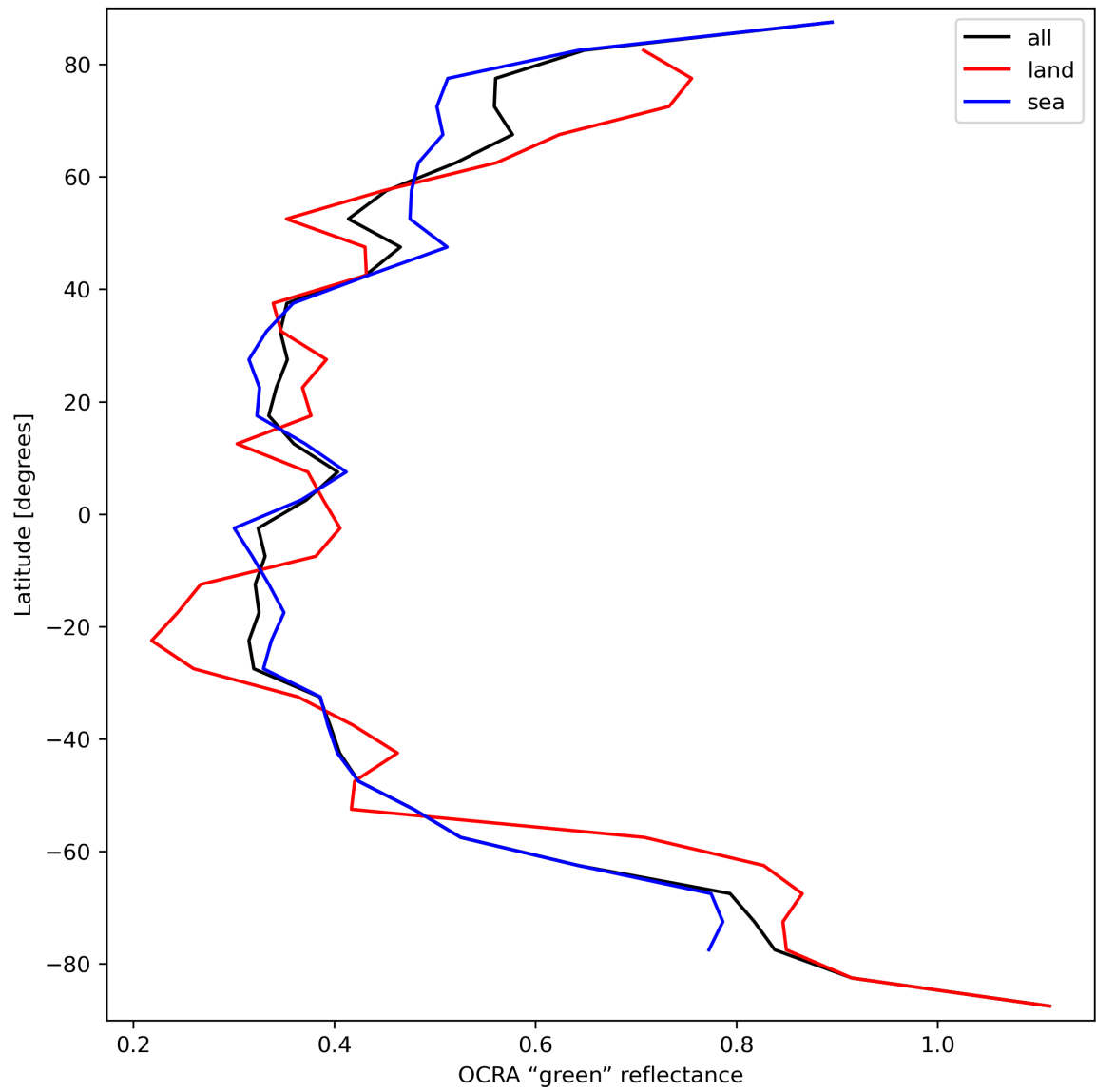


Figure 36: Zonal average of “OCRA “green” reflectance” for 2023-09-20 to 2023-09-22.



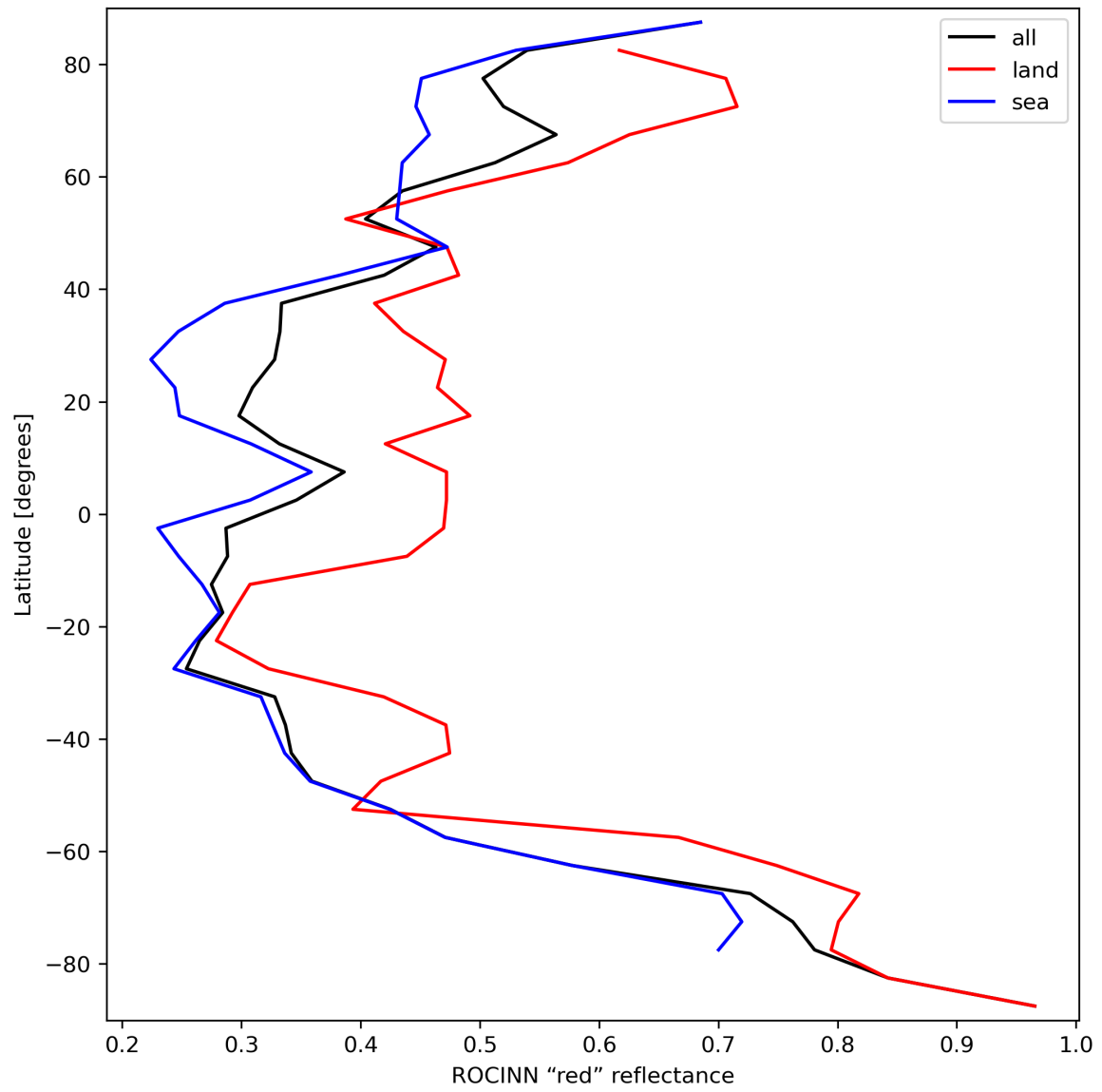


Figure 37: Zonal average of “ROCINN “red” reflectance” for 2023-09-20 to 2023-09-22.

## 8 Histograms

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

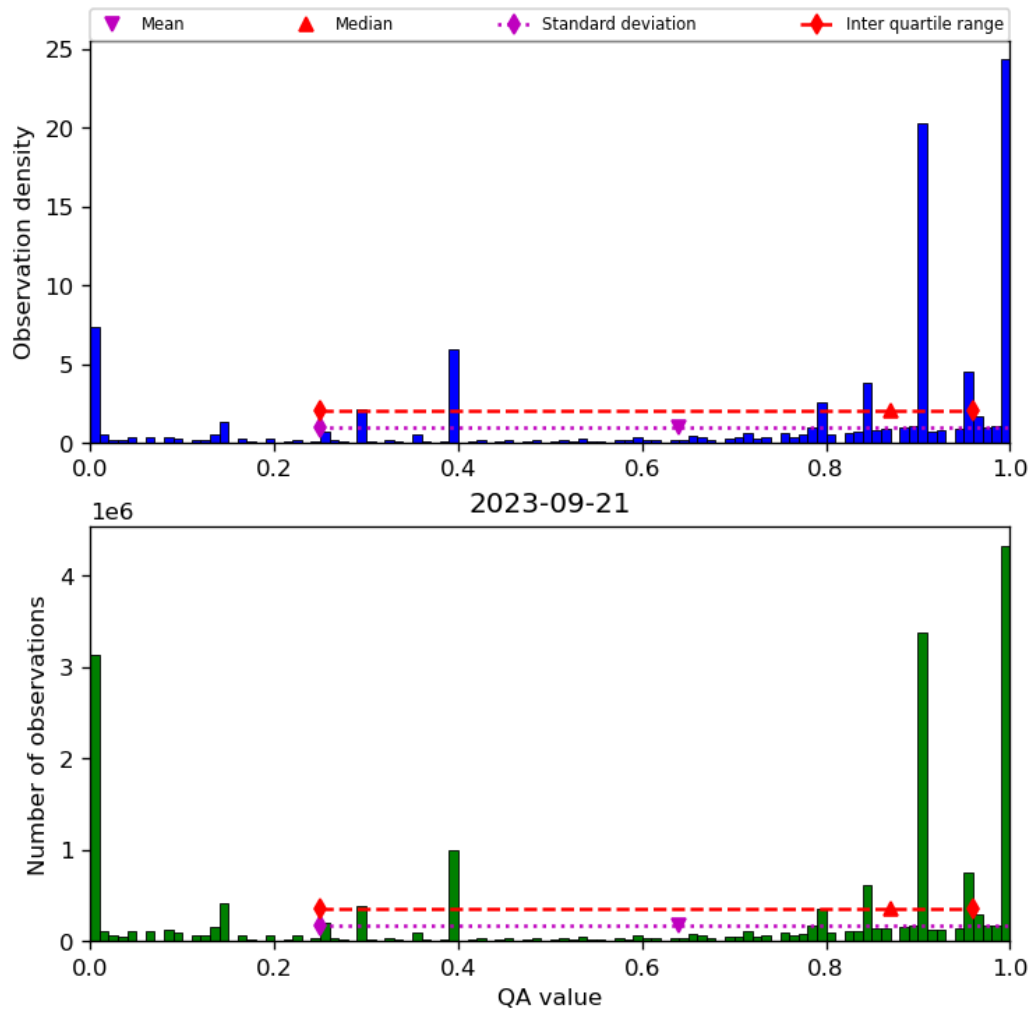


Figure 38: Histogram of “QA value” for 2023-09-20 to 2023-09-22

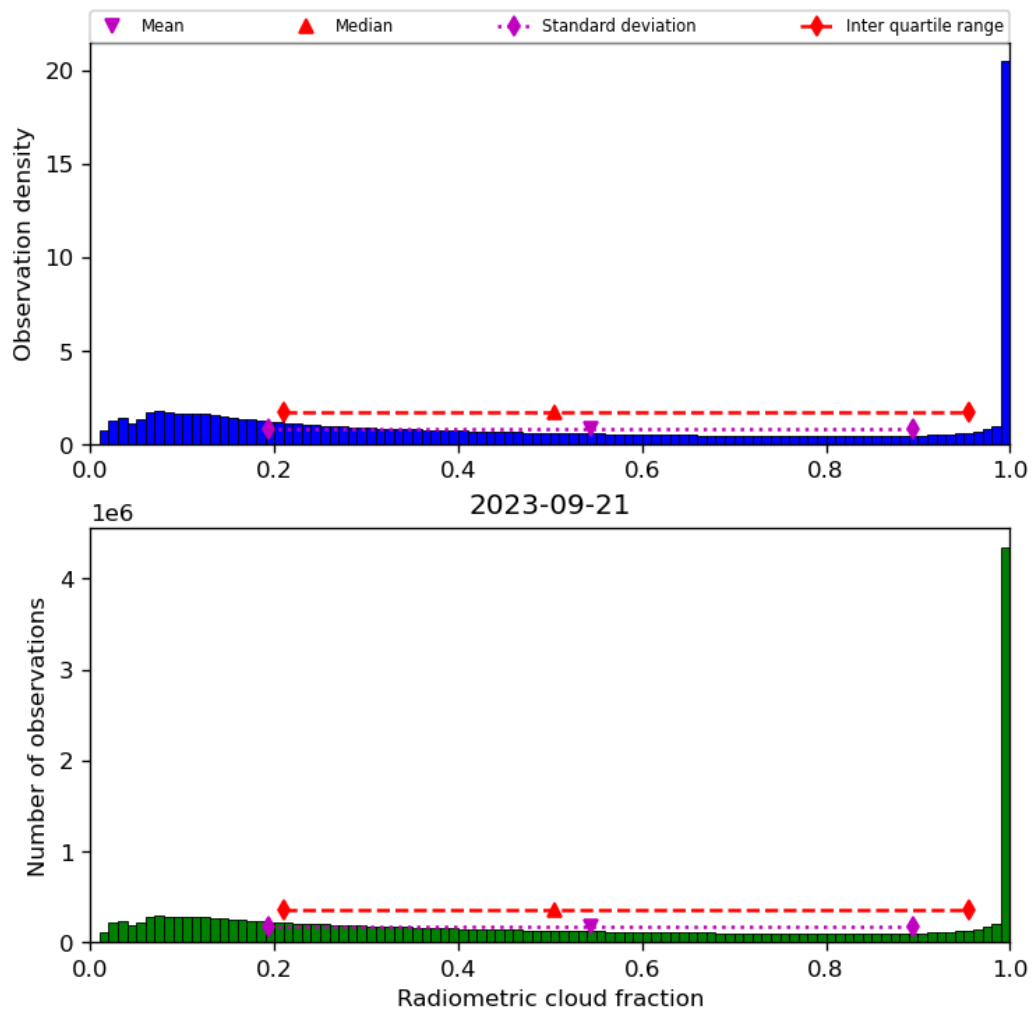


Figure 39: Histogram of “Radiometric cloud fraction” for 2023-09-20 to 2023-09-22

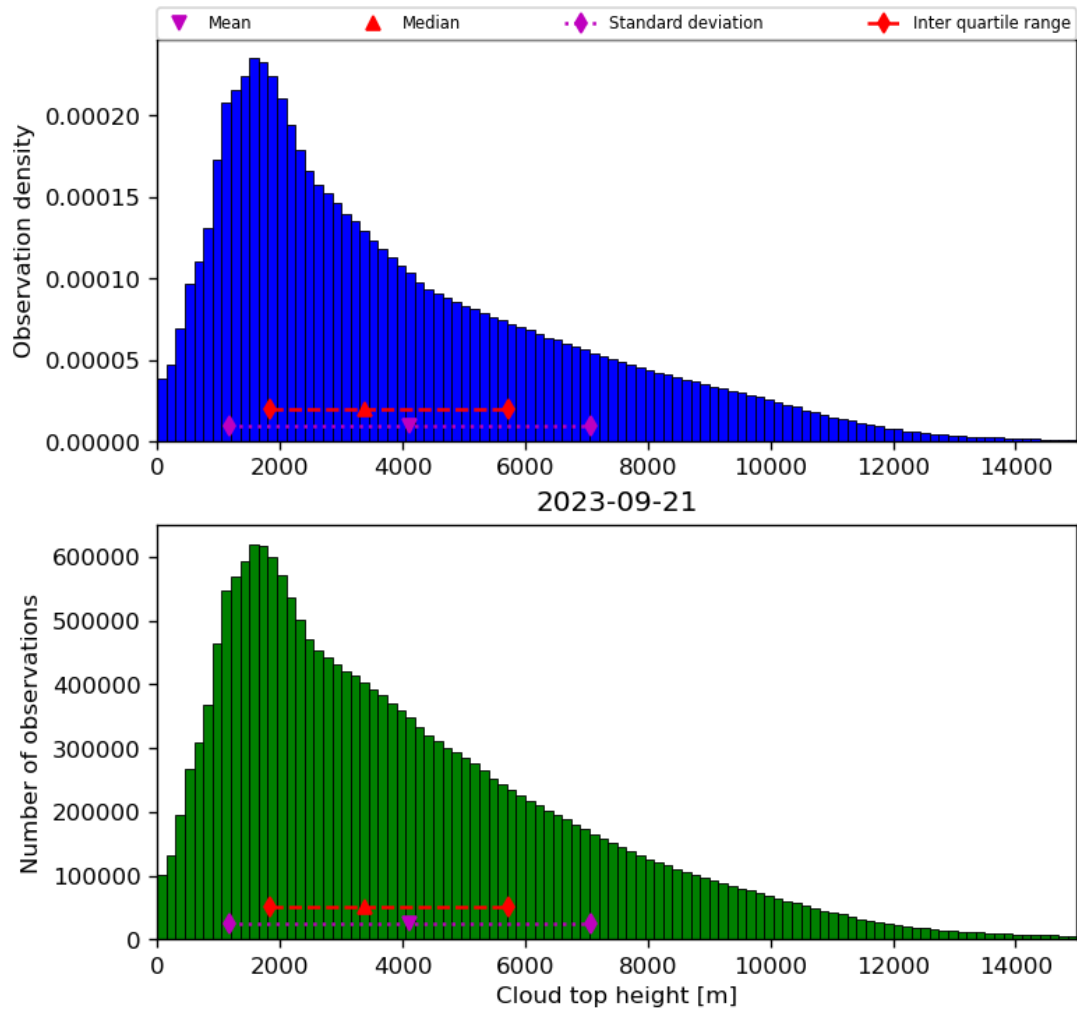


Figure 40: Histogram of “Cloud top height” for 2023-09-20 to 2023-09-22

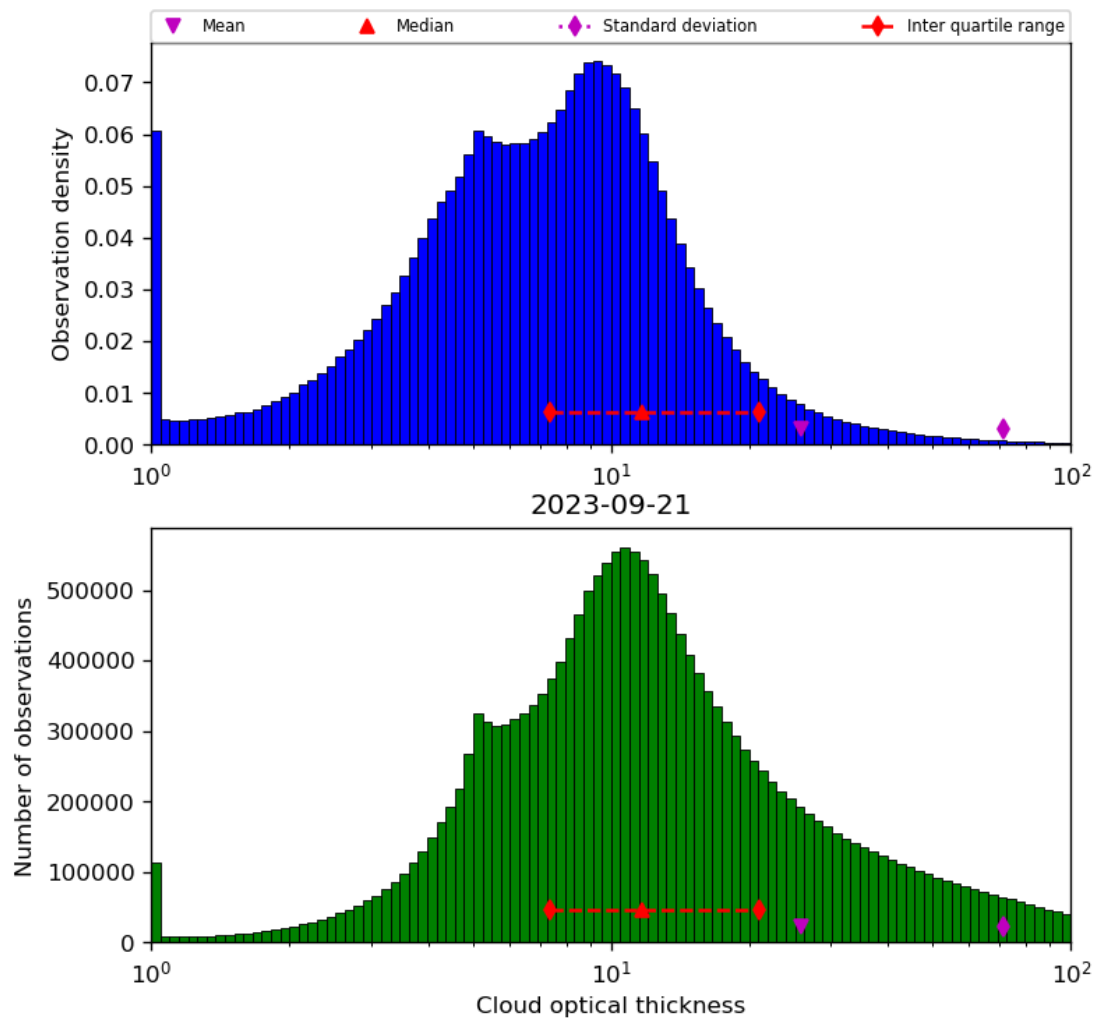


Figure 41: Histogram of “Cloud optical thickness” for 2023-09-20 to 2023-09-22

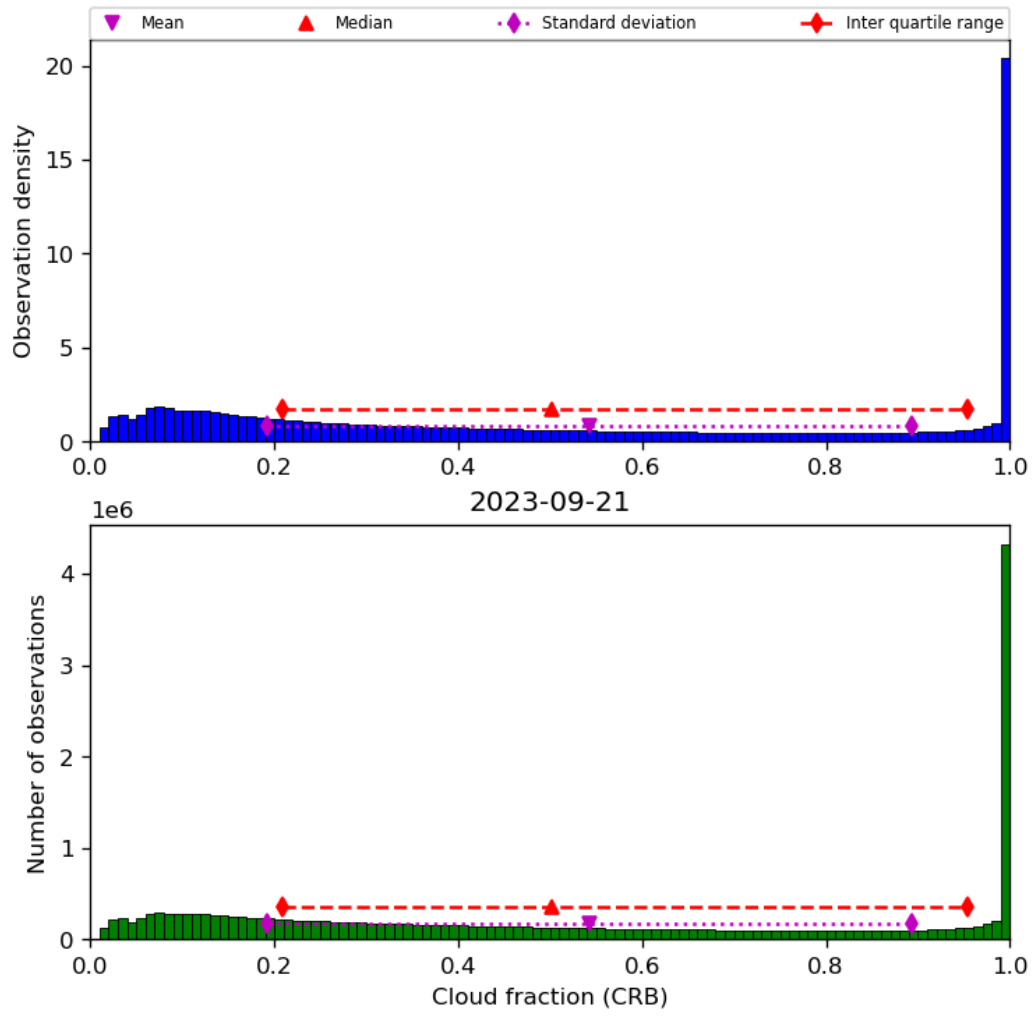


Figure 42: Histogram of “Cloud fraction (CRB)” for 2023-09-20 to 2023-09-22



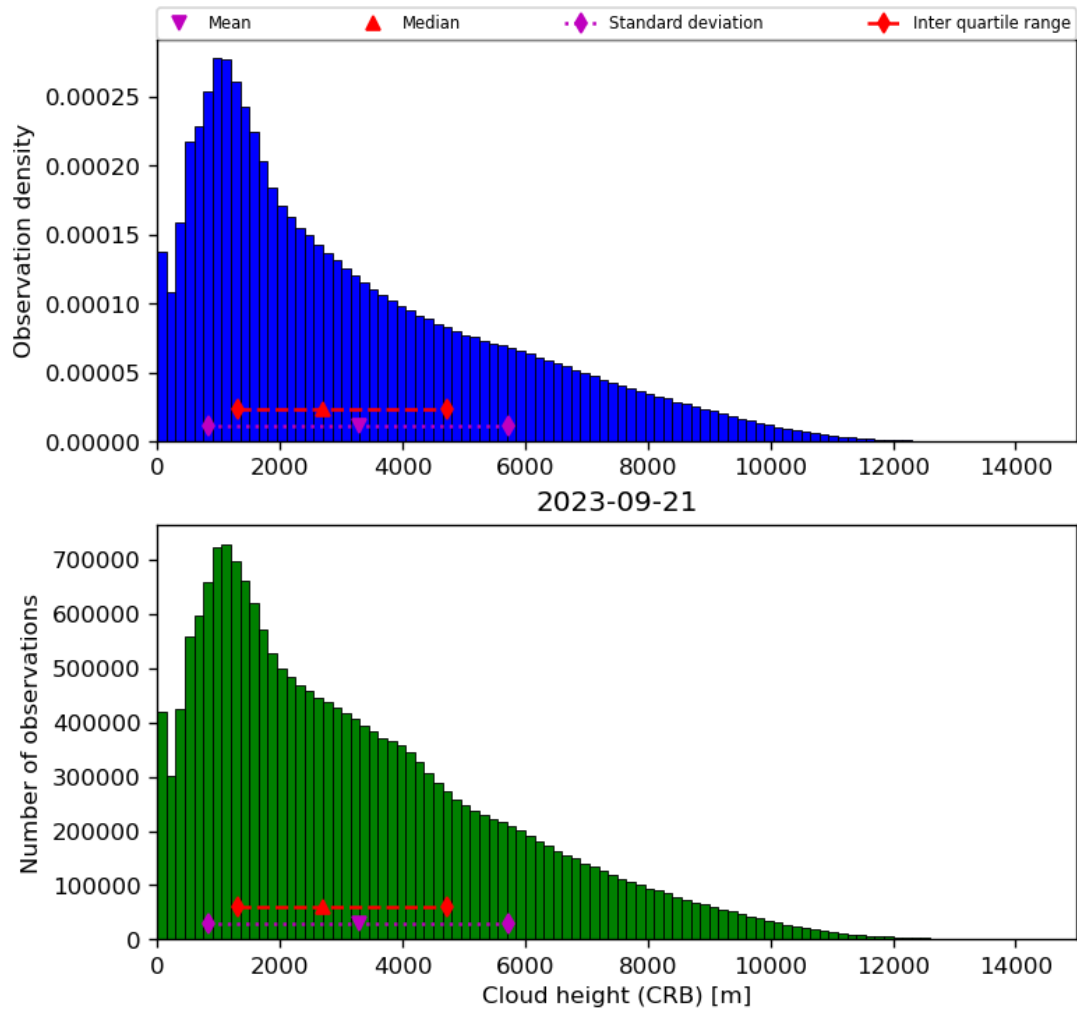


Figure 43: Histogram of “Cloud height (CRB)” for 2023-09-20 to 2023-09-22

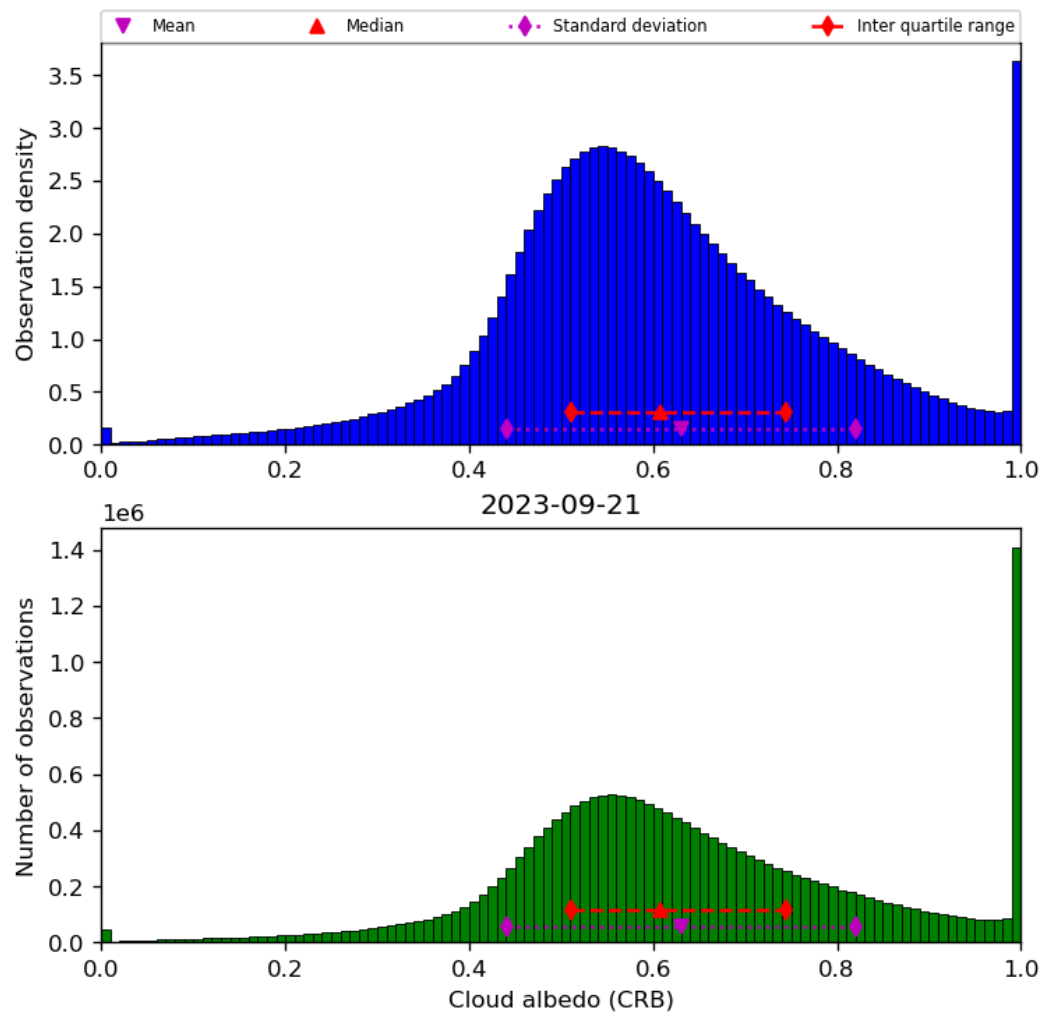


Figure 44: Histogram of “Cloud albedo (CRB)” for 2023-09-20 to 2023-09-22

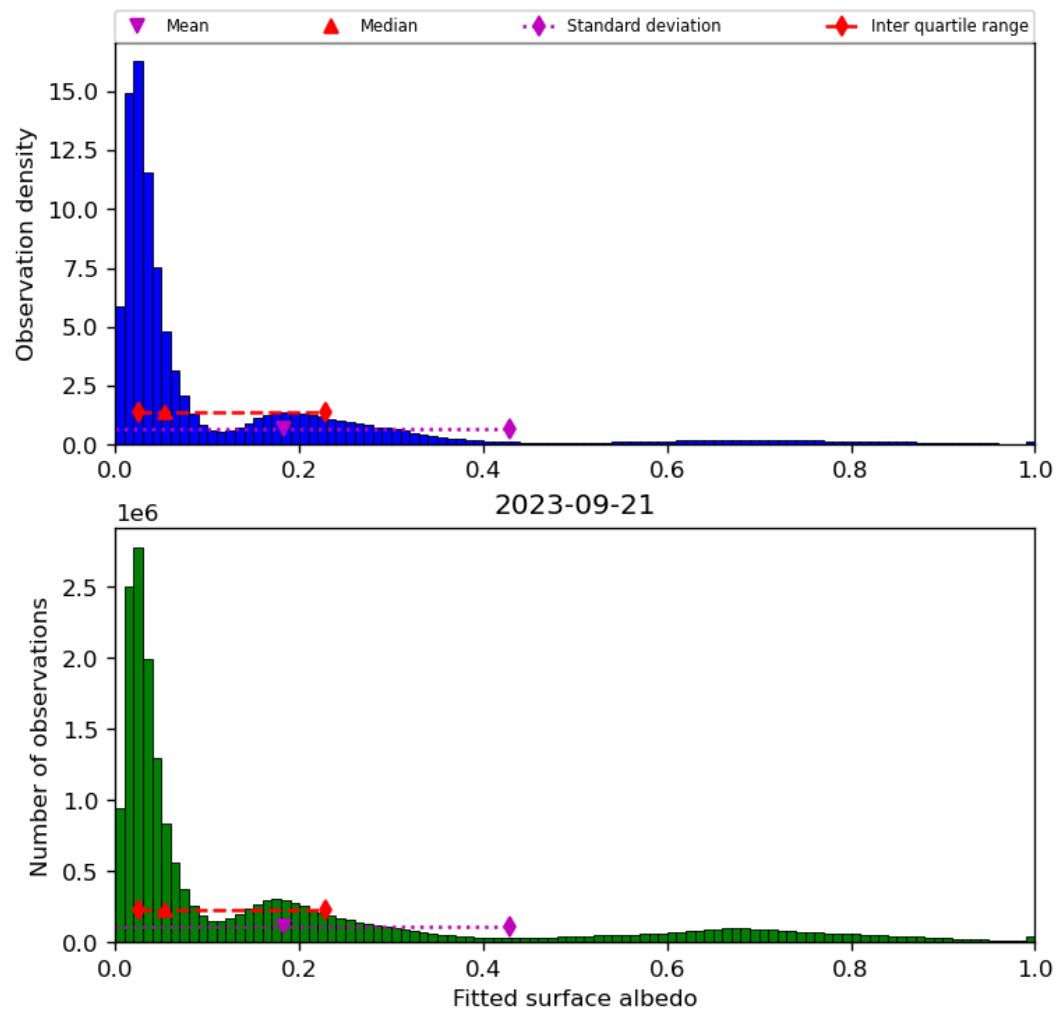


Figure 45: Histogram of “Fitted surface albedo” for 2023-09-20 to 2023-09-22

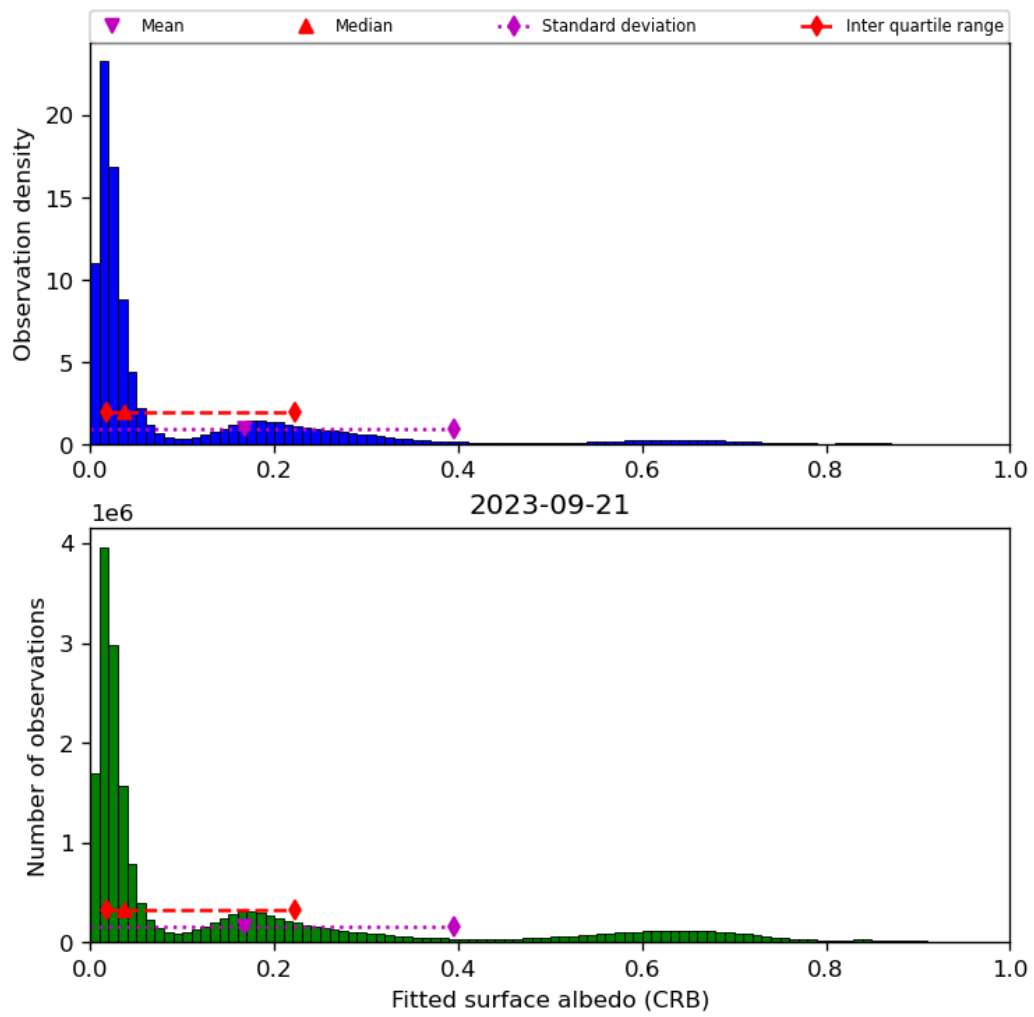


Figure 46: Histogram of “Fitted surface albedo (CRB)” for 2023-09-20 to 2023-09-22

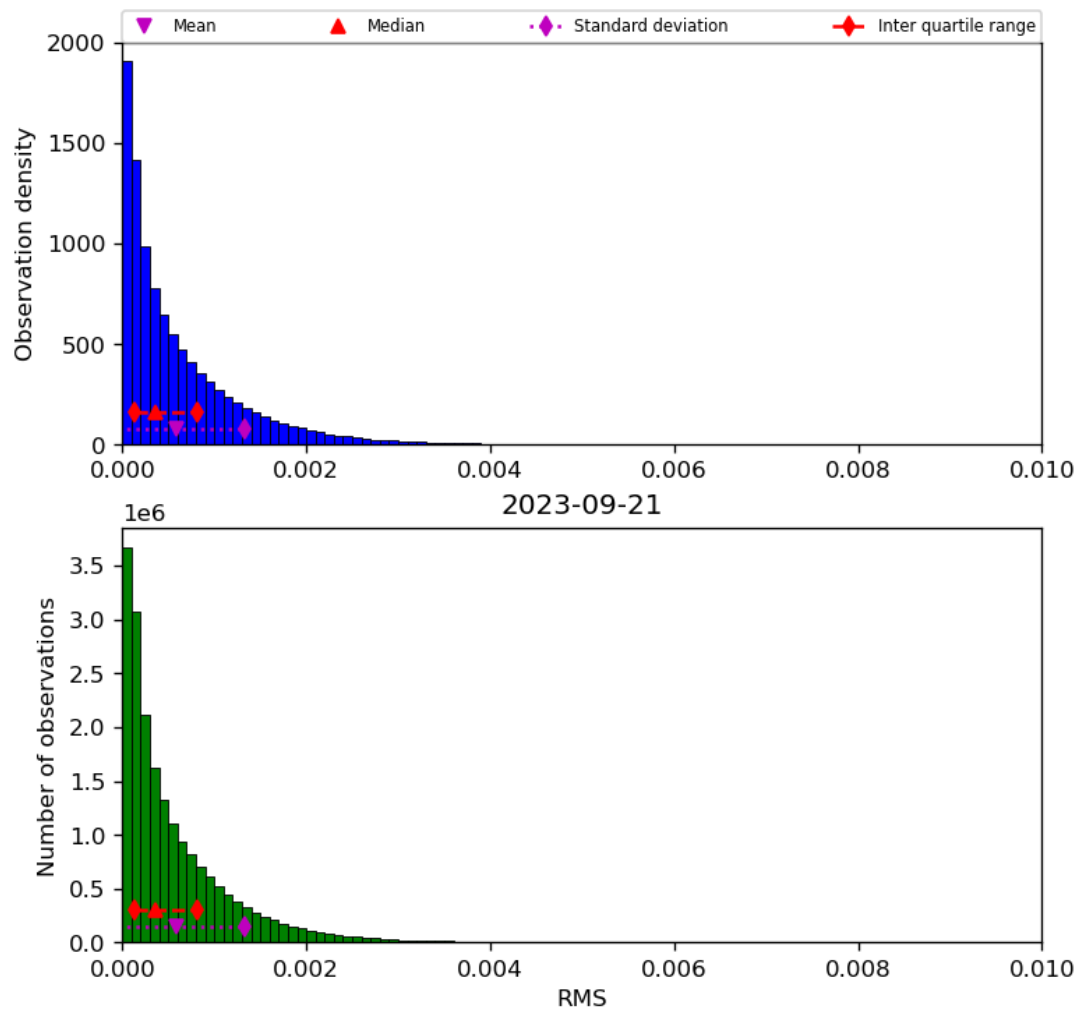


Figure 47: Histogram of “RMS” for 2023-09-20 to 2023-09-22

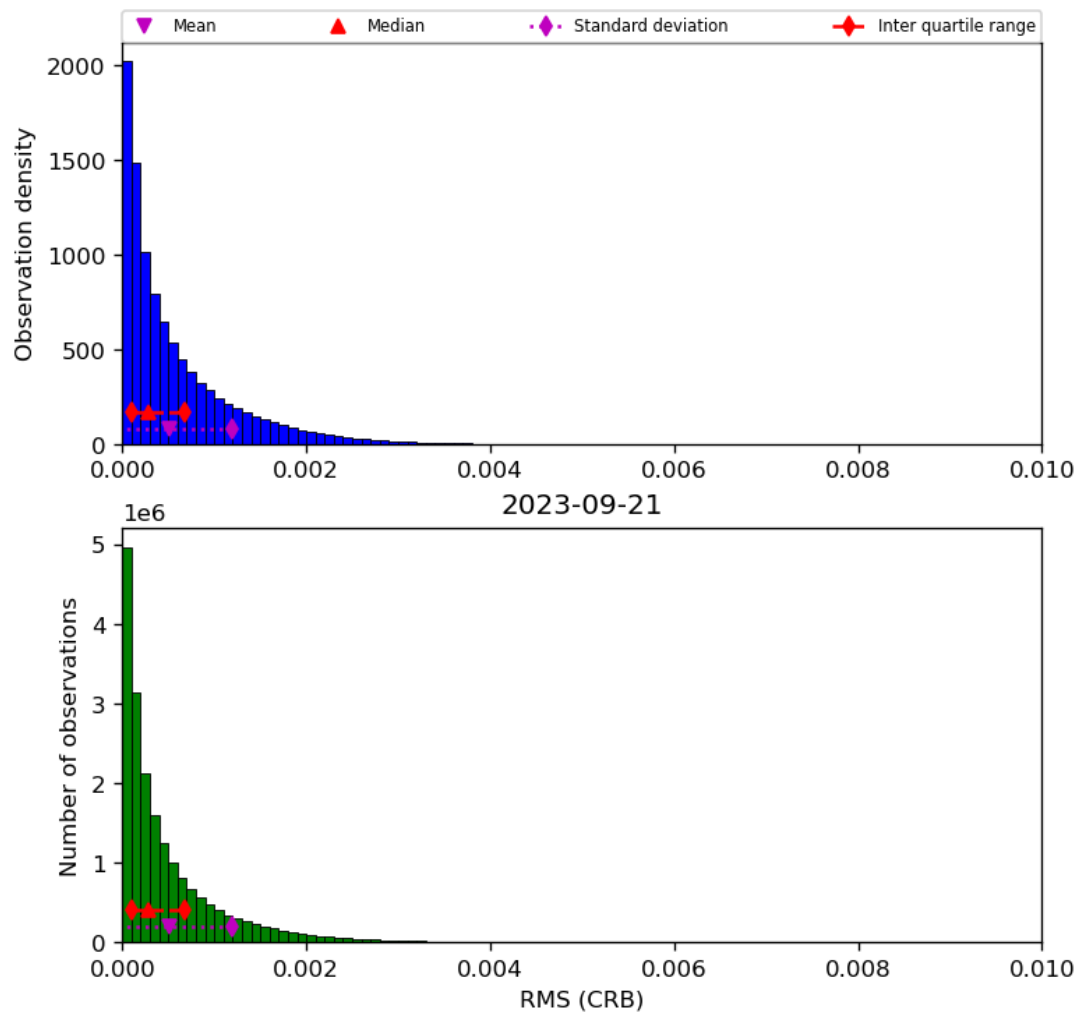


Figure 48: Histogram of “RMS (CRB)” for 2023-09-20 to 2023-09-22

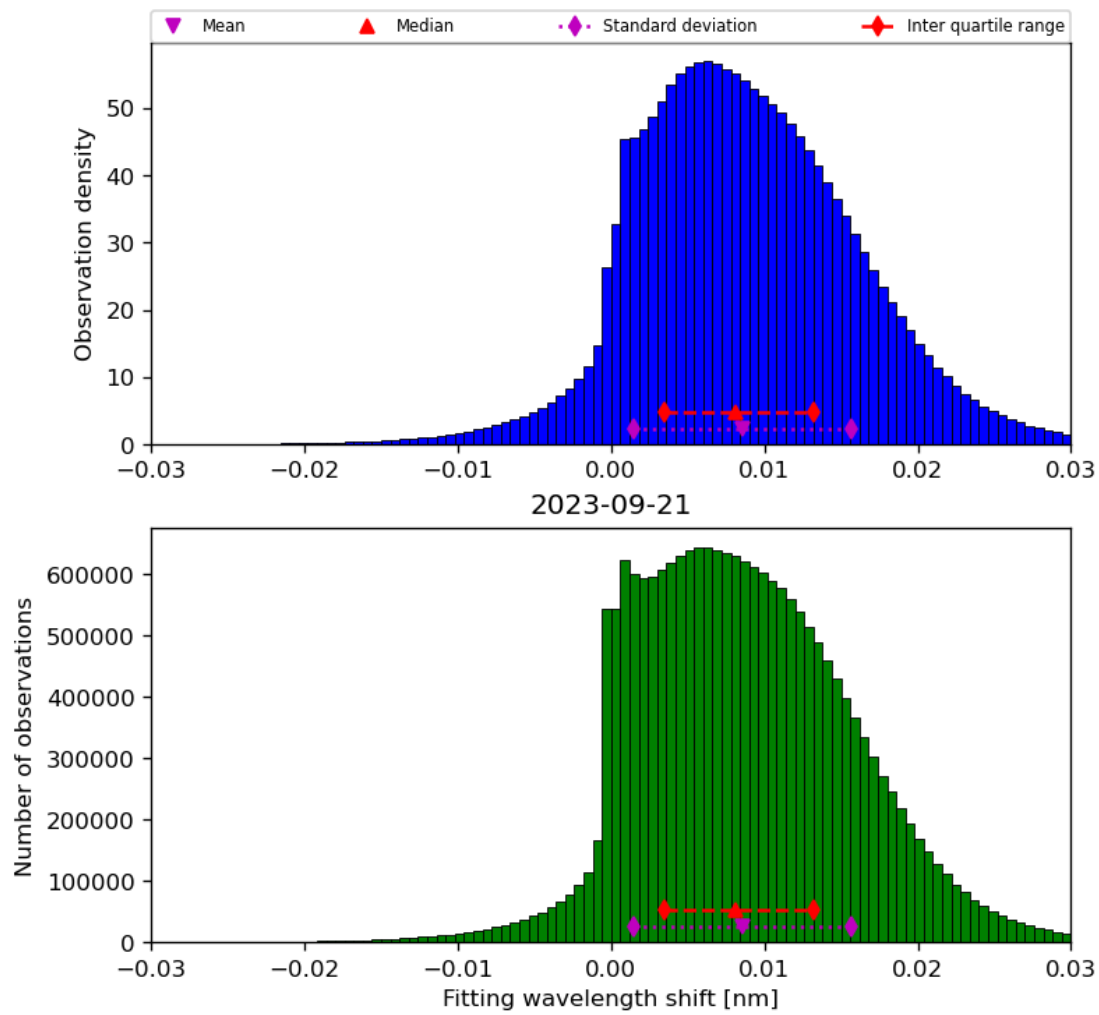


Figure 49: Histogram of “Fitting wavelength shift” for 2023-09-20 to 2023-09-22



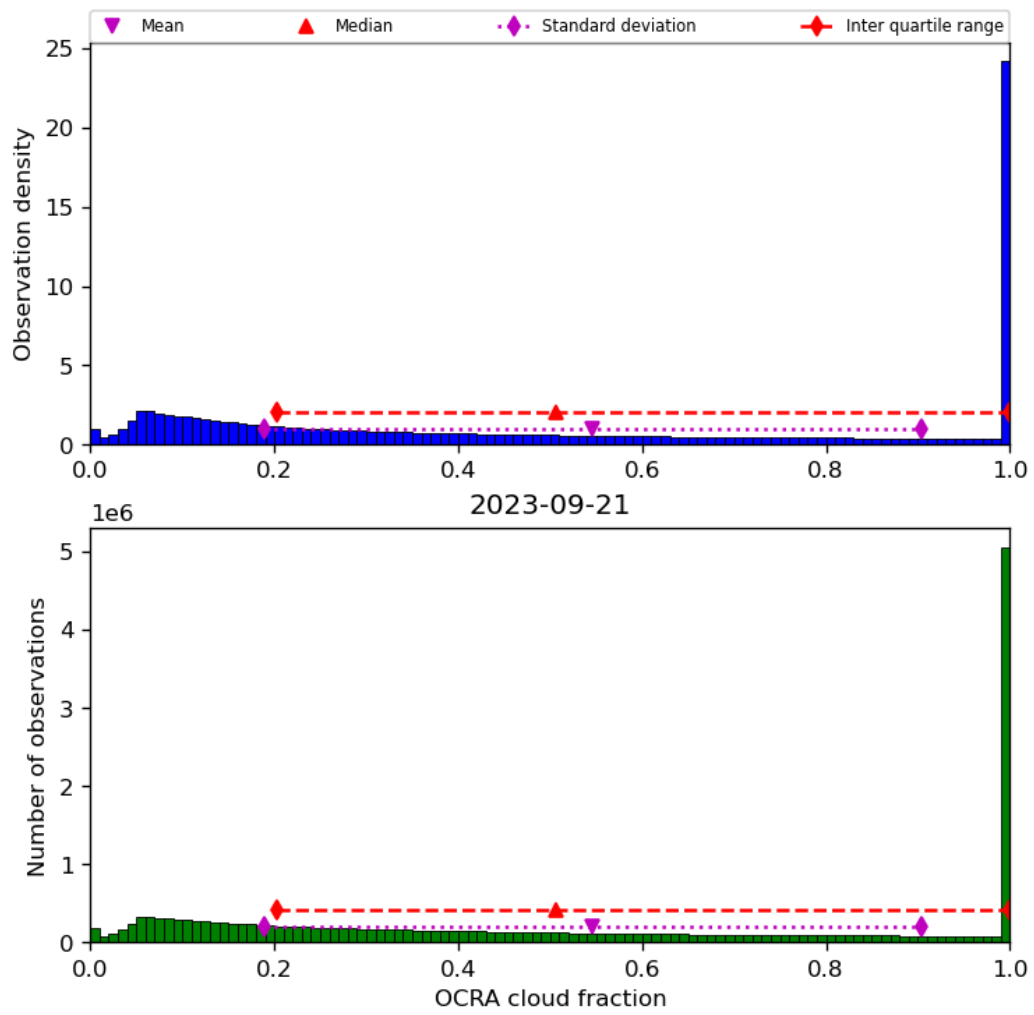


Figure 50: Histogram of “OCRA cloud fraction” for 2023-09-20 to 2023-09-22

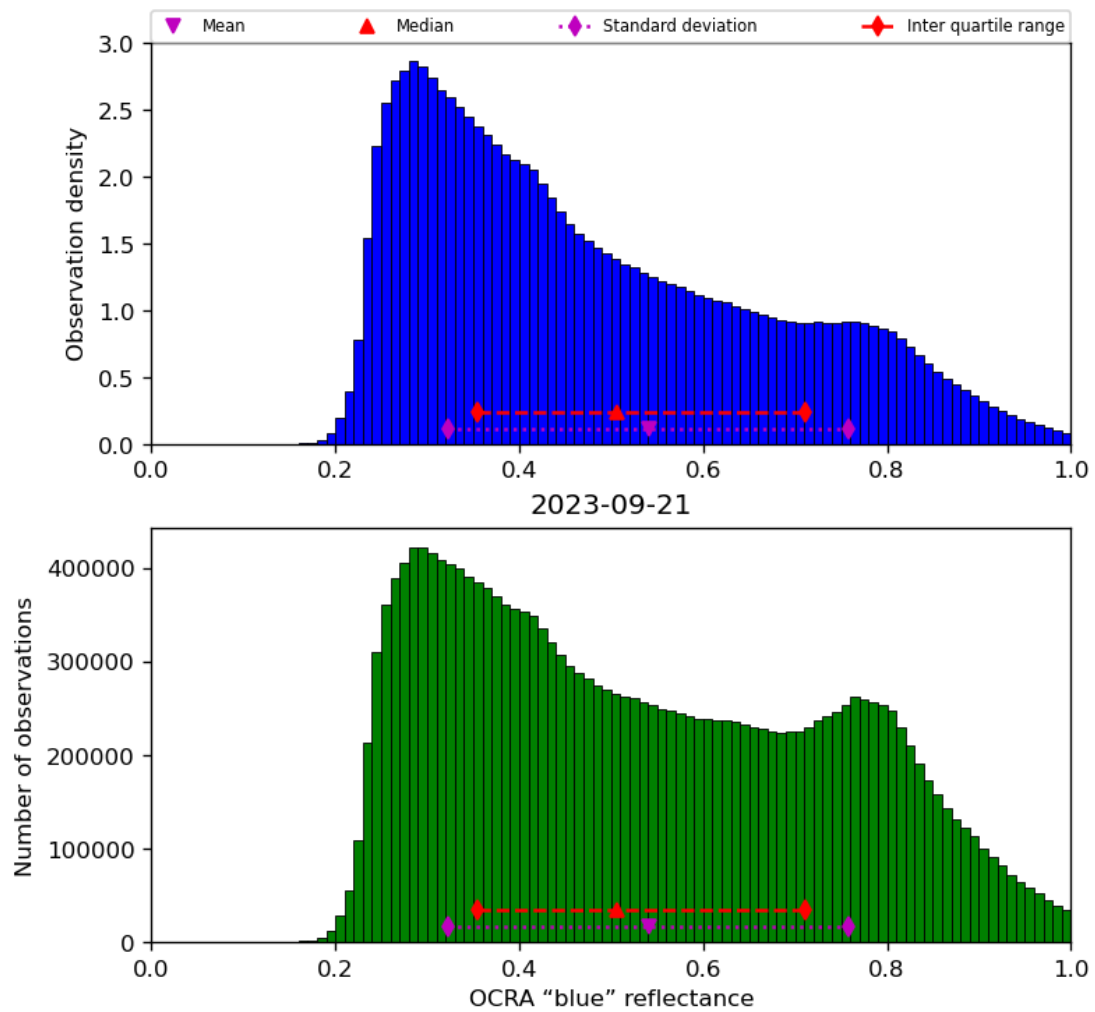


Figure 51: Histogram of “OCRA “blue” reflectance” for 2023-09-20 to 2023-09-22

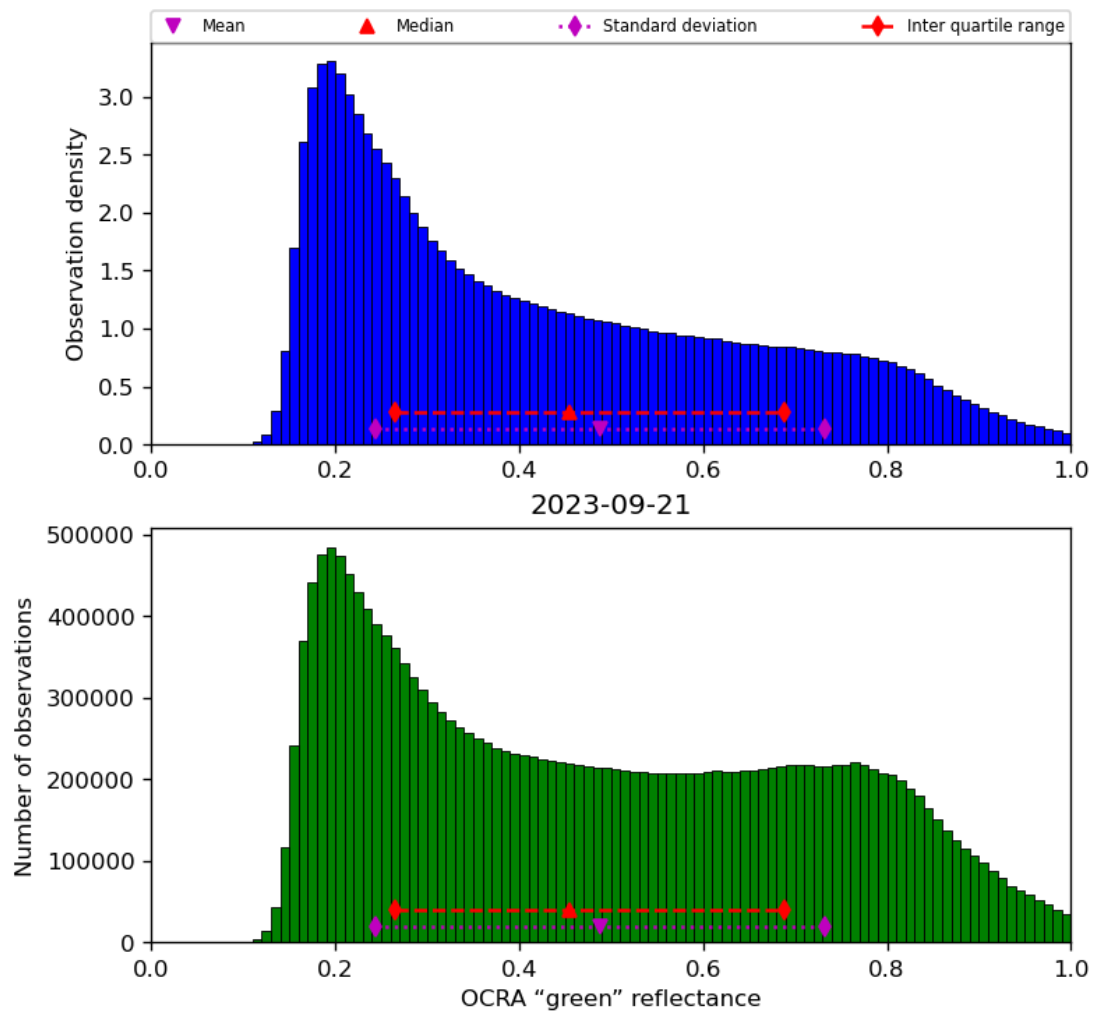


Figure 52: Histogram of “OCRA “green” reflectance” for 2023-09-20 to 2023-09-22

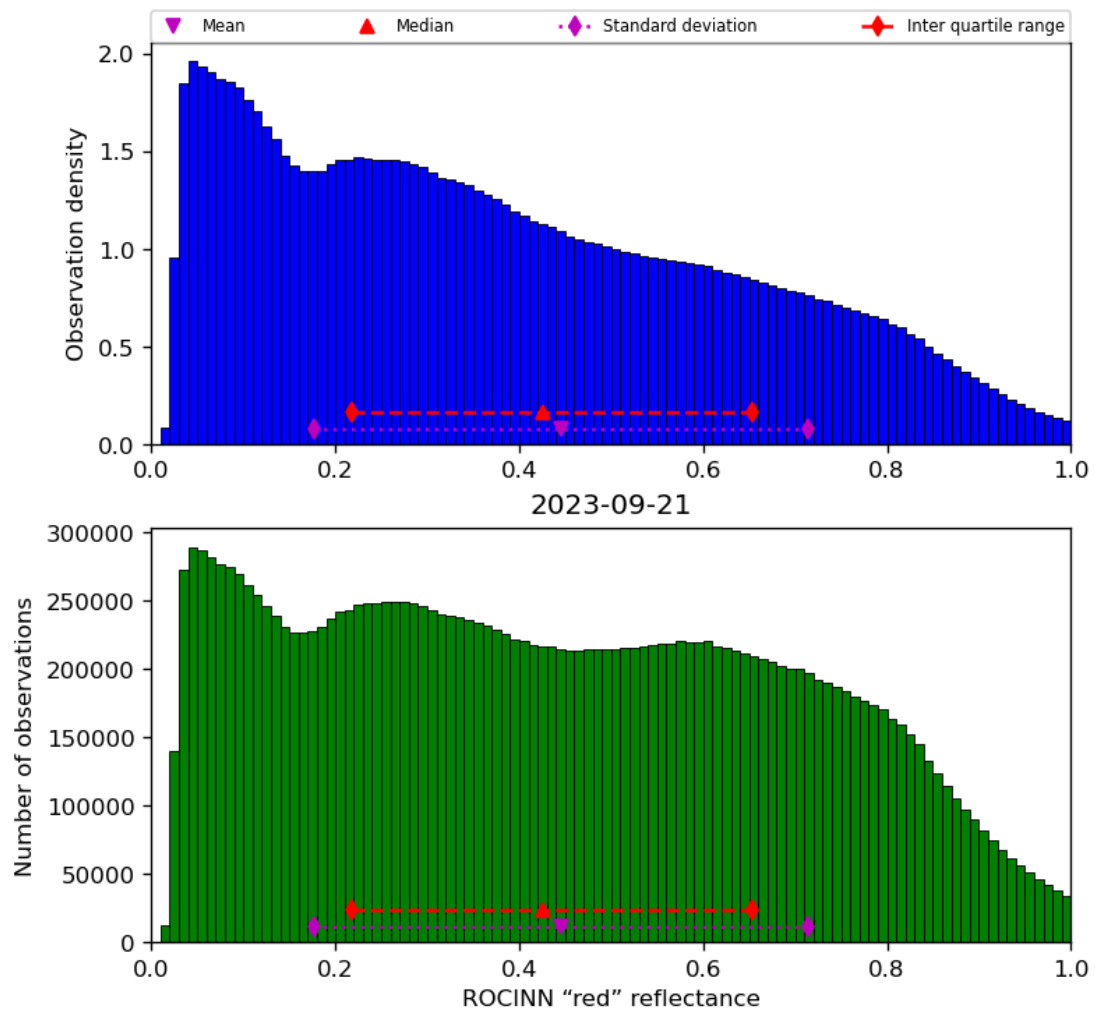


Figure 53: Histogram of “ROCINN “red” reflectance” for 2023-09-20 to 2023-09-22

## 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.

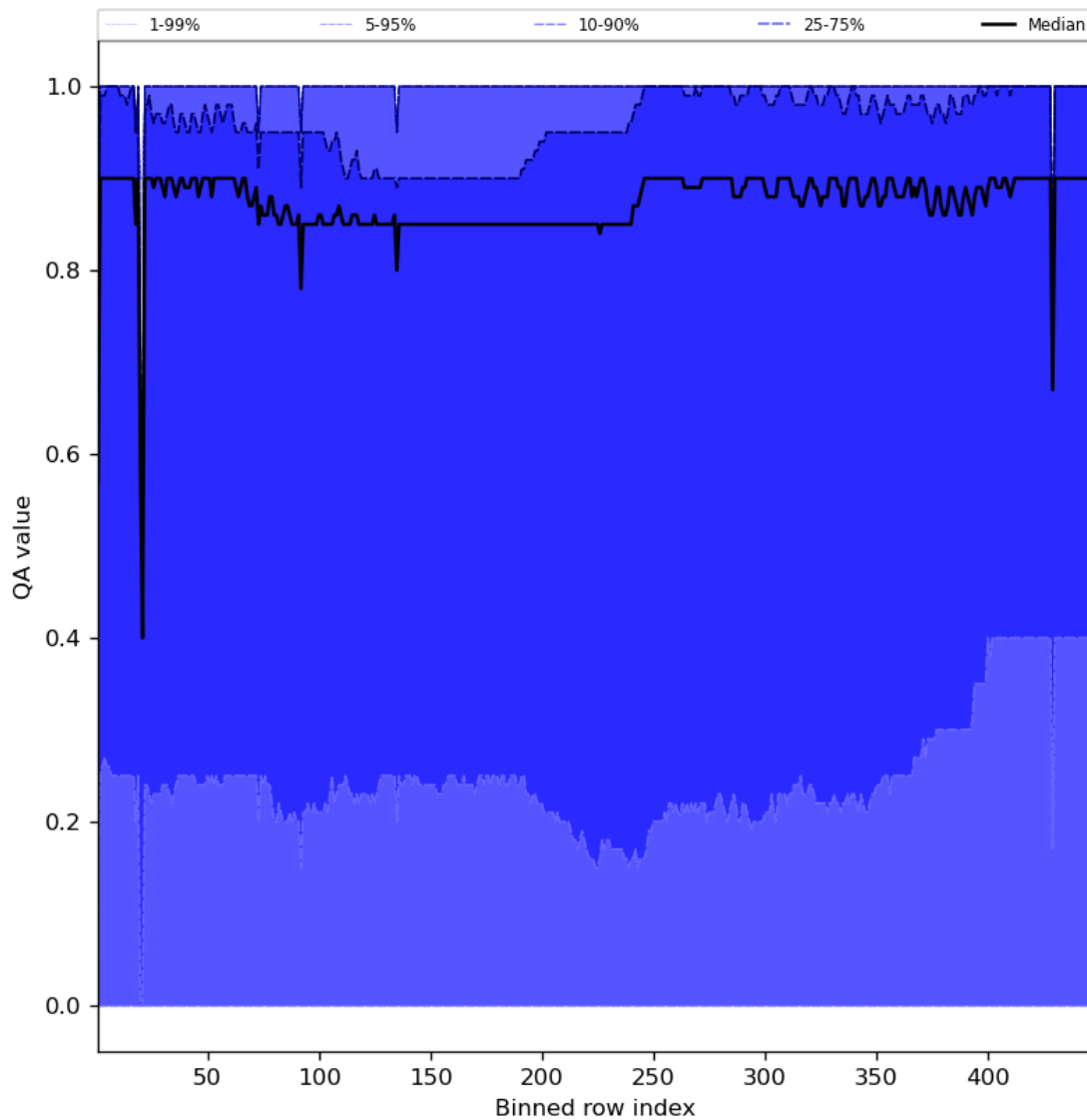


Figure 54: Along track statistics of “QA value” for 2023-09-20 to 2023-09-22

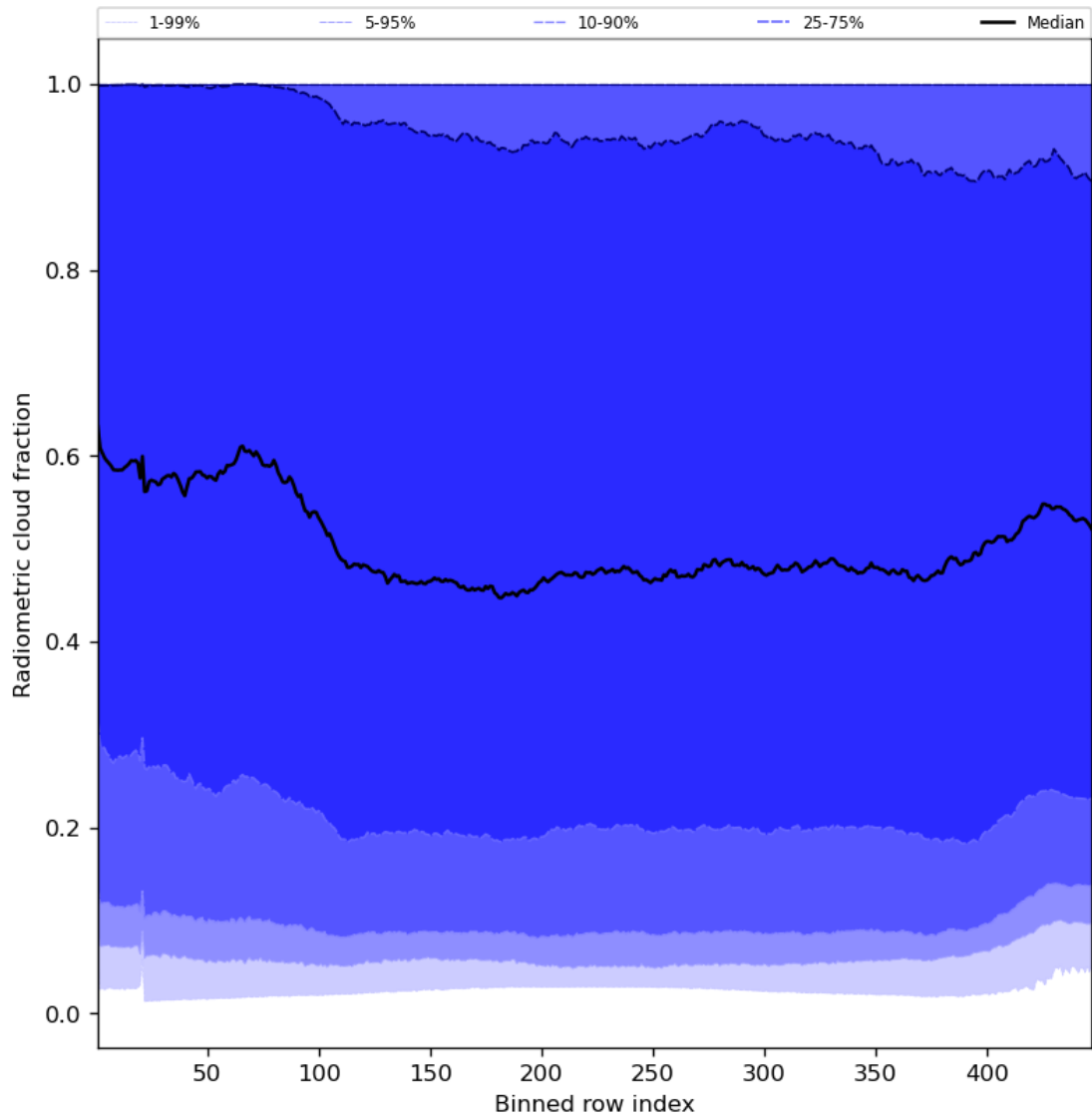


Figure 55: Along track statistics of “Radiometric cloud fraction” for 2023-09-20 to 2023-09-22

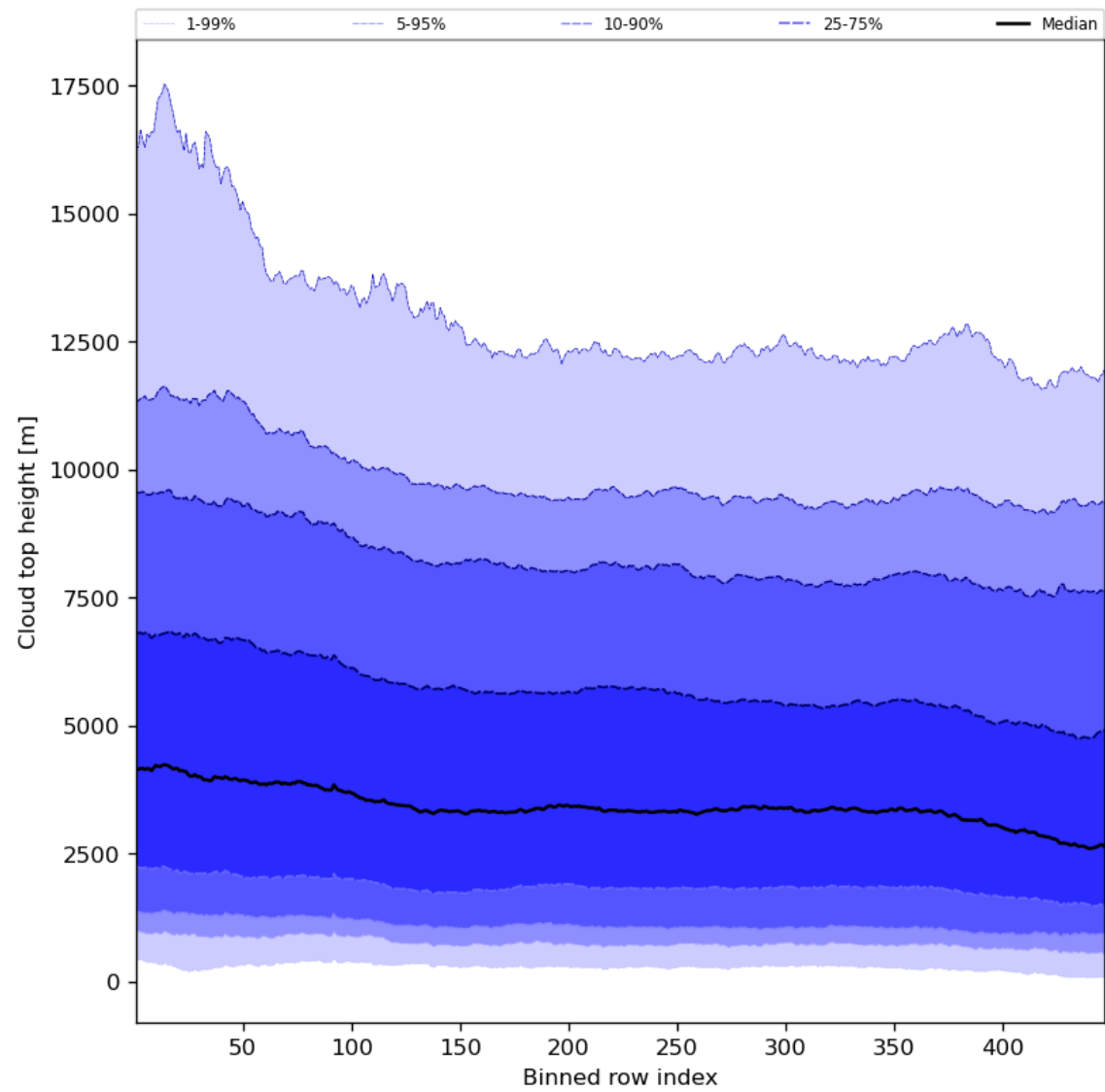


Figure 56: Along track statistics of “Cloud top height” for 2023-09-20 to 2023-09-22



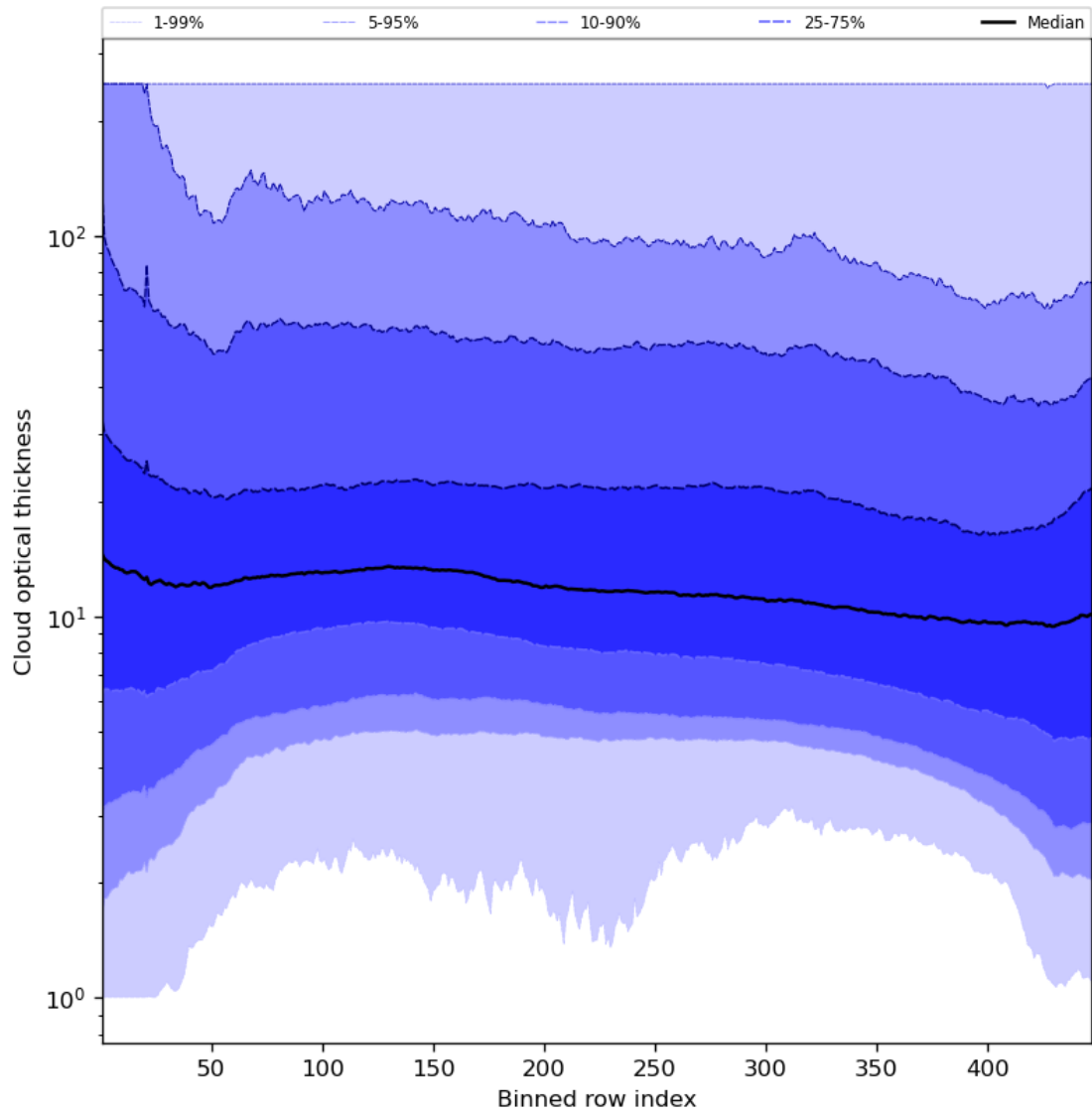


Figure 57: Along track statistics of “Cloud optical thickness” for 2023-09-20 to 2023-09-22

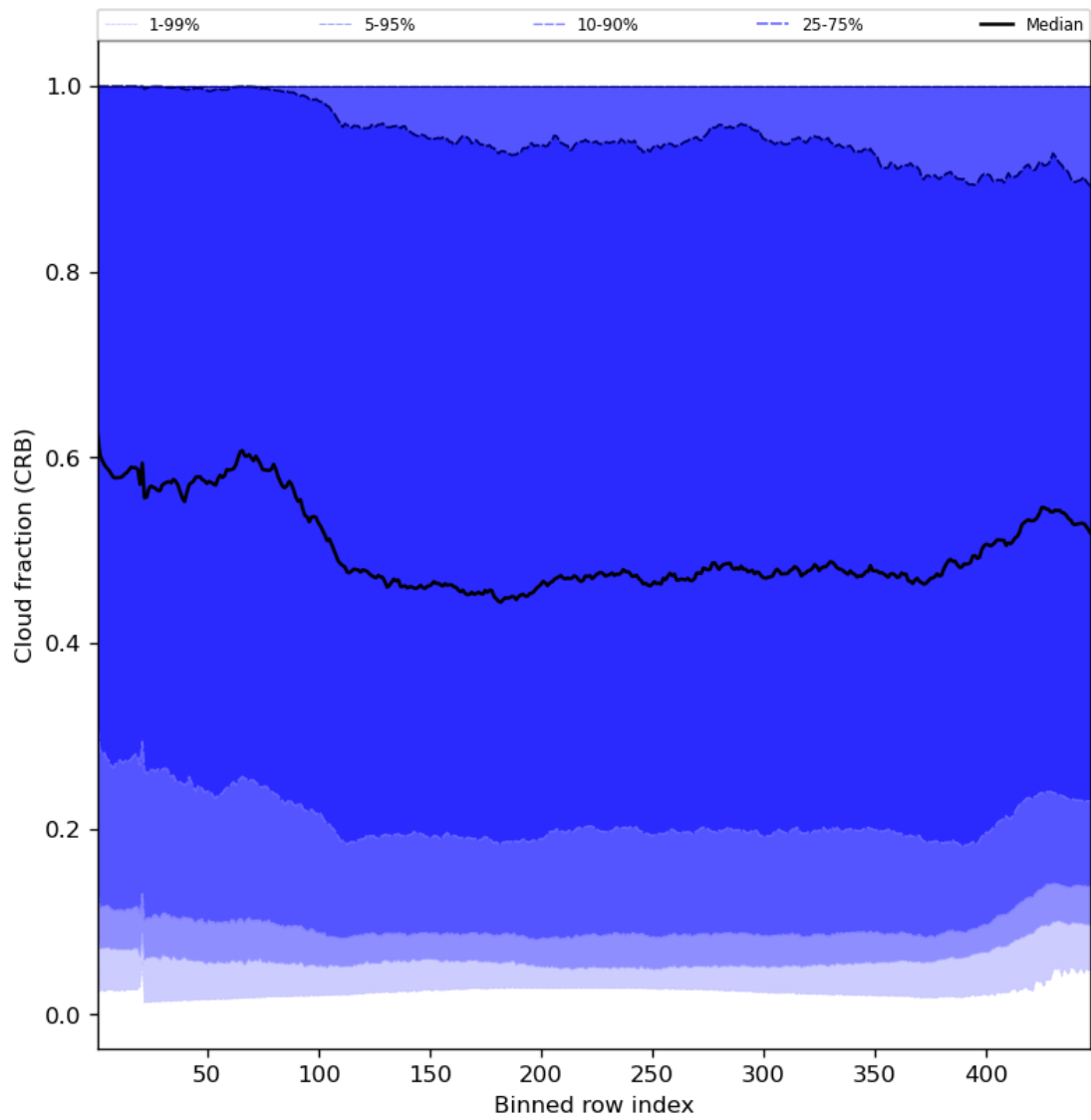


Figure 58: Along track statistics of “Cloud fraction (CRB)” for 2023-09-20 to 2023-09-22

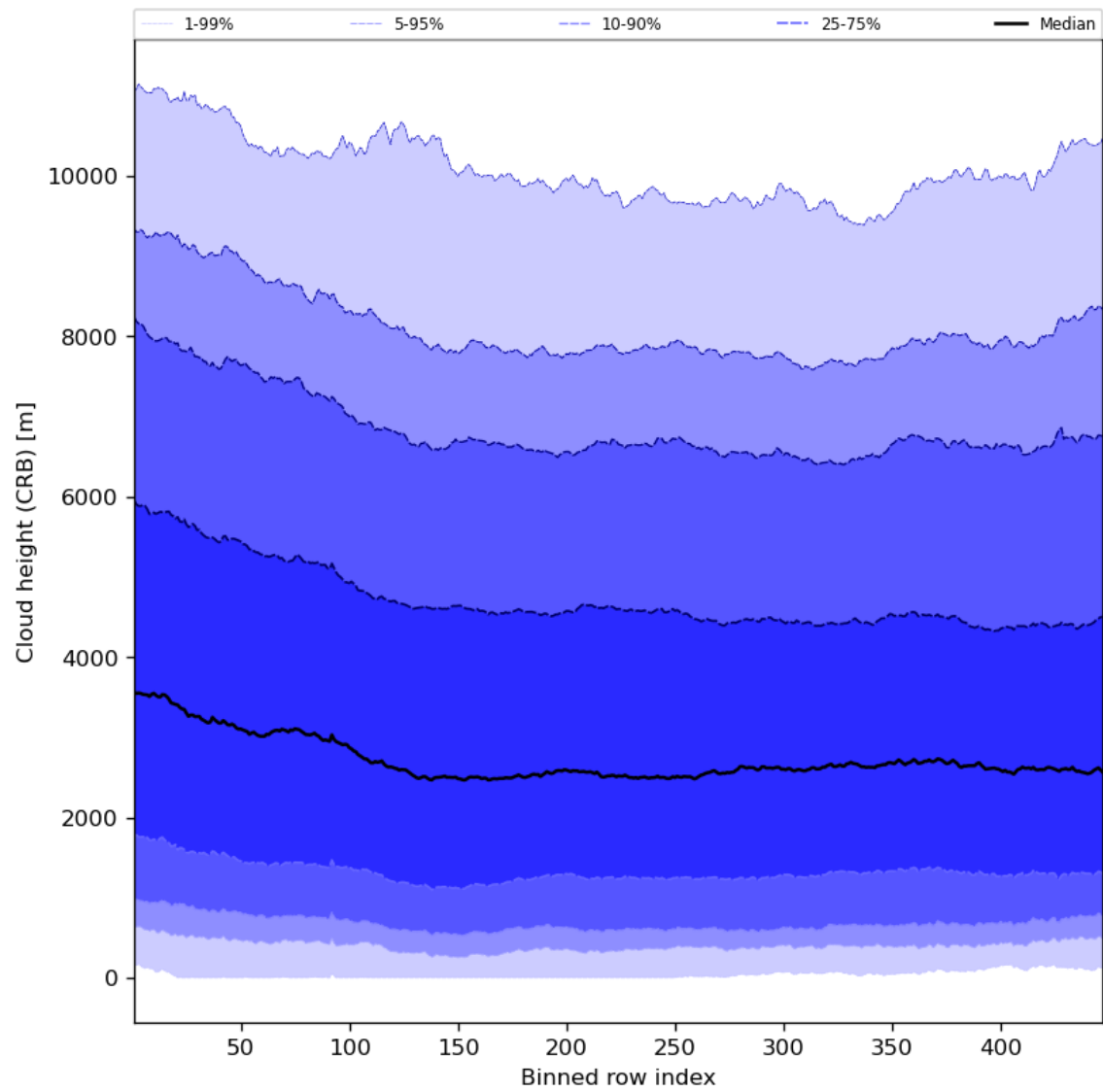


Figure 59: Along track statistics of “Cloud height (CRB)” for 2023-09-20 to 2023-09-22

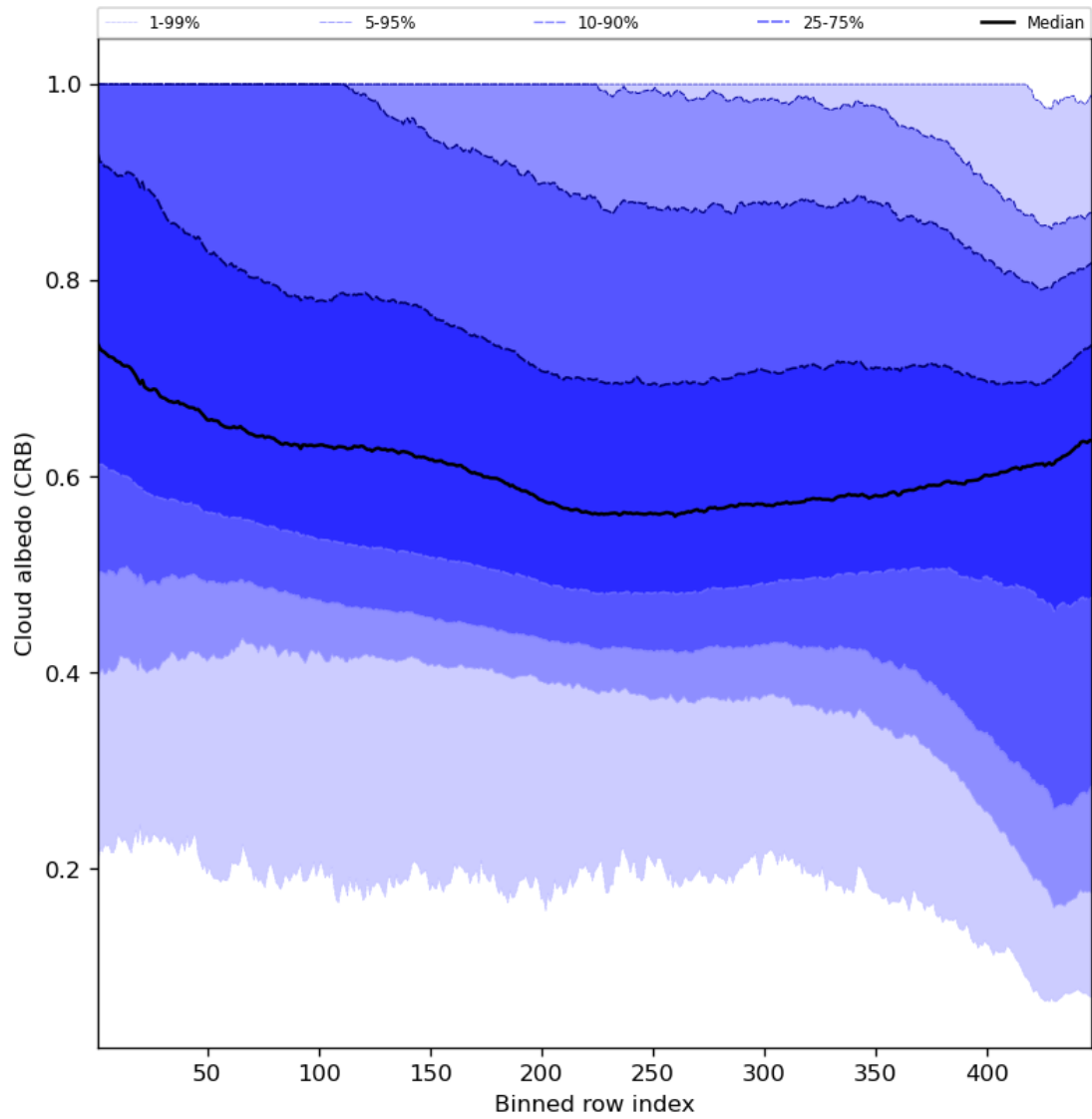


Figure 60: Along track statistics of “Cloud albedo (CRB)” for 2023-09-20 to 2023-09-22

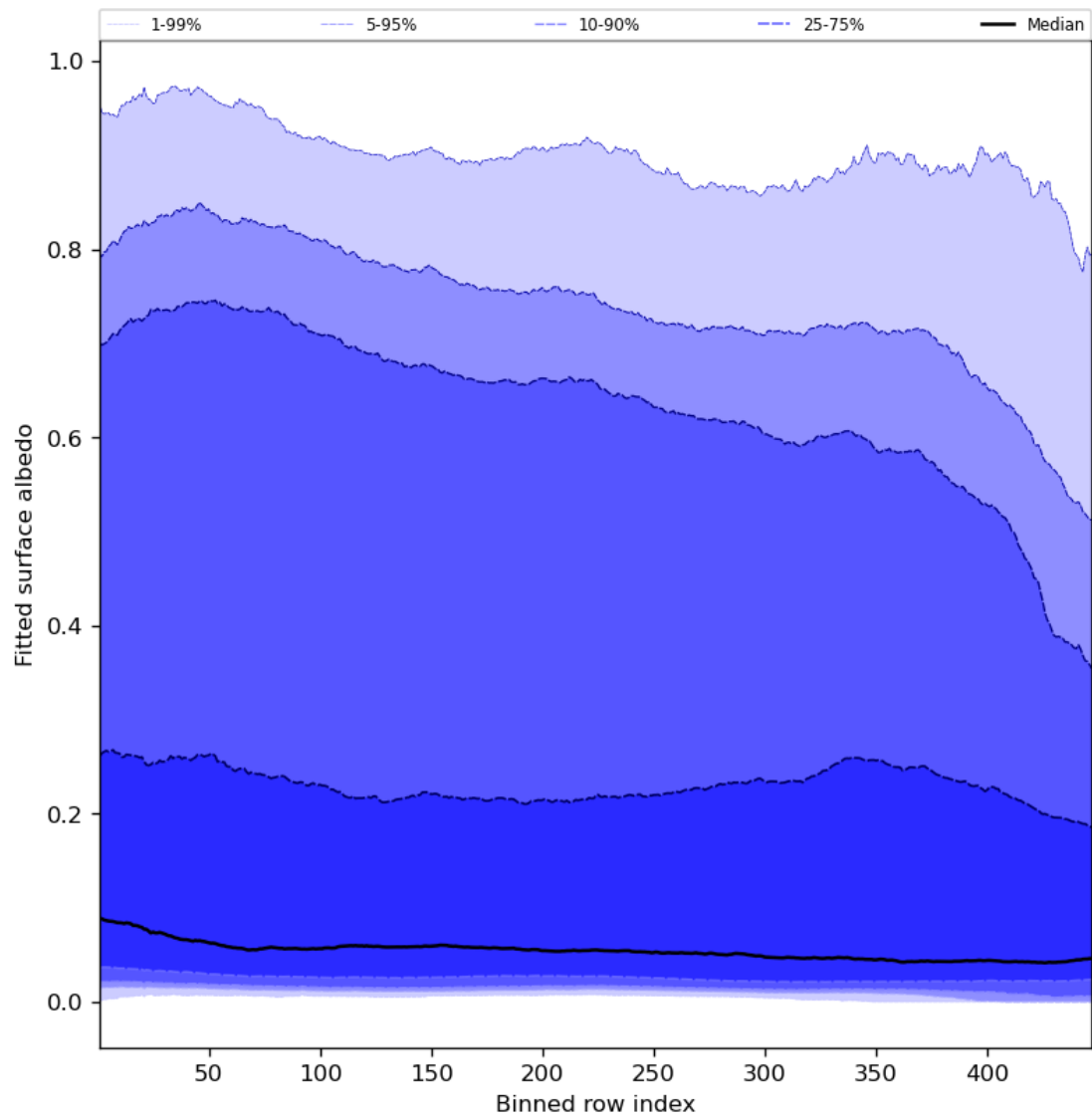


Figure 61: Along track statistics of “Fitted surface albedo” for 2023-09-20 to 2023-09-22

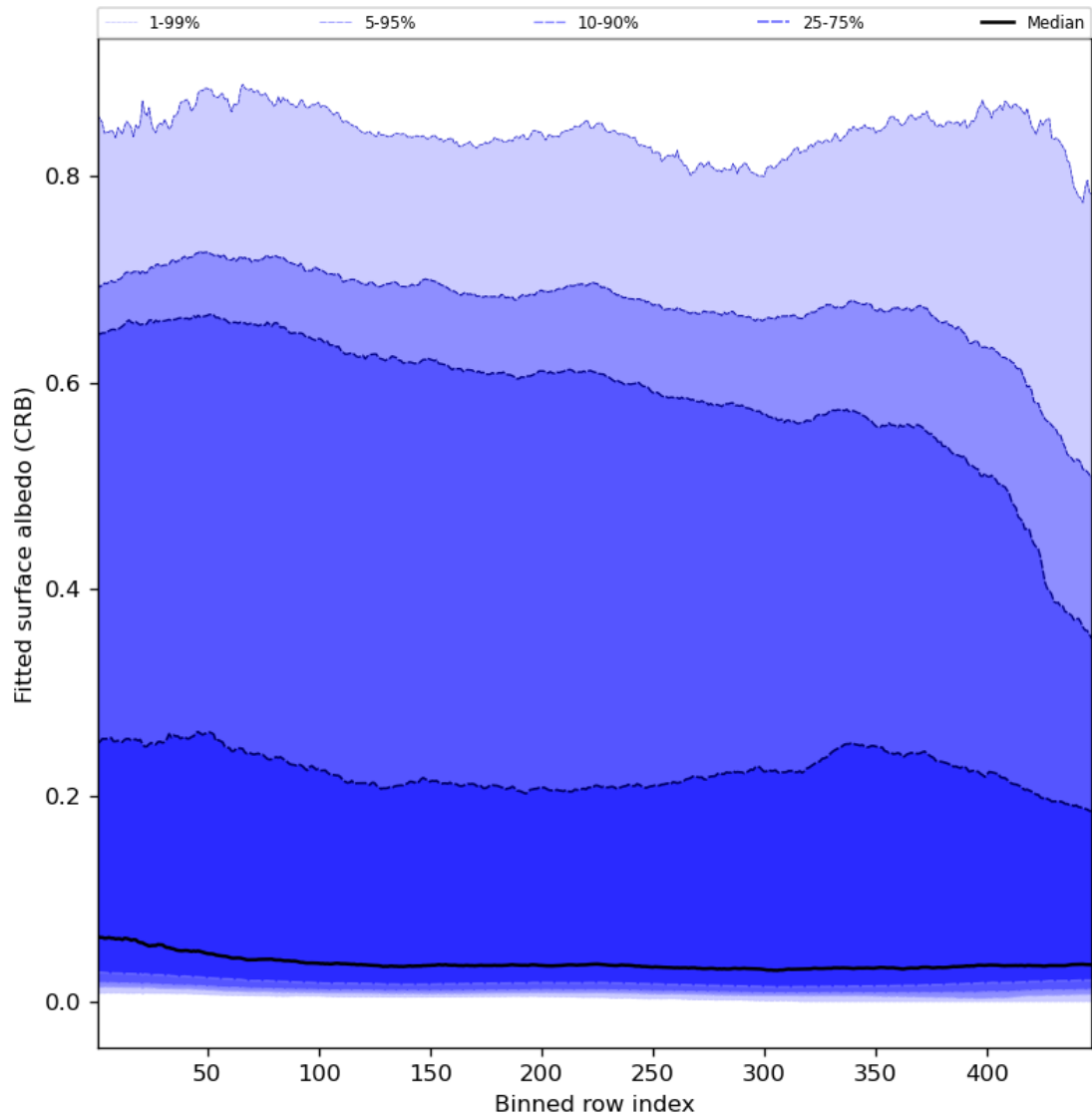


Figure 62: Along track statistics of “Fitted surface albedo (CRB)” for 2023-09-20 to 2023-09-22

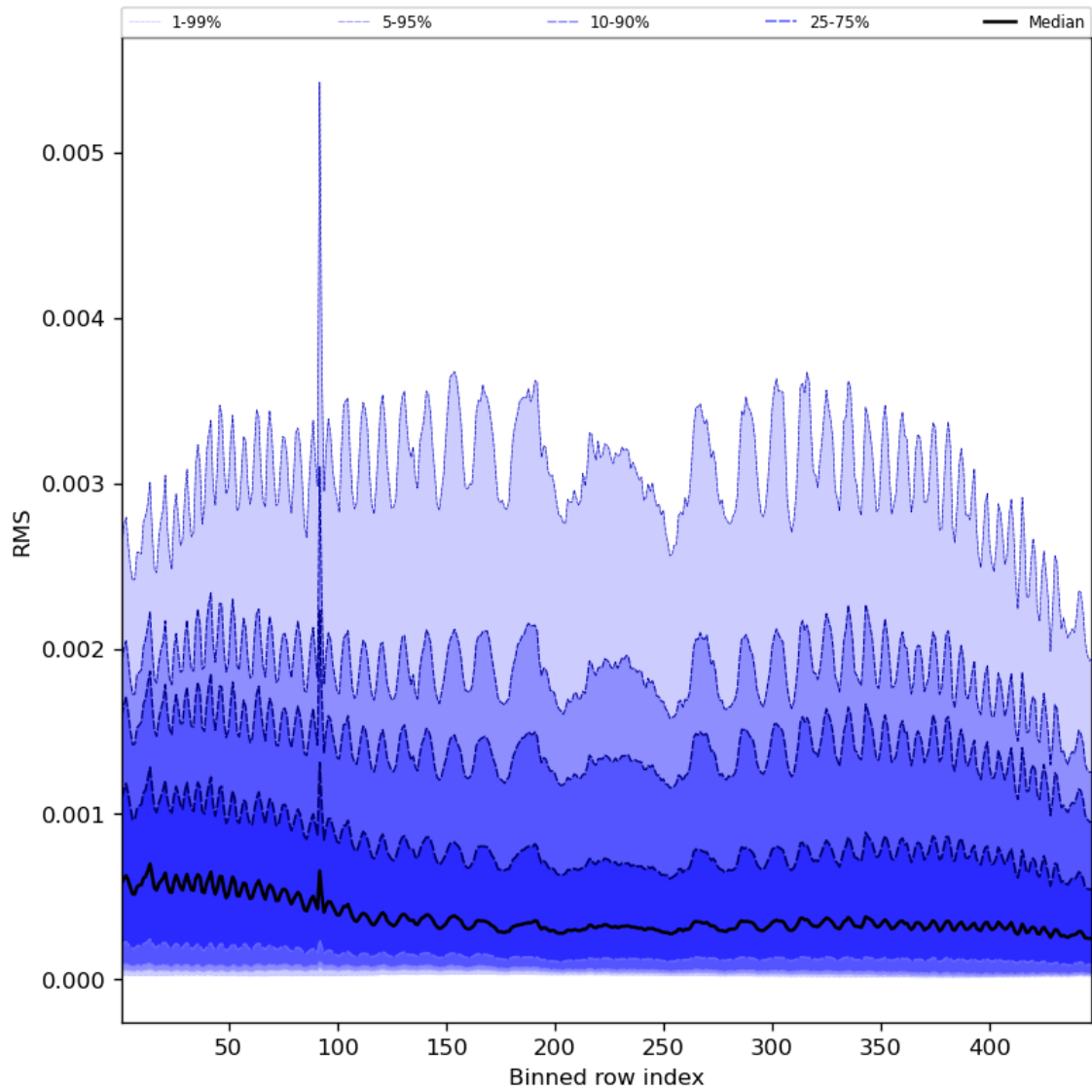


Figure 63: Along track statistics of “RMS” for 2023-09-20 to 2023-09-22

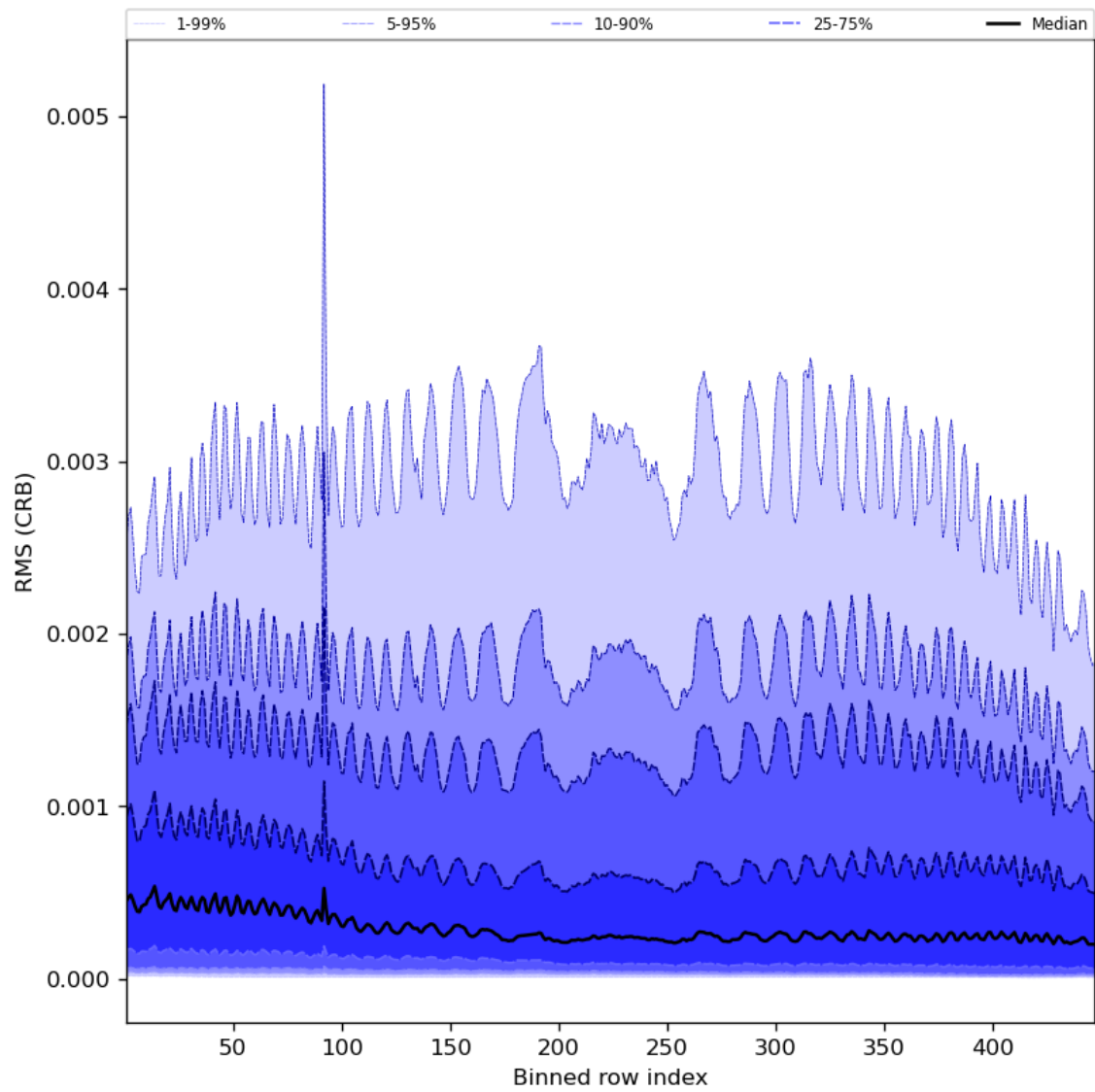


Figure 64: Along track statistics of “RMS (CRB)” for 2023-09-20 to 2023-09-22



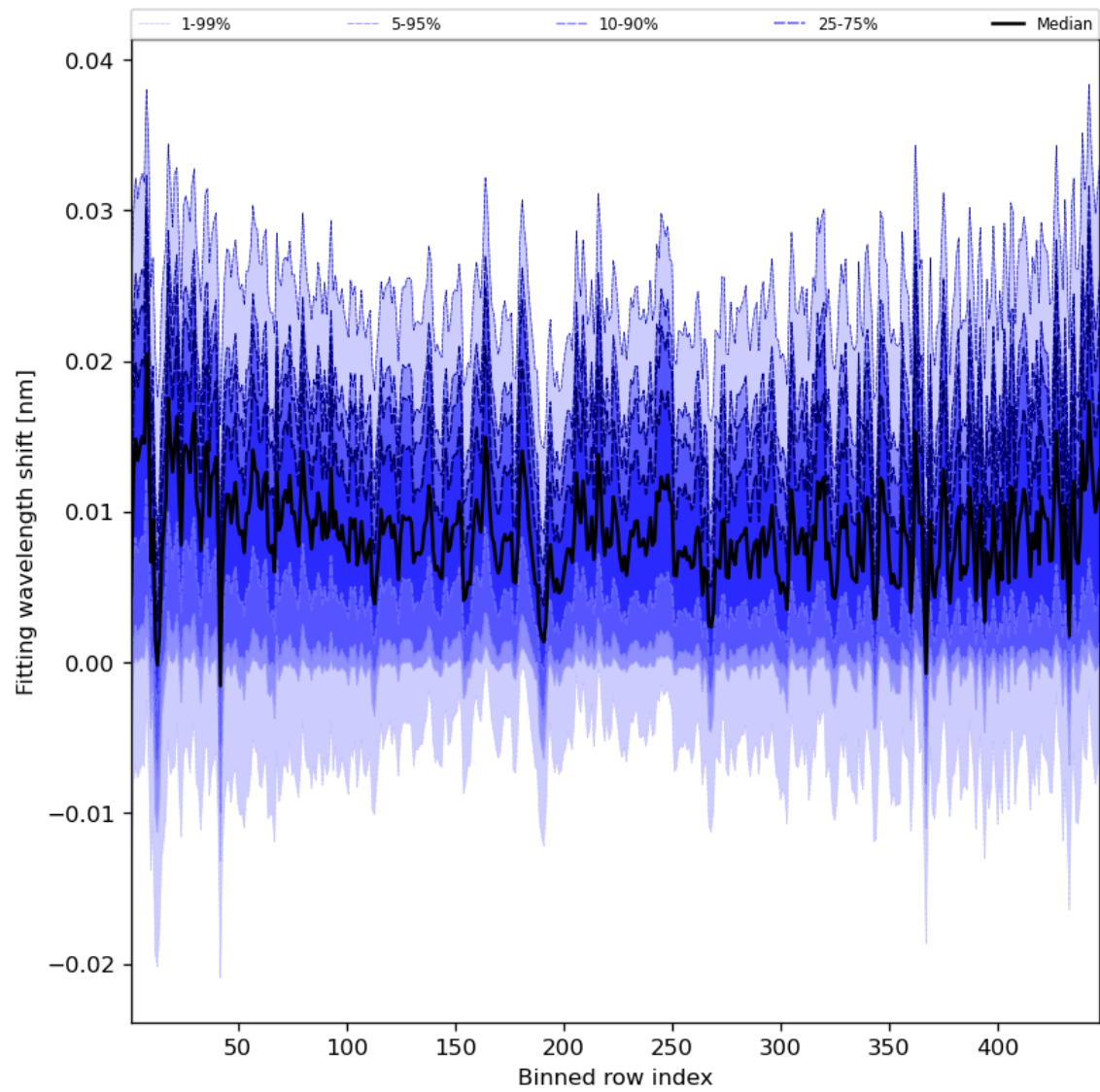


Figure 65: Along track statistics of “Fitting wavelength shift” for 2023-09-20 to 2023-09-22

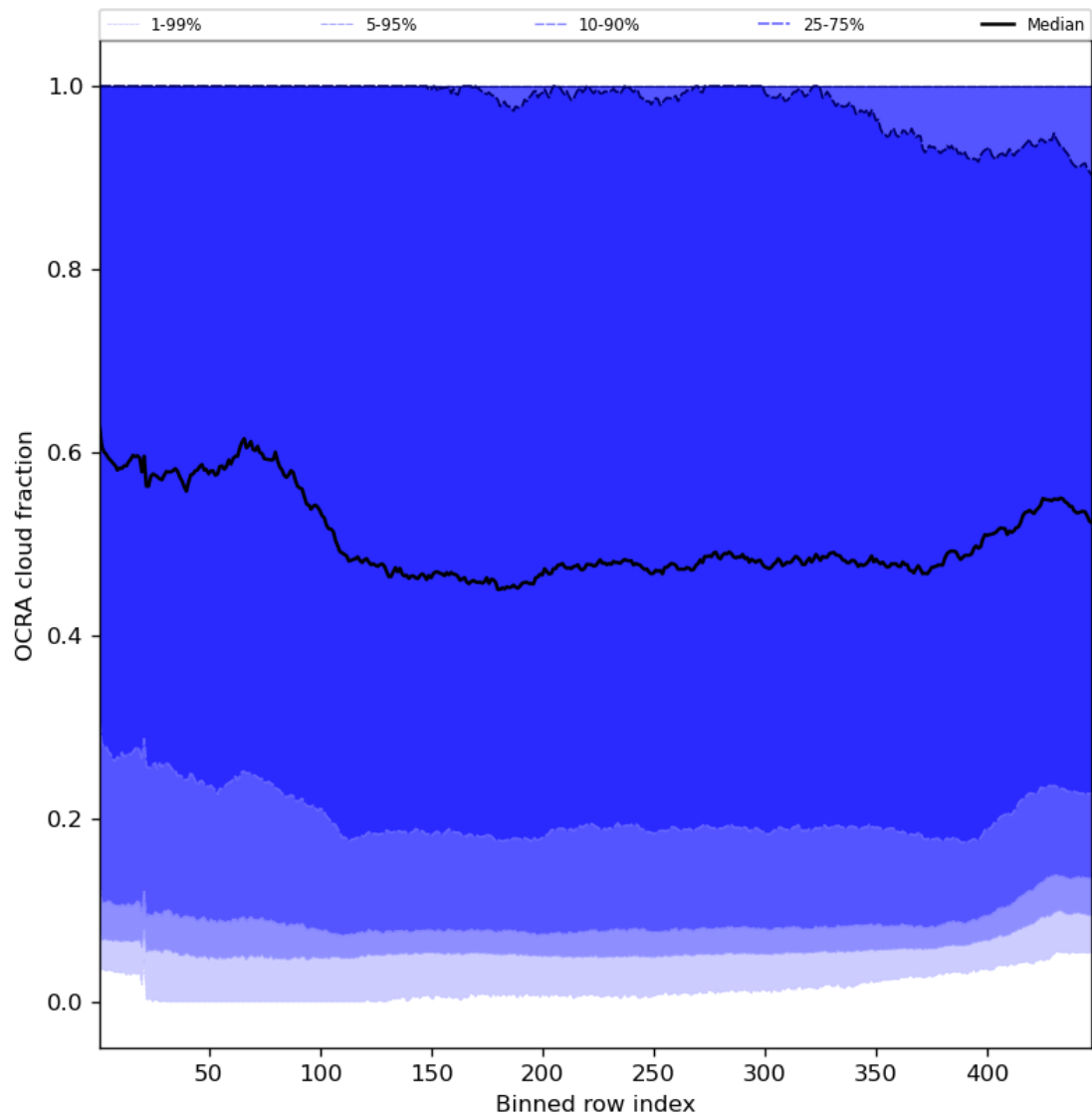


Figure 66: Along track statistics of “OCRA cloud fraction” for 2023-09-20 to 2023-09-22

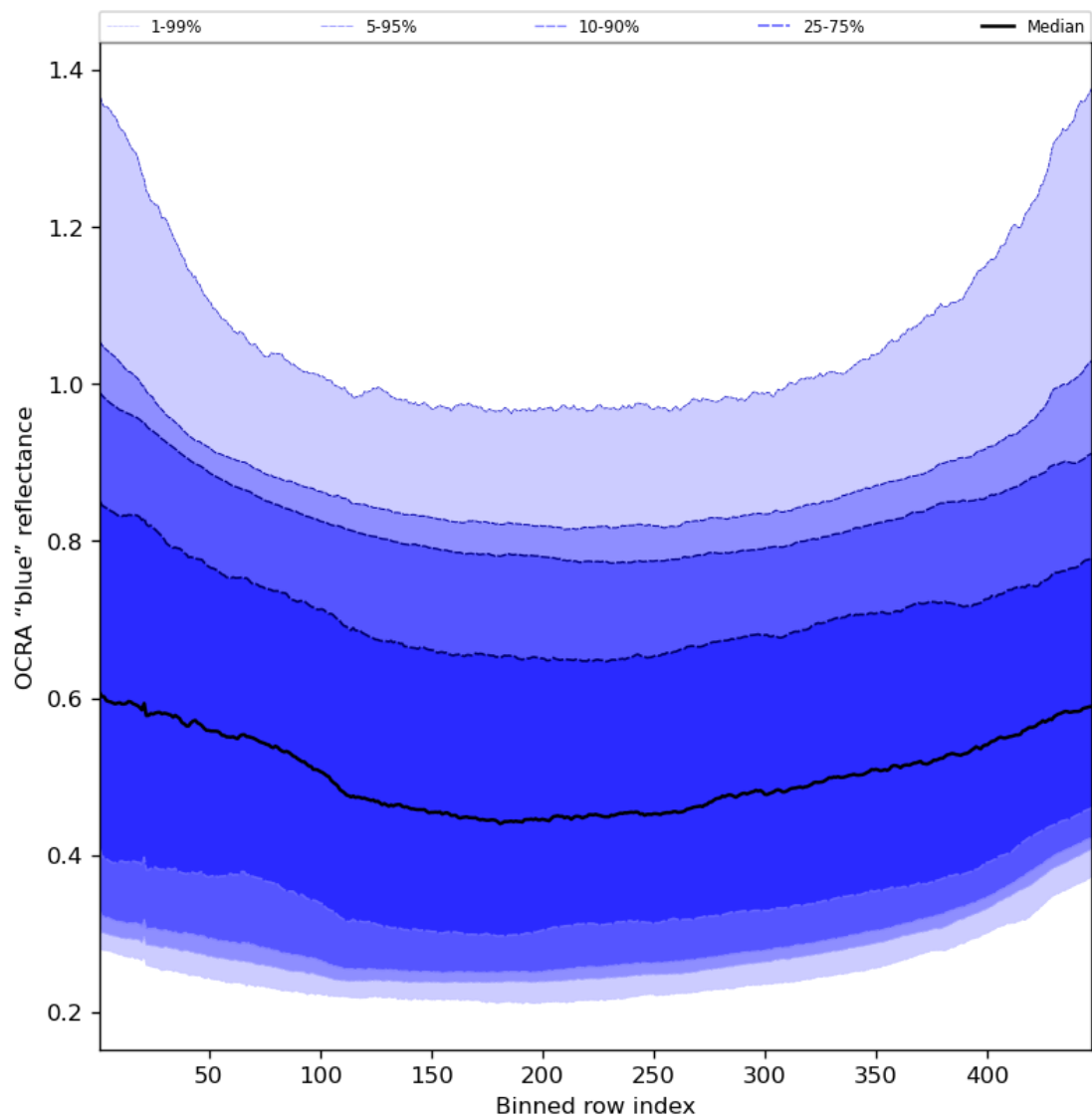


Figure 67: Along track statistics of “OCRA “blue” reflectance” for 2023-09-20 to 2023-09-22

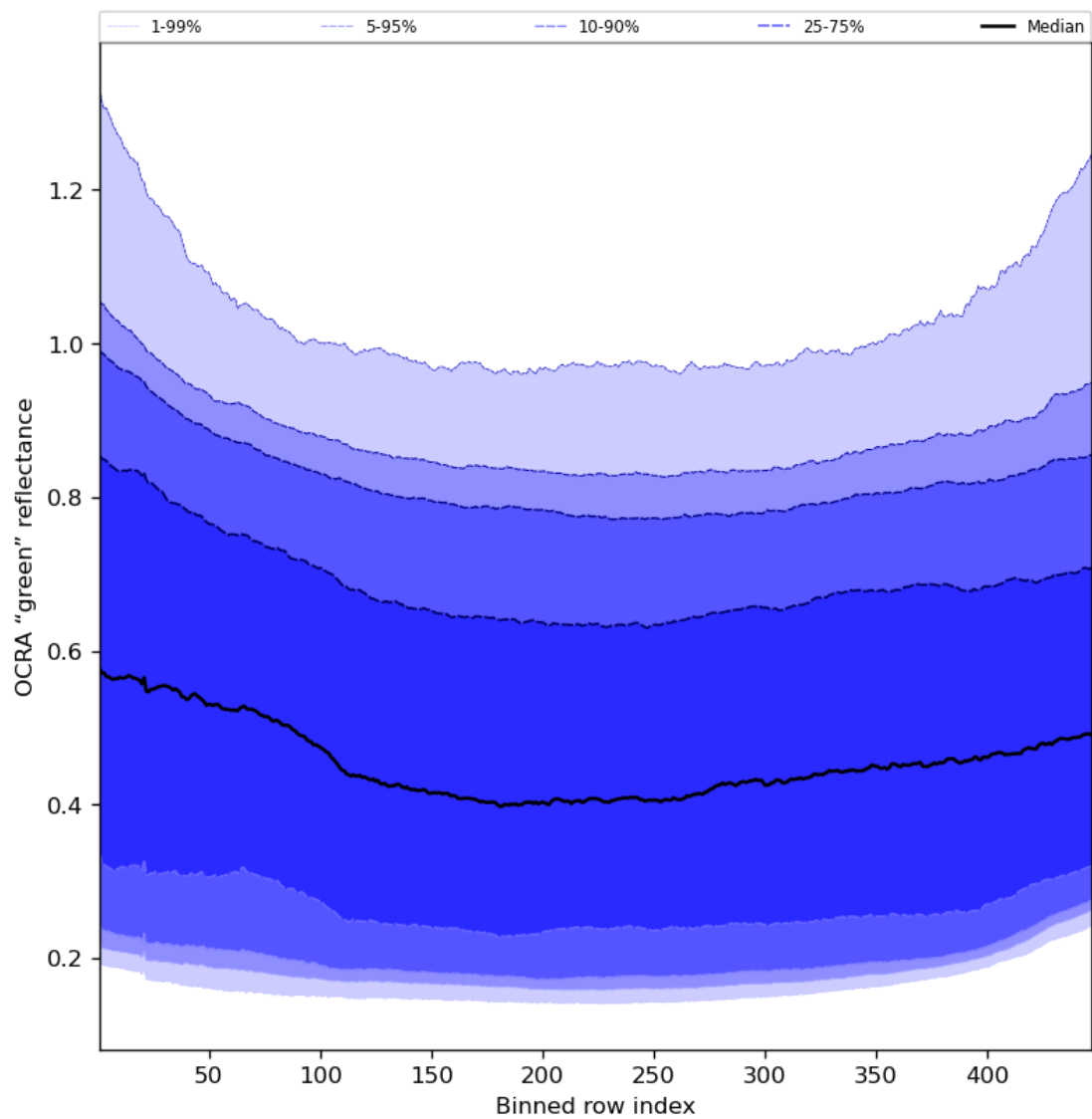


Figure 68: Along track statistics of “OCRA “green” reflectance” for 2023-09-20 to 2023-09-22

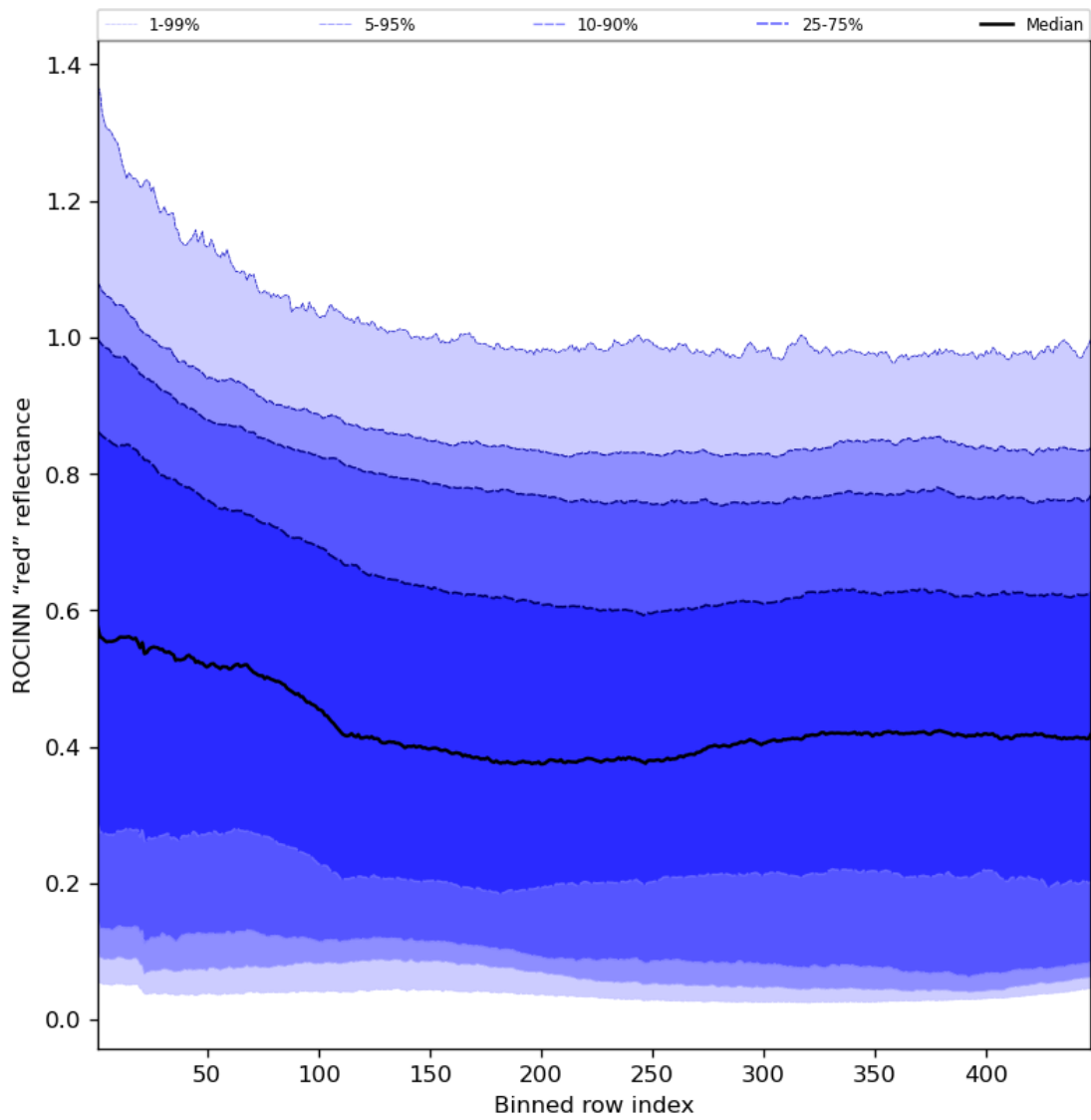


Figure 69: Along track statistics of “ROCINN “red” reflectance” for 2023-09-20 to 2023-09-22

## 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.

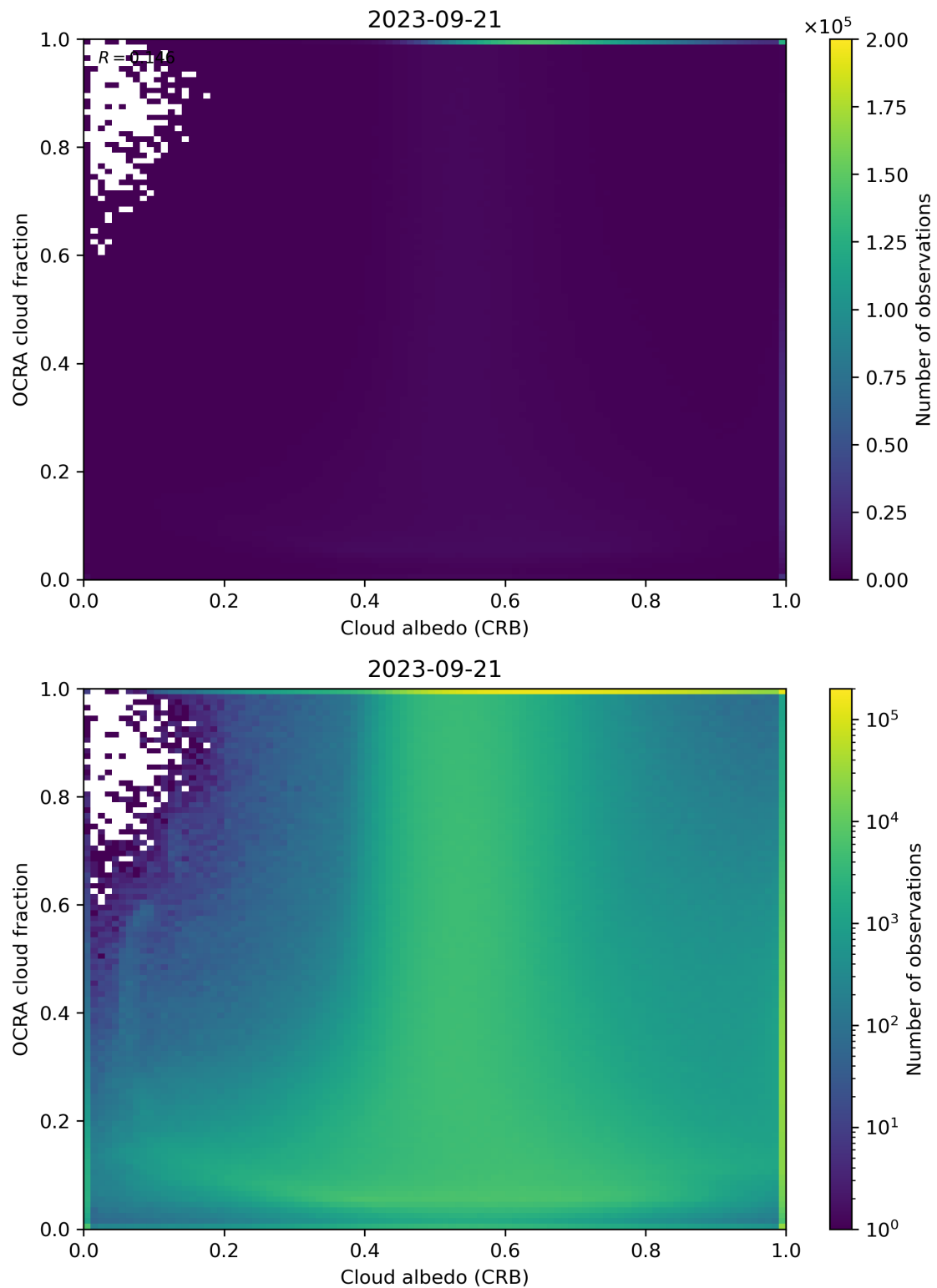


Figure 70: Scatter density plot of “Cloud albedo (CRB)” against “OCRA cloud fraction” for 2023-09-20 to 2023-09-22.

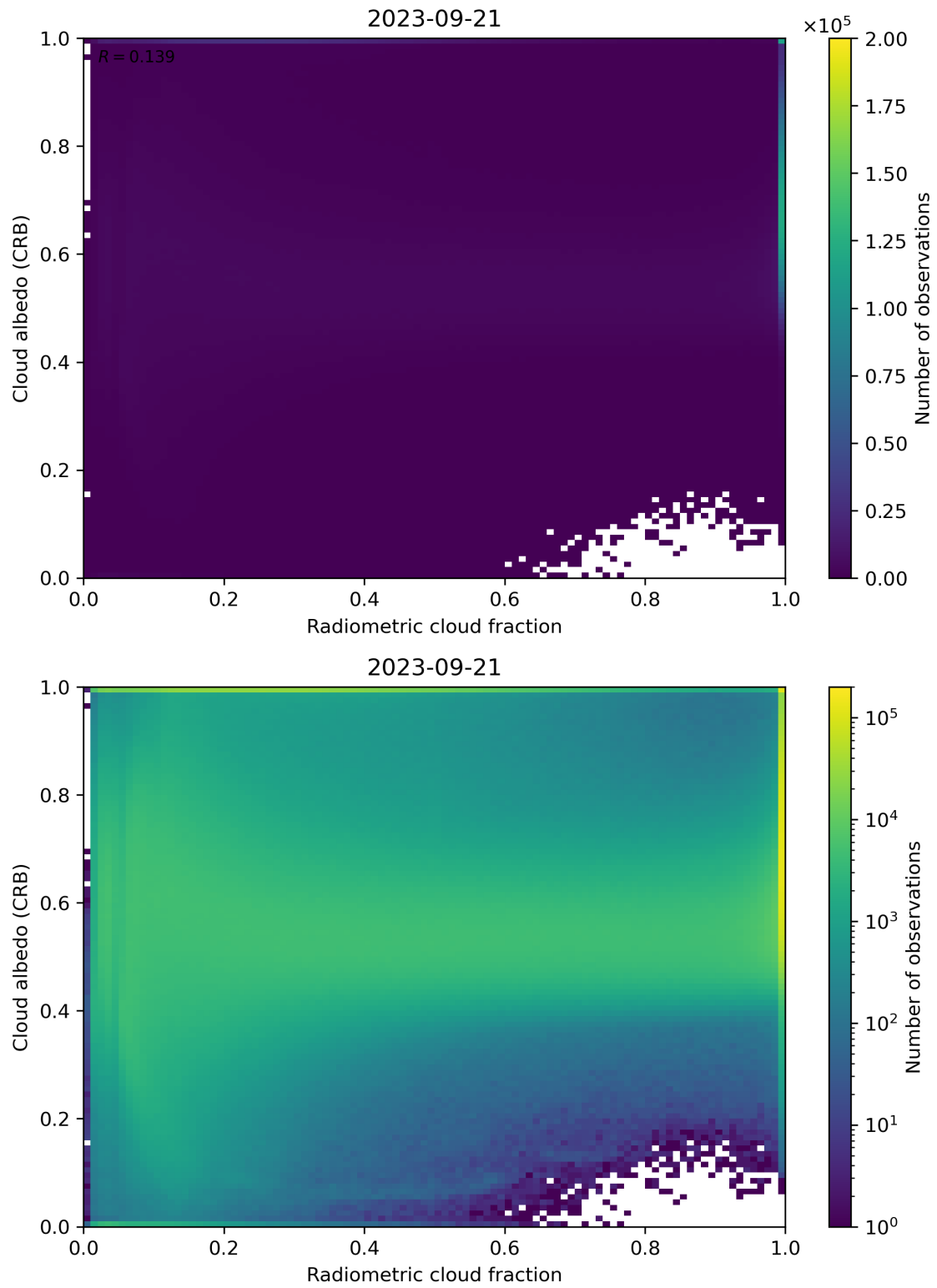


Figure 71: Scatter density plot of “Radiometric cloud fraction” against “Cloud albedo (CRB)” for 2023-09-20 to 2023-09-22.

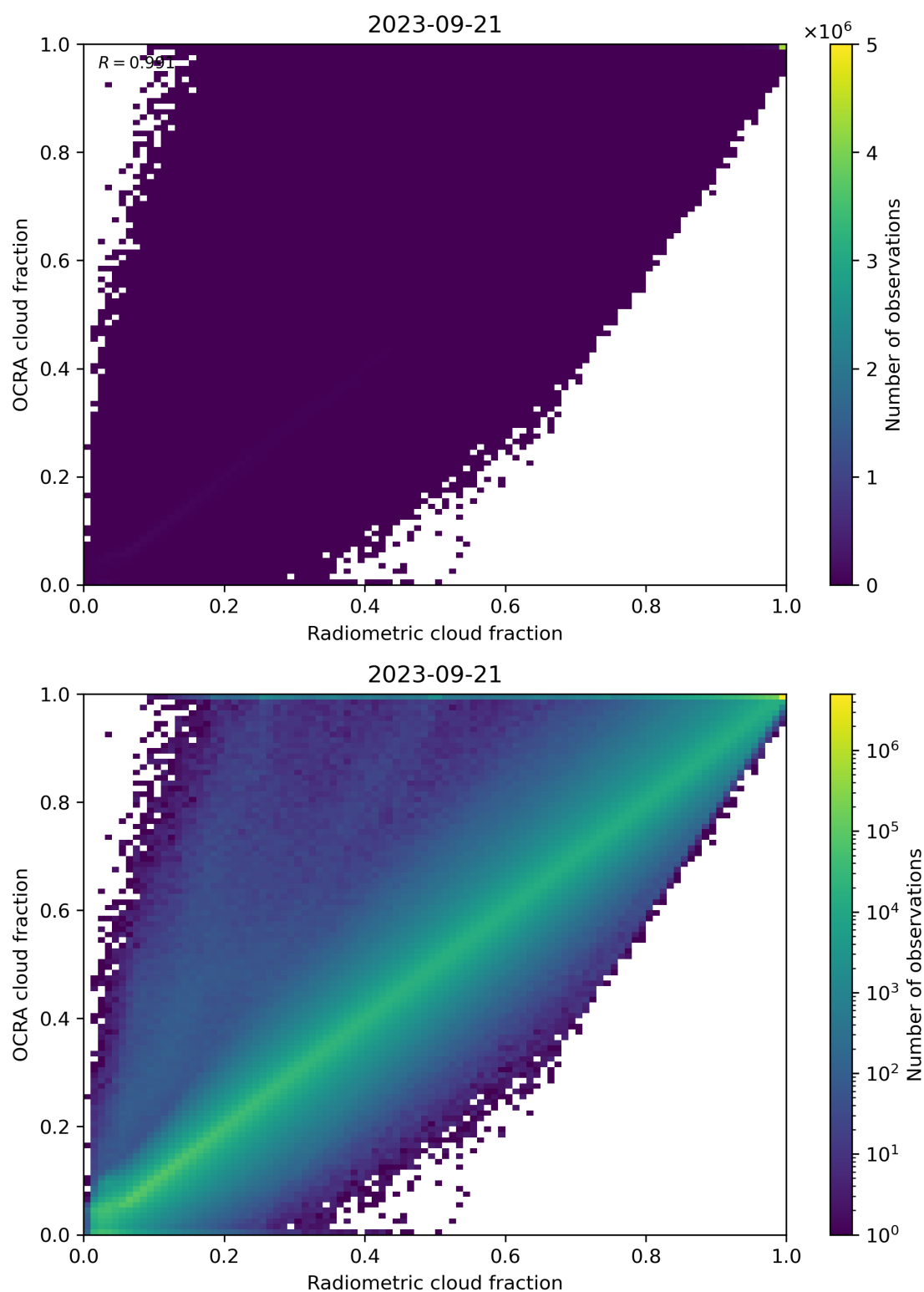


Figure 72: Scatter density plot of “Radiometric cloud fraction” against “OCRA cloud fraction” for 2023-09-20 to 2023-09-22.



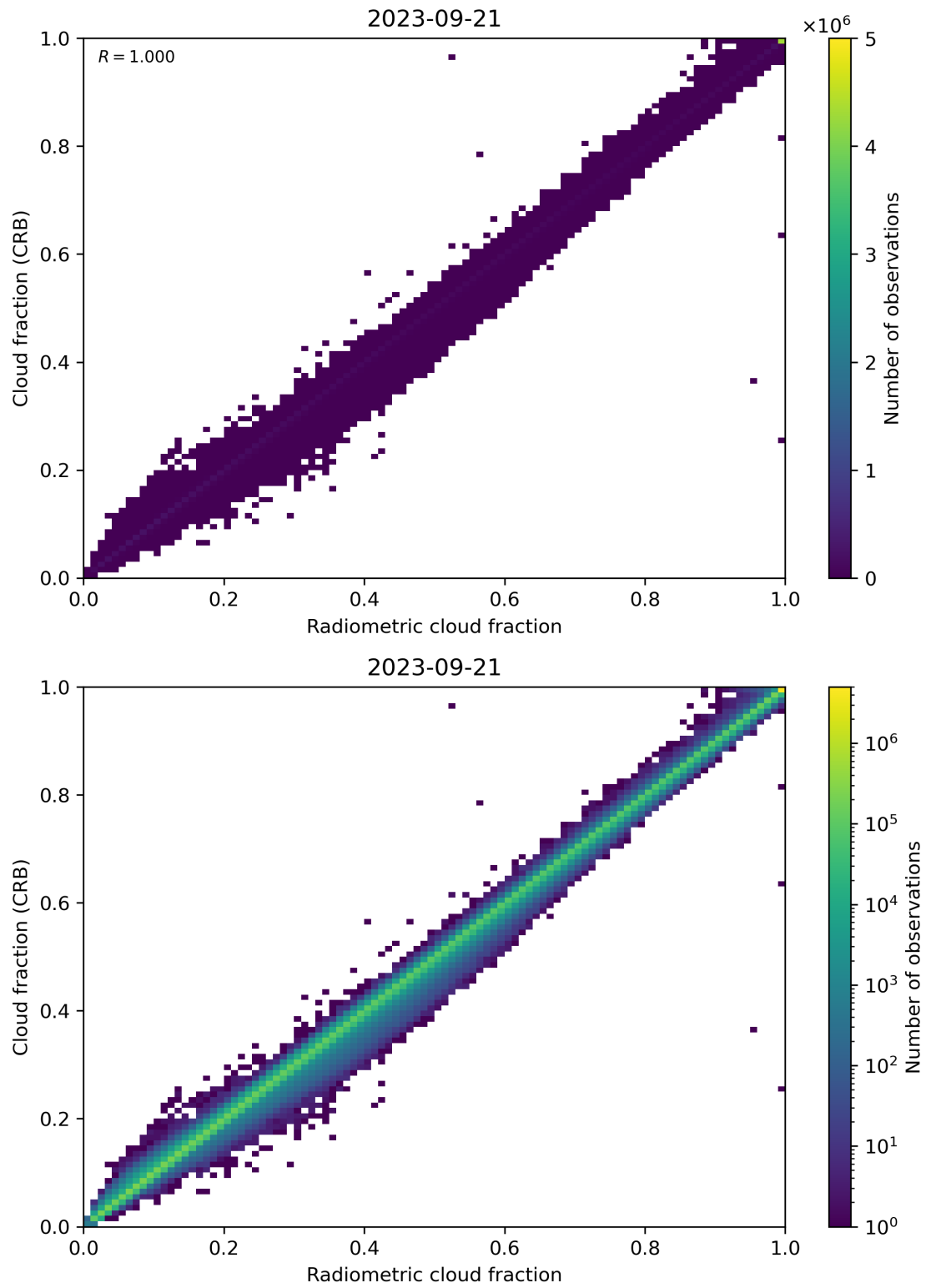


Figure 73: Scatter density plot of “Radiometric cloud fraction” against “Cloud fraction (CRB)” for 2023-09-20 to 2023-09-22.

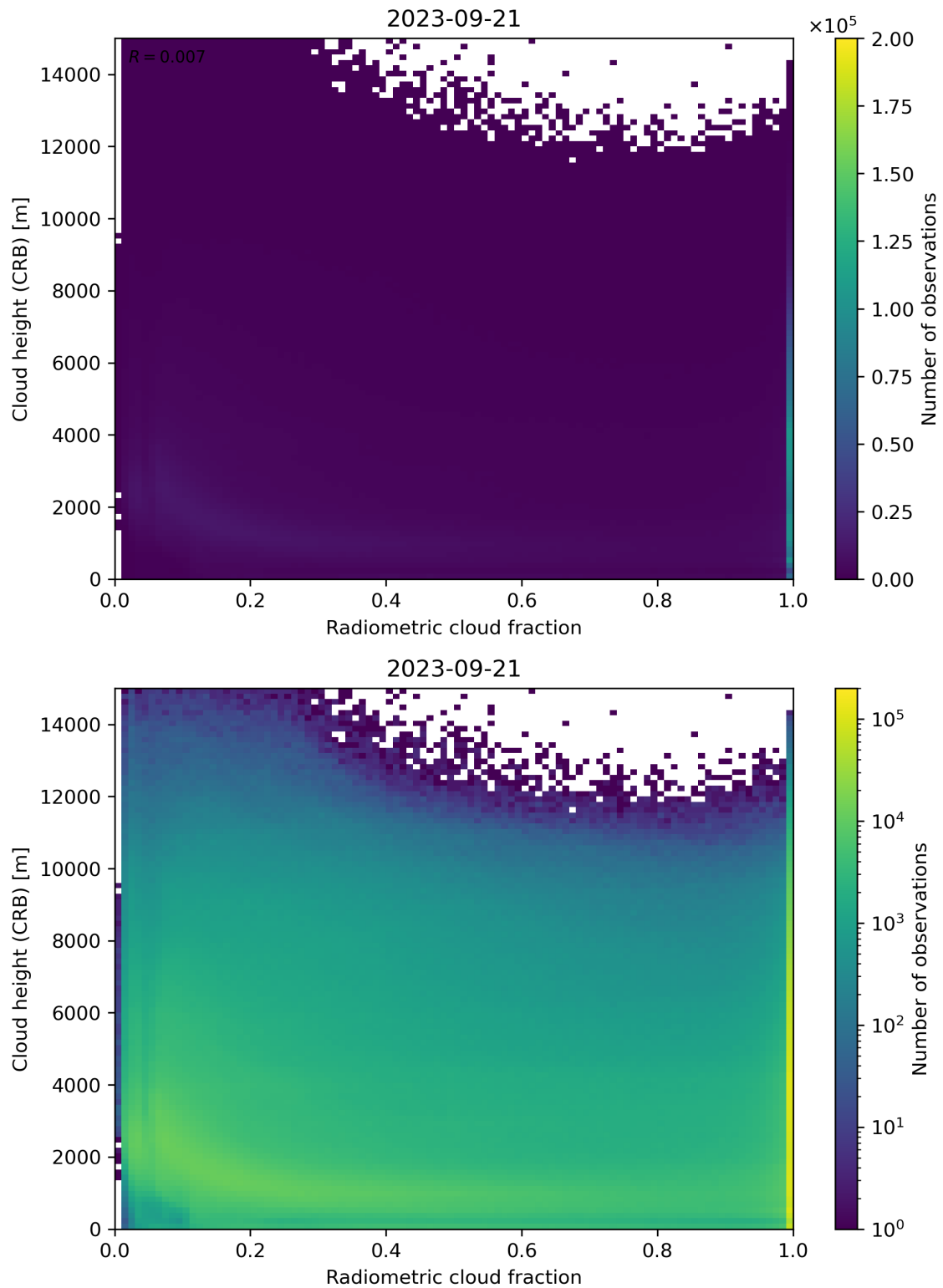


Figure 74: Scatter density plot of “Radiometric cloud fraction” against “Cloud height (CRB)” for 2023-09-20 to 2023-09-22.

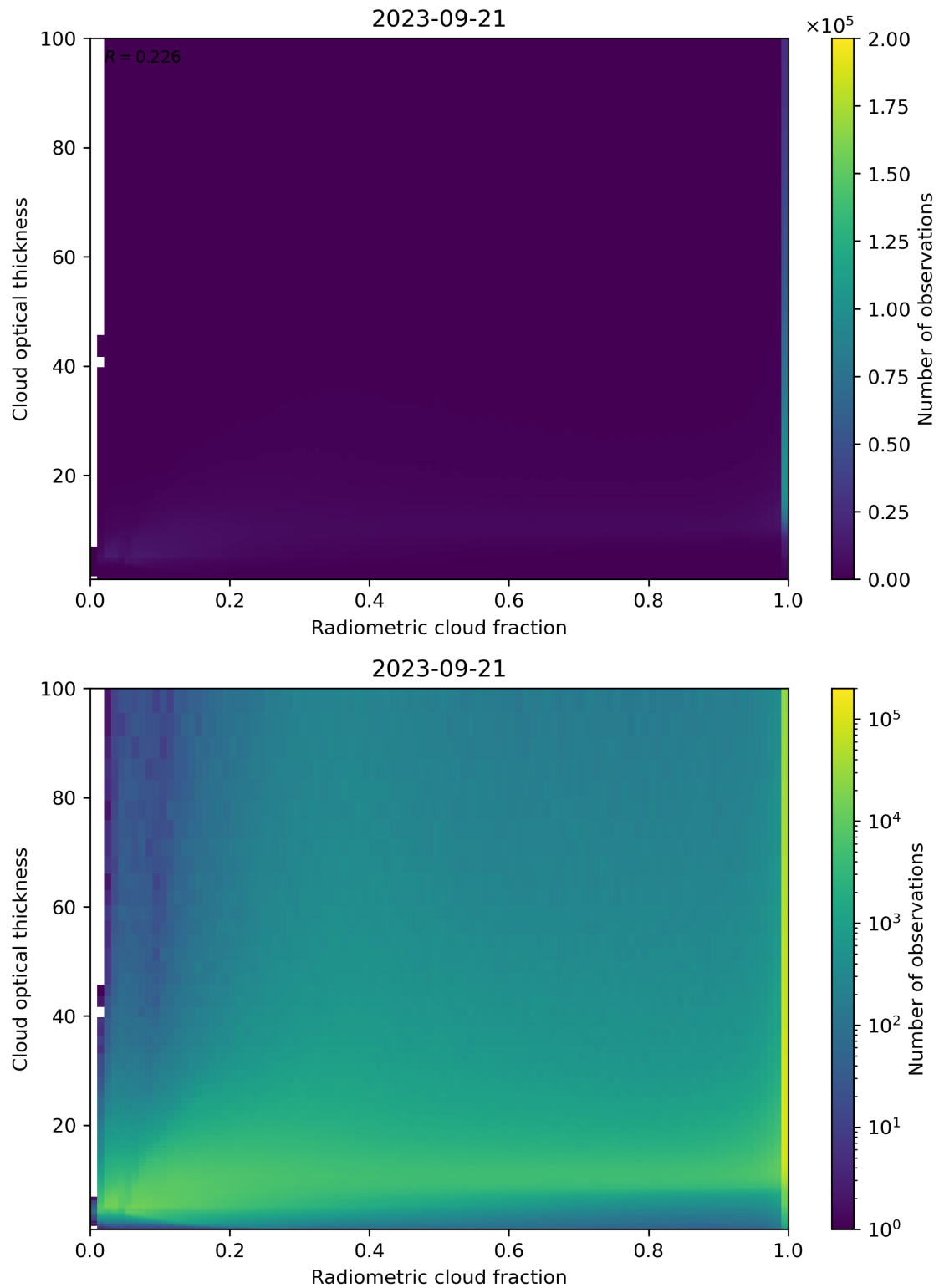


Figure 75: Scatter density plot of “Radiometric cloud fraction” against “Cloud optical thickness” for 2023-09-20 to 2023-09-22.

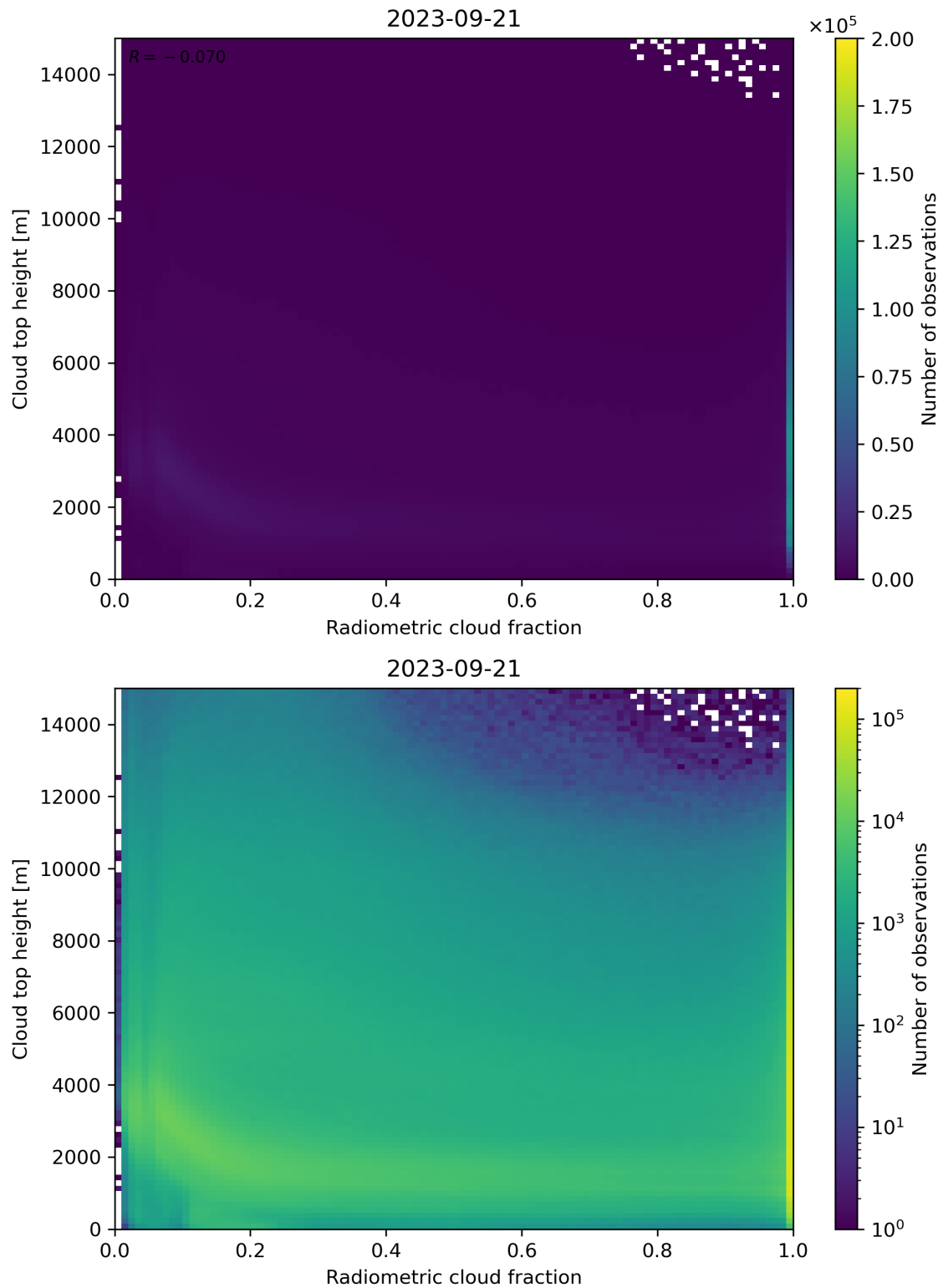


Figure 76: Scatter density plot of “Radiometric cloud fraction” against “Cloud top height” for 2023-09-20 to 2023-09-22.

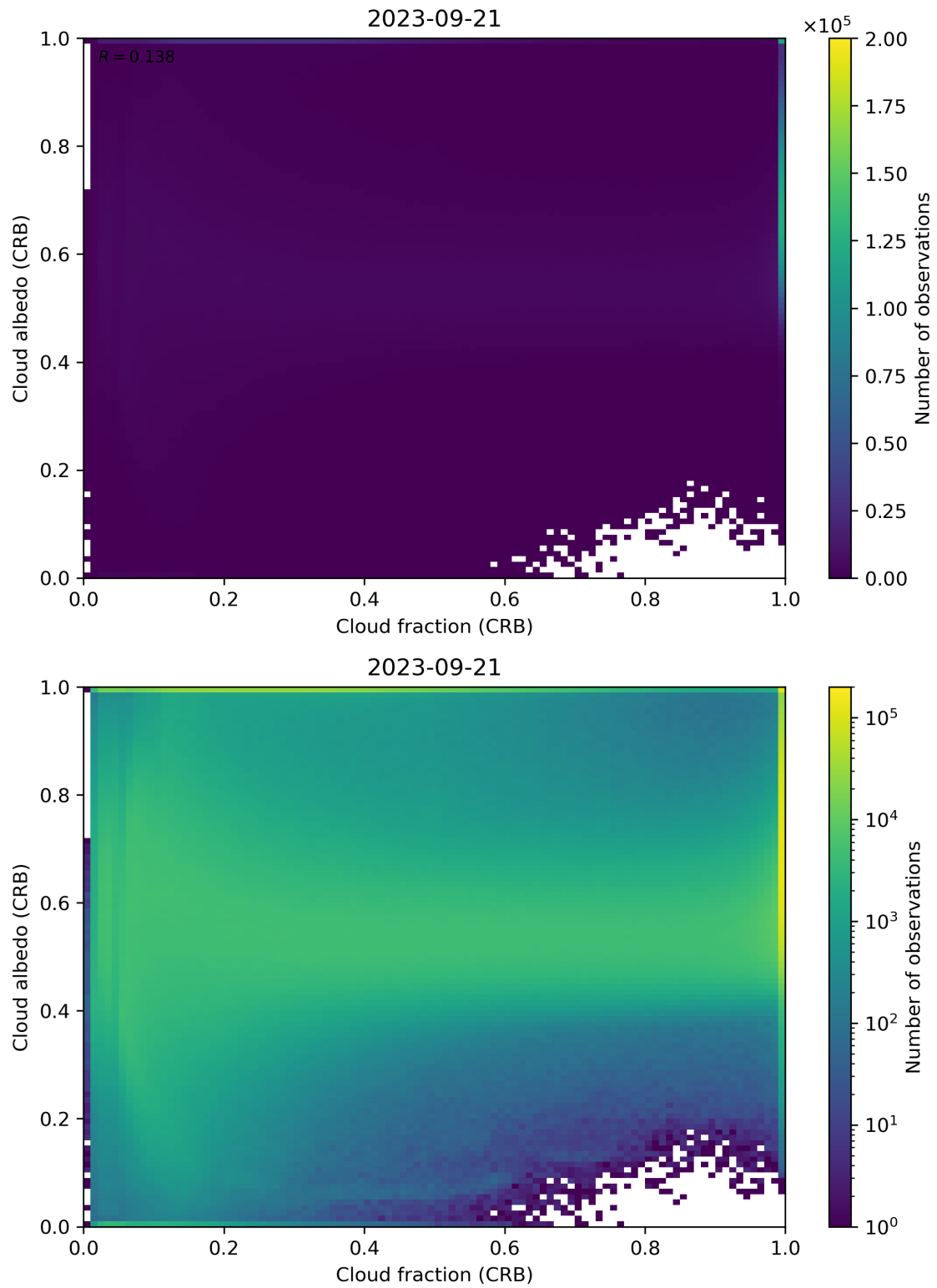


Figure 77: Scatter density plot of “Cloud fraction (CRB)” against “Cloud albedo (CRB)” for 2023-09-20 to 2023-09-22.

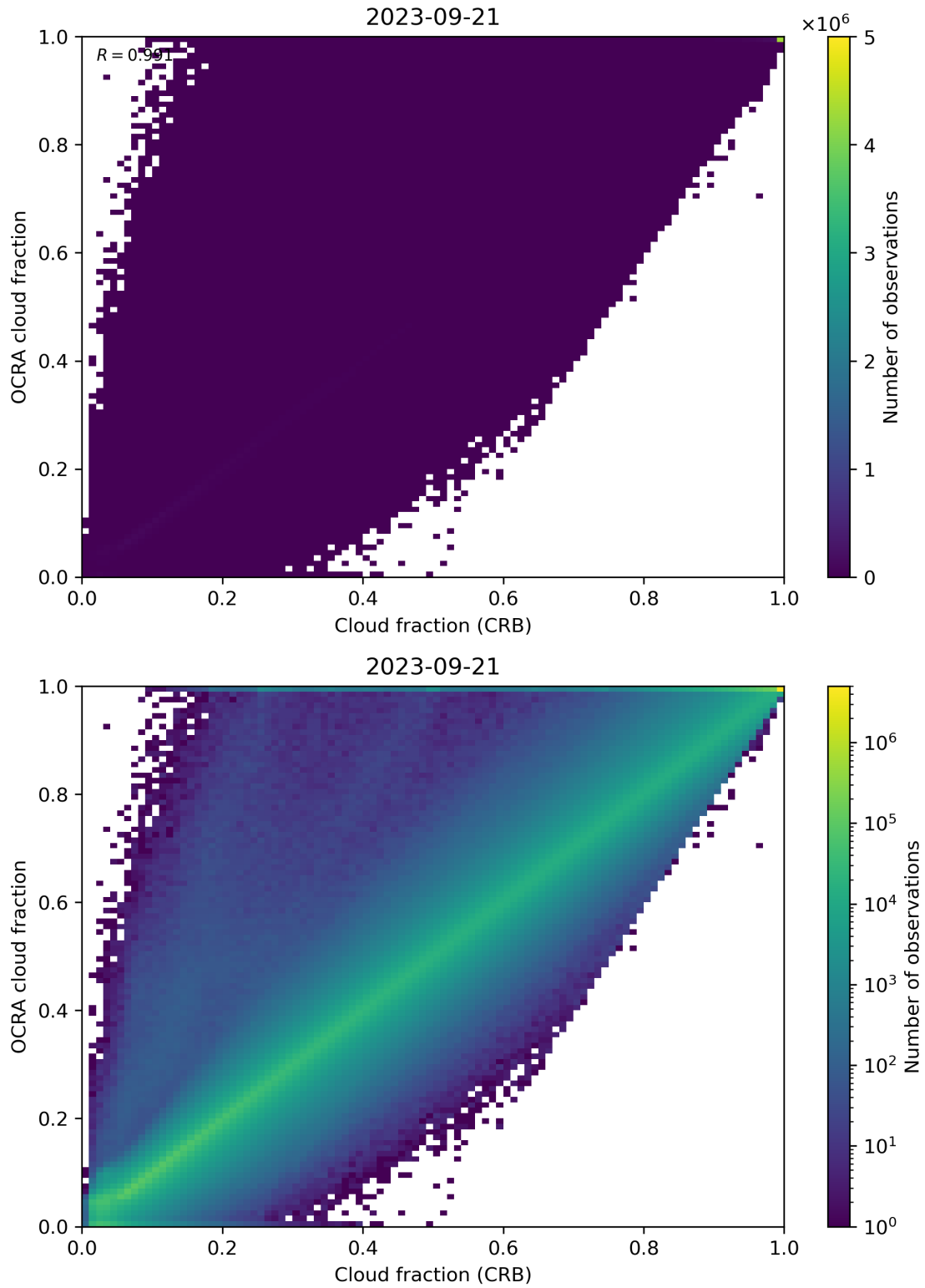


Figure 78: Scatter density plot of “Cloud fraction (CRB)” against “OCRA cloud fraction” for 2023-09-20 to 2023-09-22.

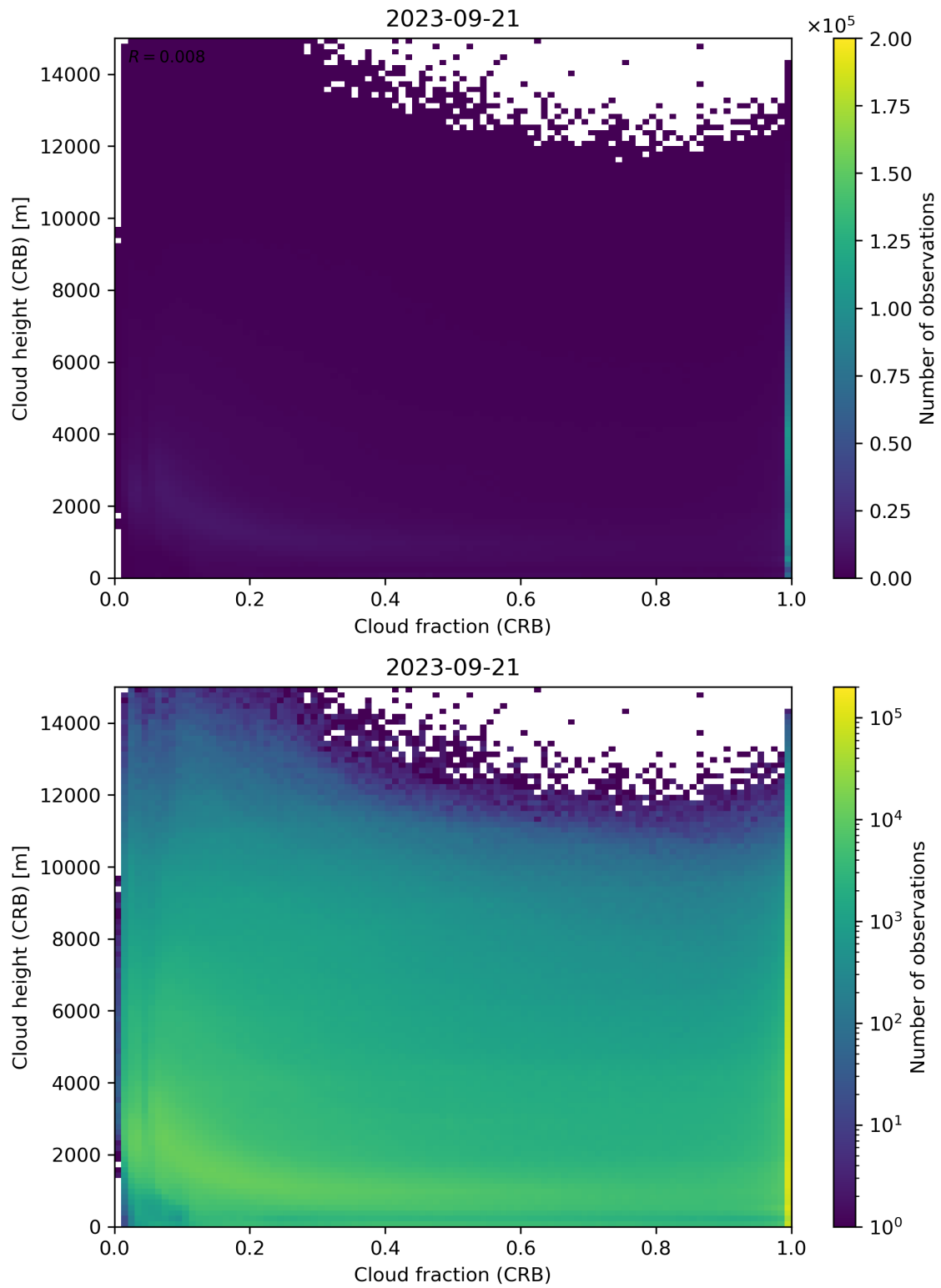


Figure 79: Scatter density plot of “Cloud fraction (CRB)” against “Cloud height (CRB)” for 2023-09-20 to 2023-09-22.

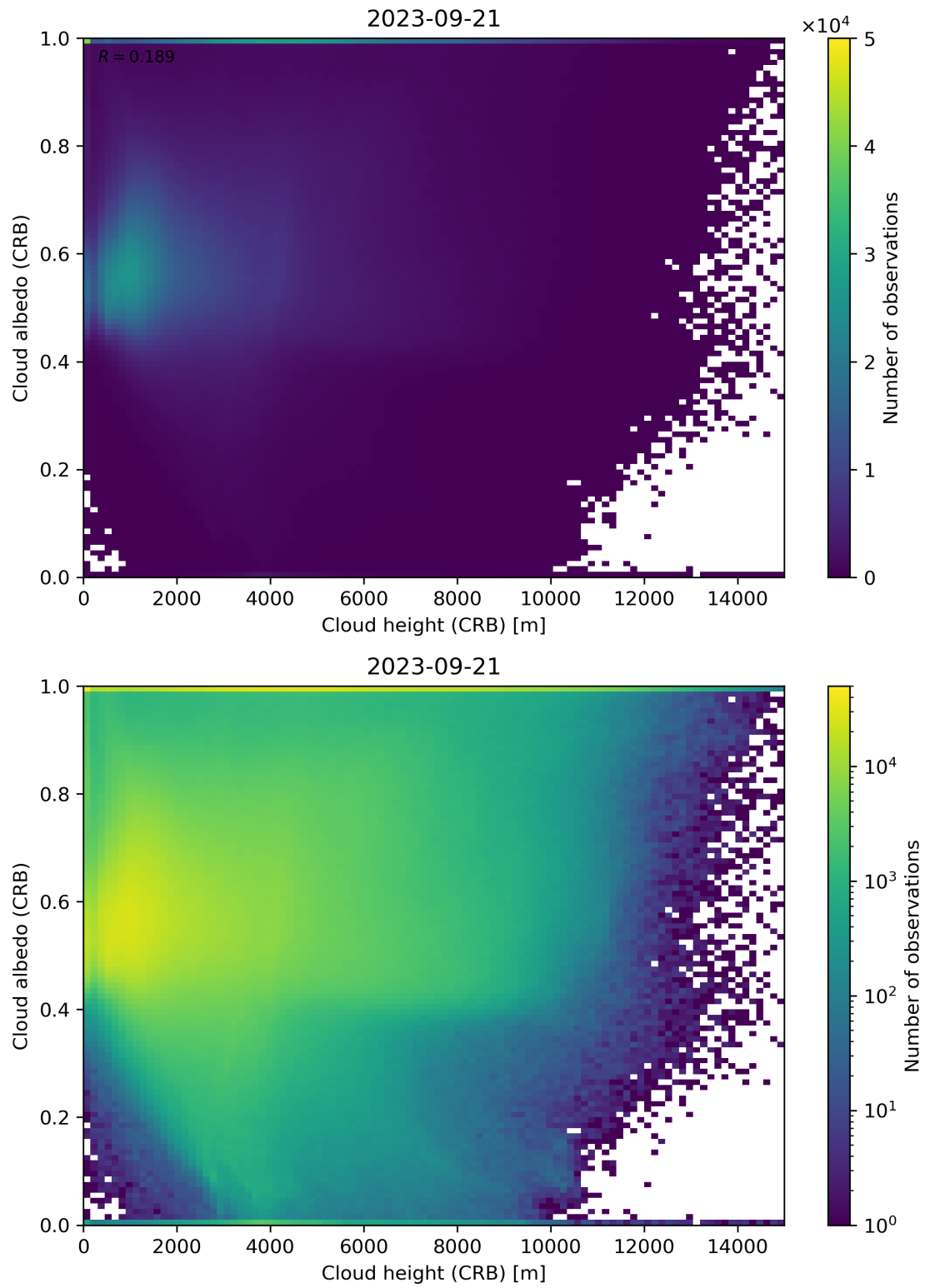


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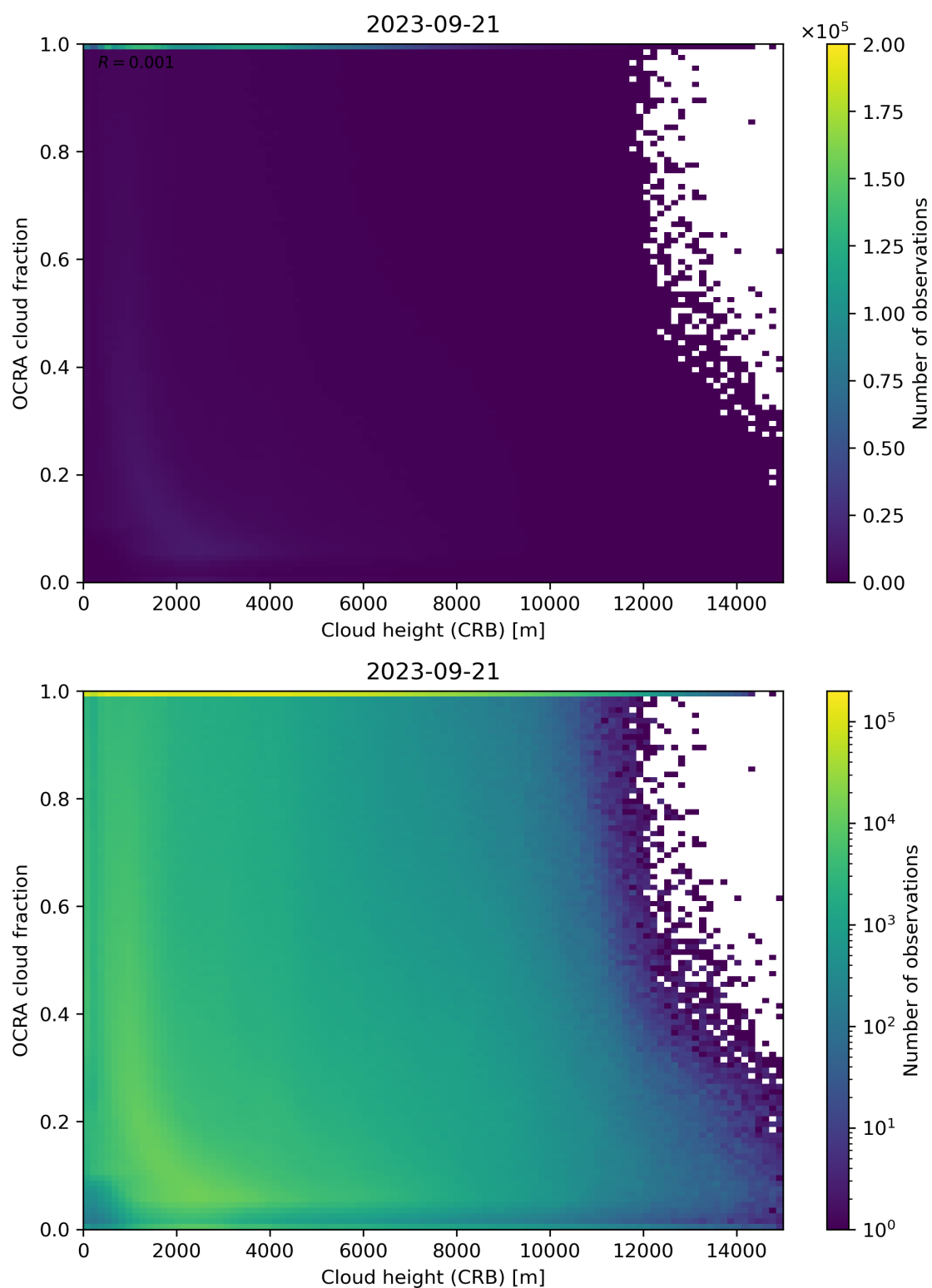


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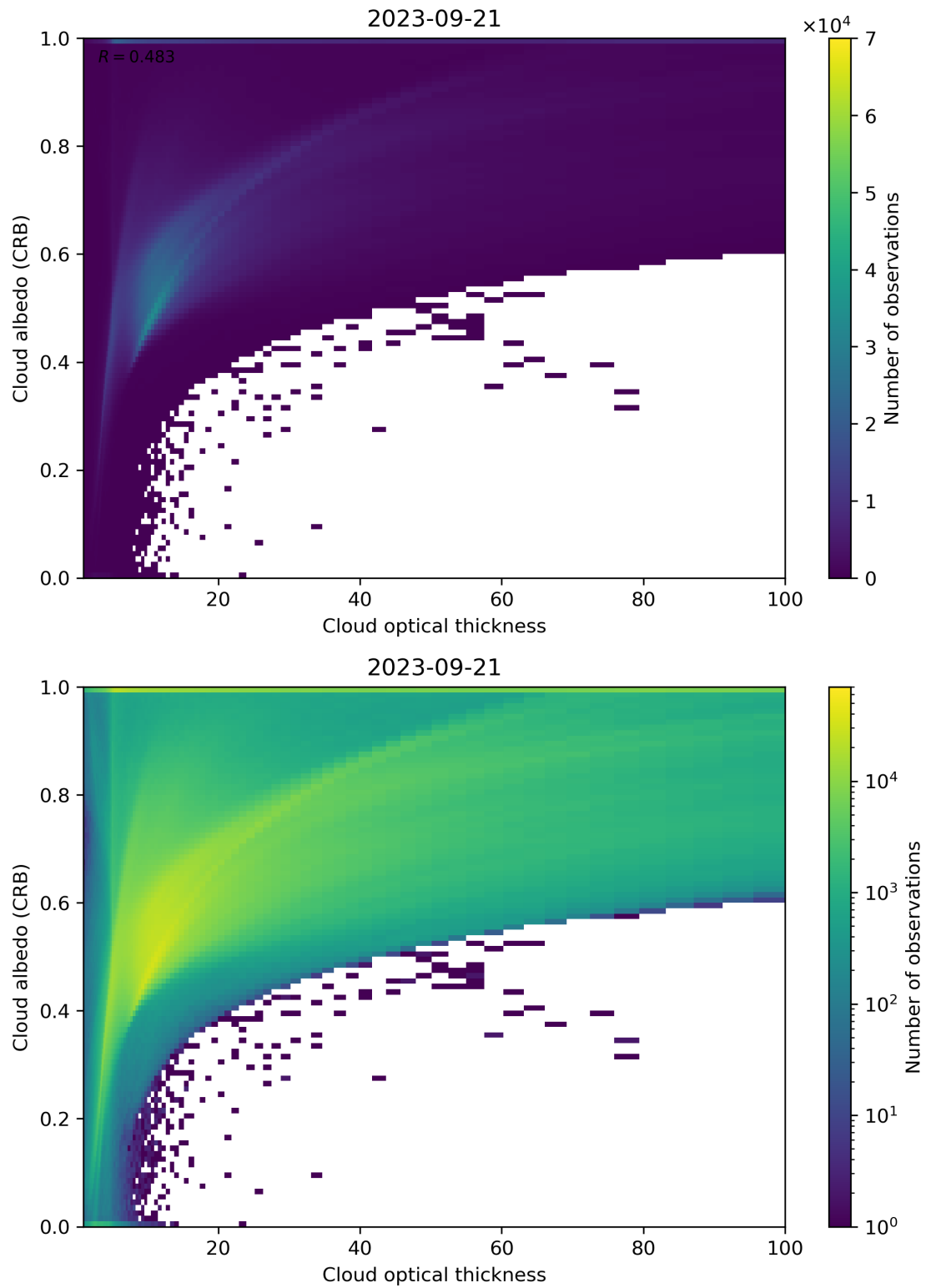


Figure 82: Scatter density plot of “Cloud optical thickness” against “Cloud albedo (CRB)” for 2023-09-20 to 2023-09-22.

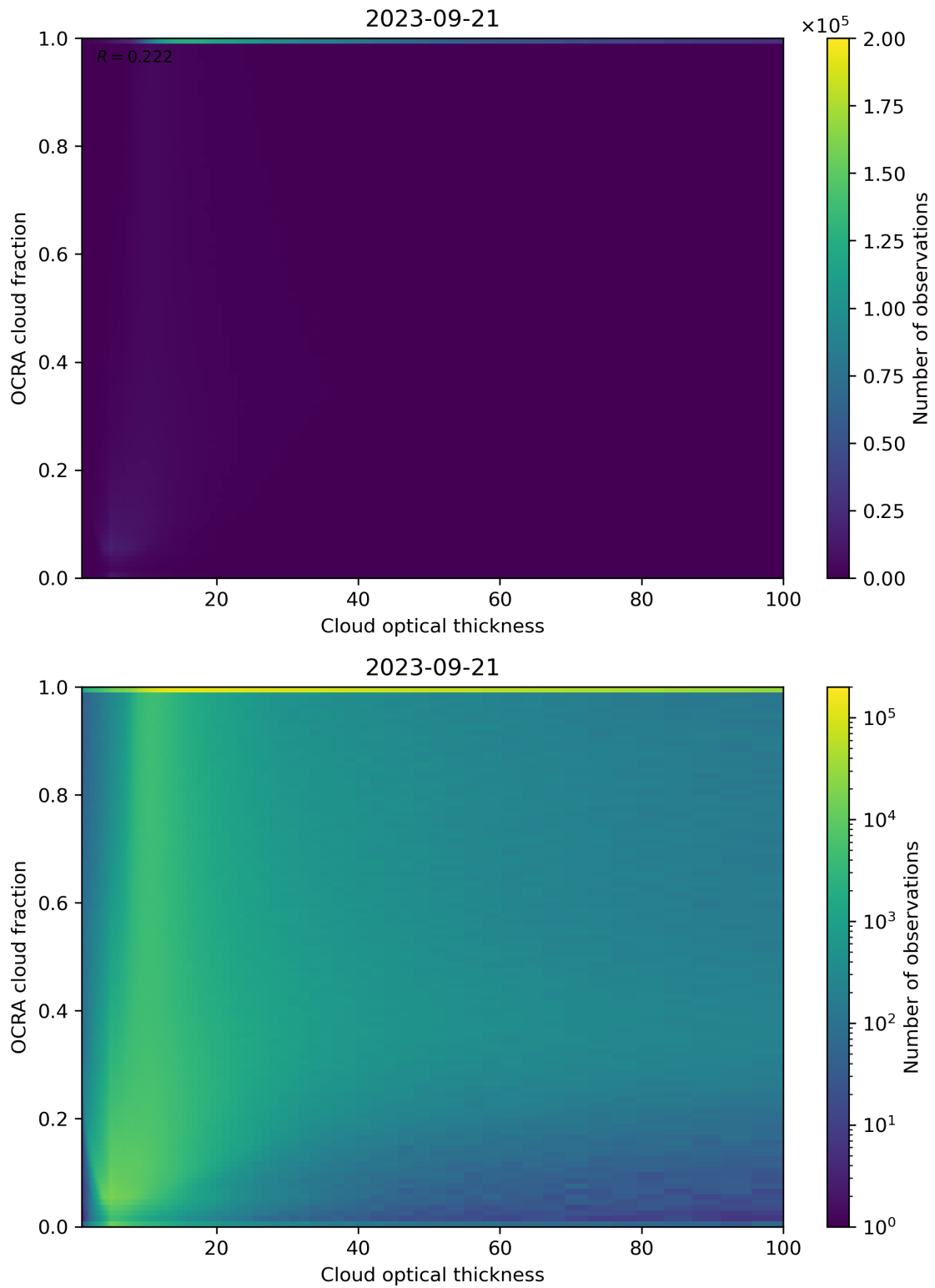


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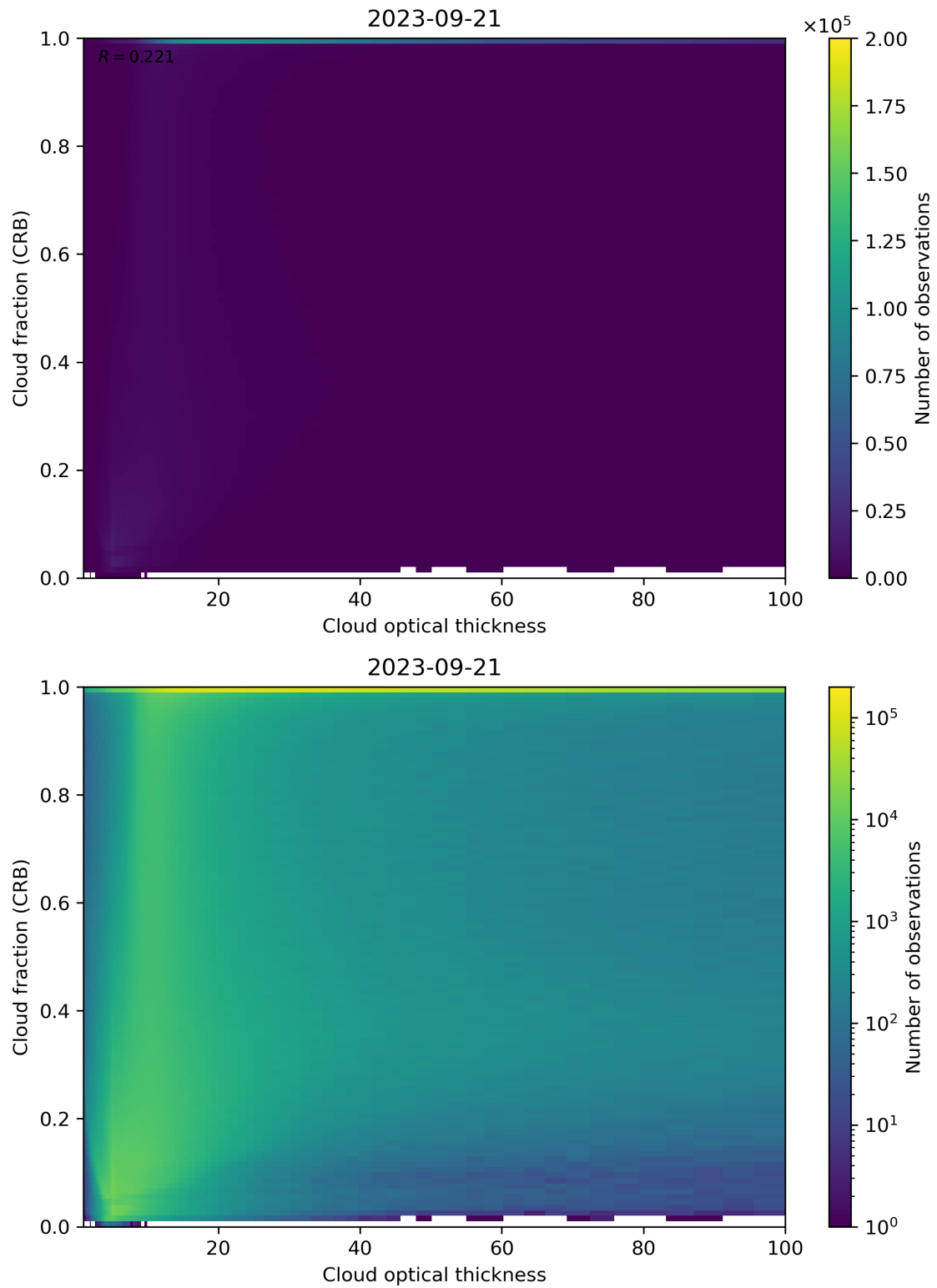


Figure 84: Scatter density plot of “Cloud optical thickness” against “Cloud fraction (CRB)” for 2023-09-20 to 2023-09-22.

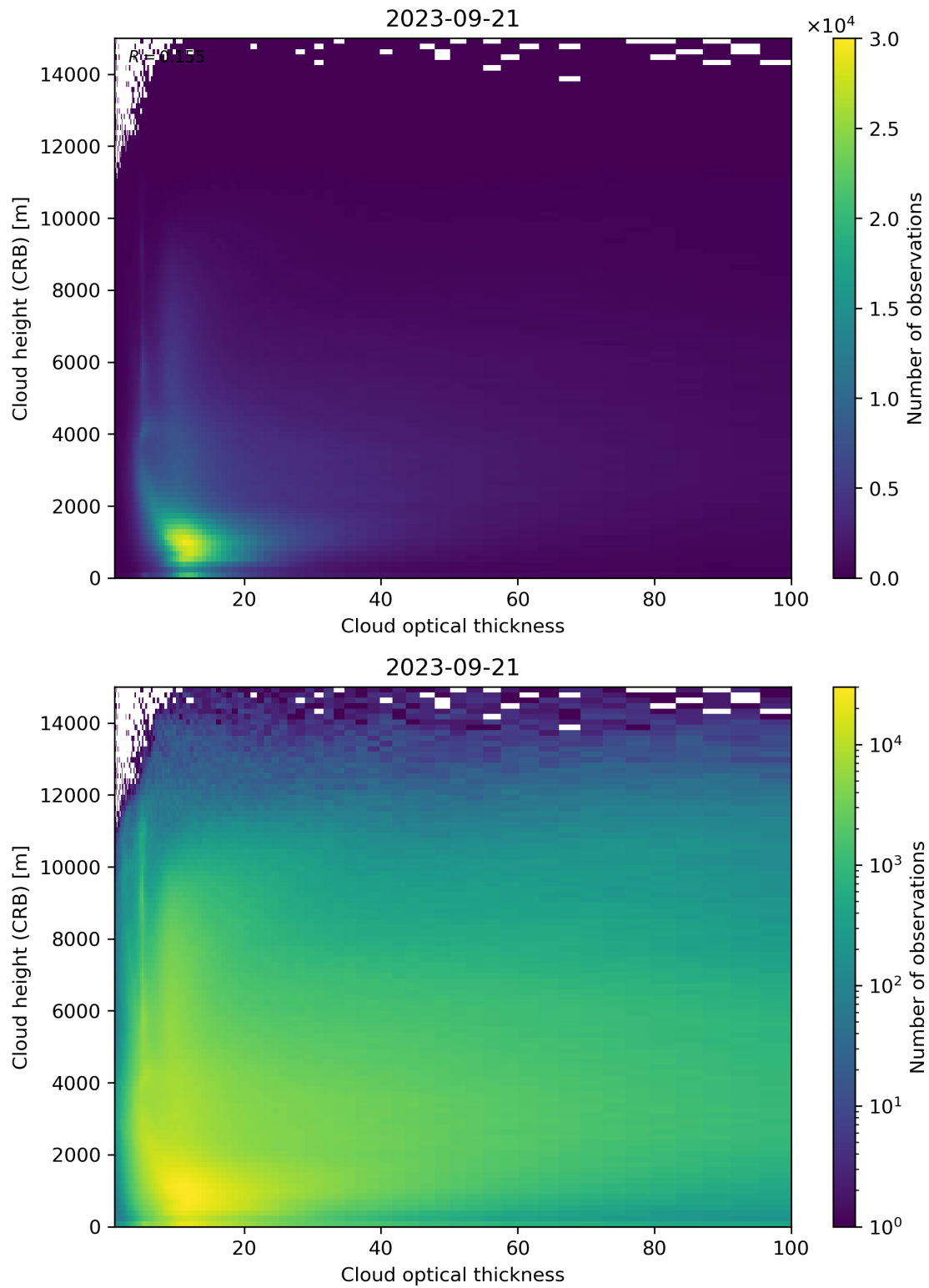


Figure 85: Scatter density plot of “Cloud optical thickness” against “Cloud height (CRB)” for 2023-09-20 to 2023-09-22.

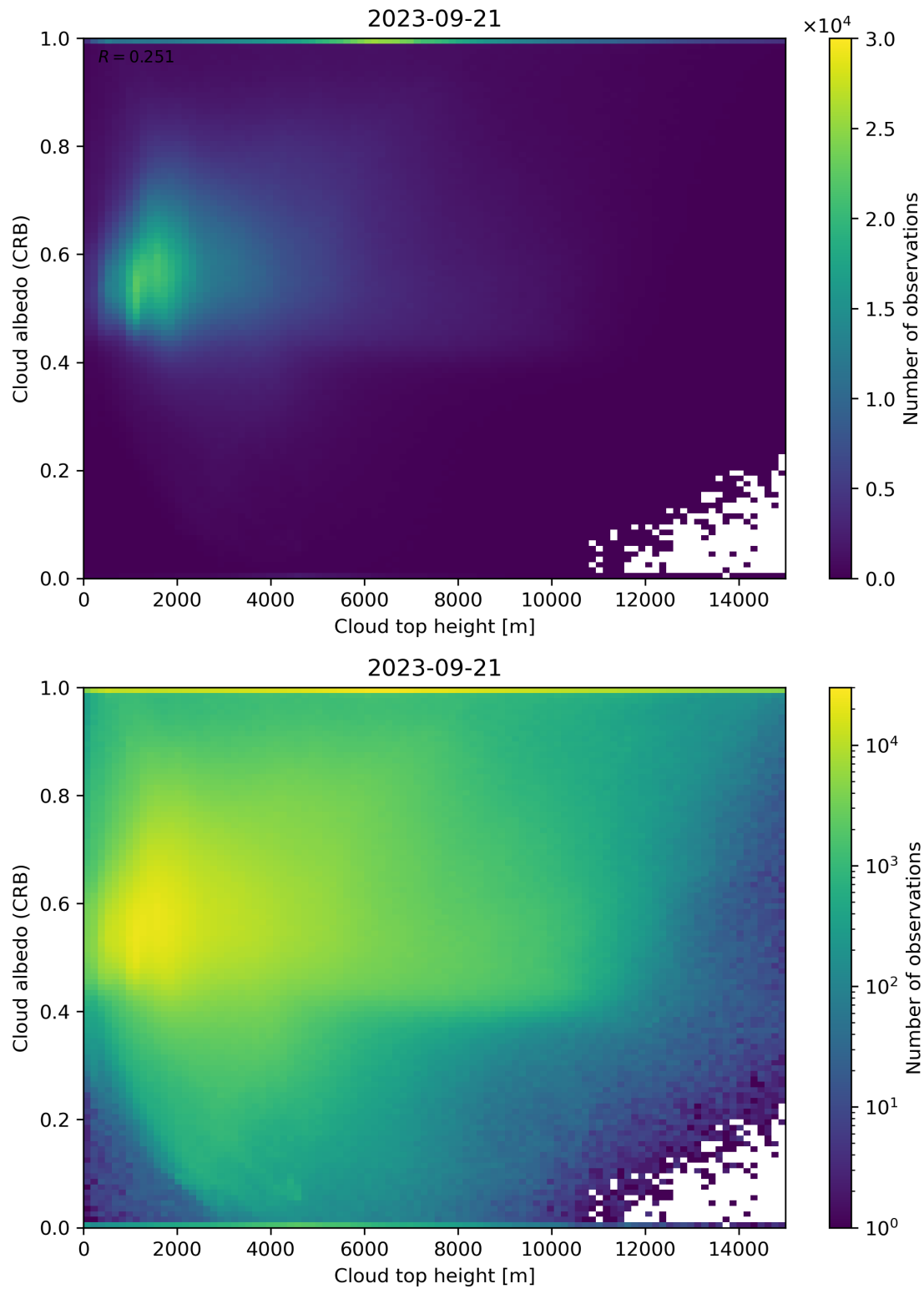


Figure 86: Scatter density plot of “Cloud top height” against “Cloud albedo (CRB)” for 2023-09-20 to 2023-09-22.

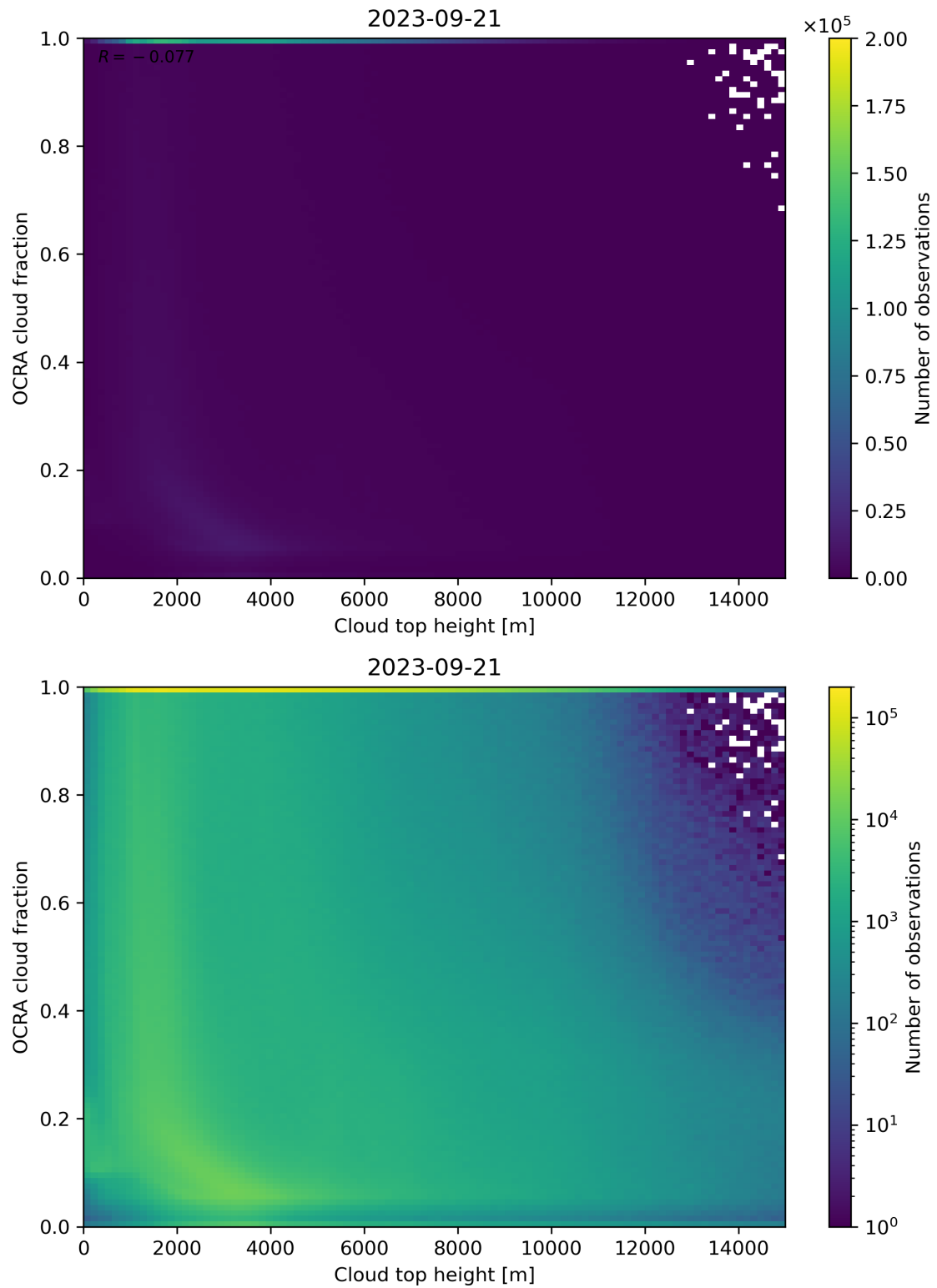


Figure 87: Scatter density plot of “Cloud top height” against “OCRA cloud fraction” for 2023-09-20 to 2023-09-22.

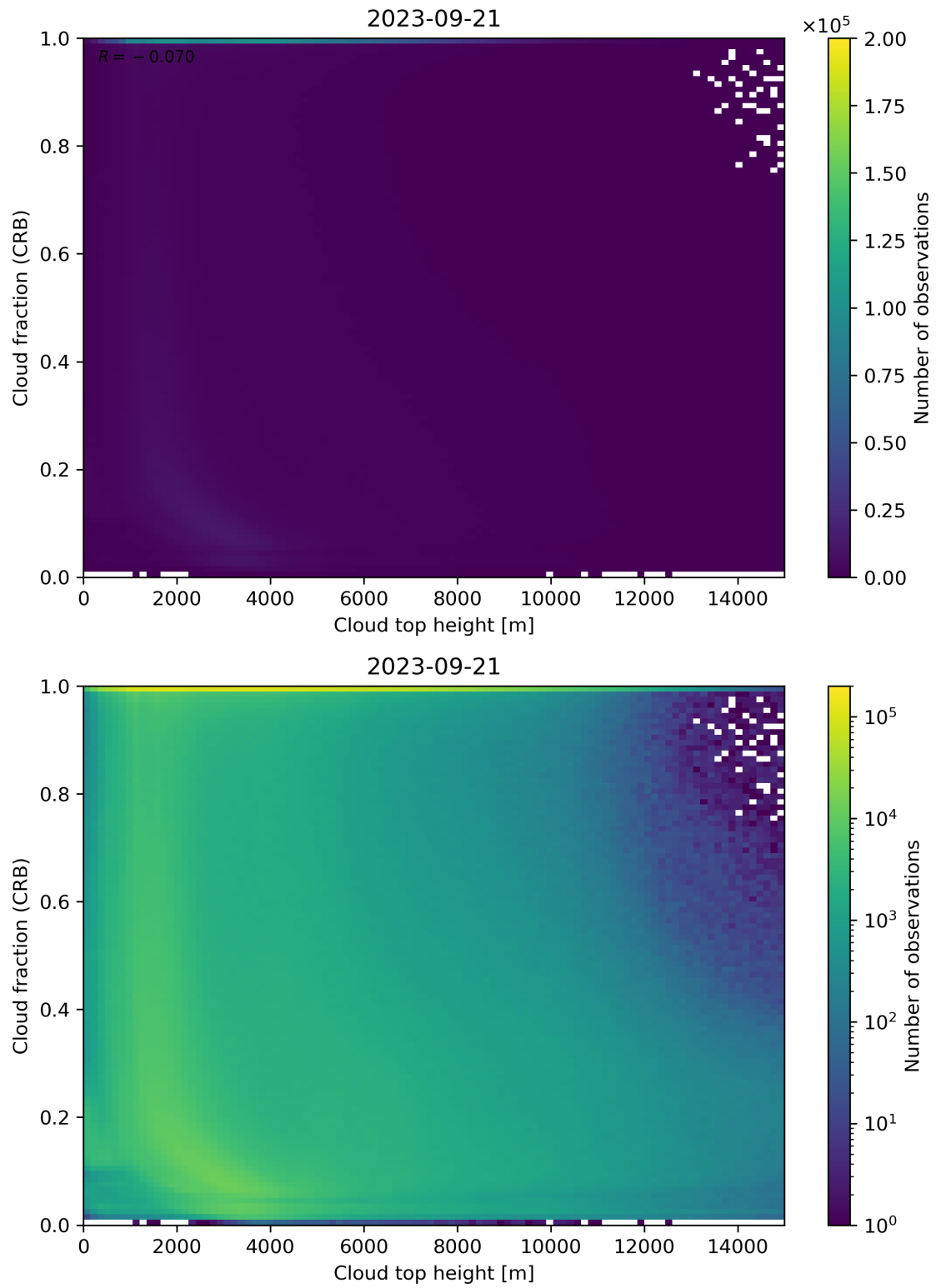


Figure 88: Scatter density plot of “Cloud top height” against “Cloud fraction (CRB)” for 2023-09-20 to 2023-09-22.



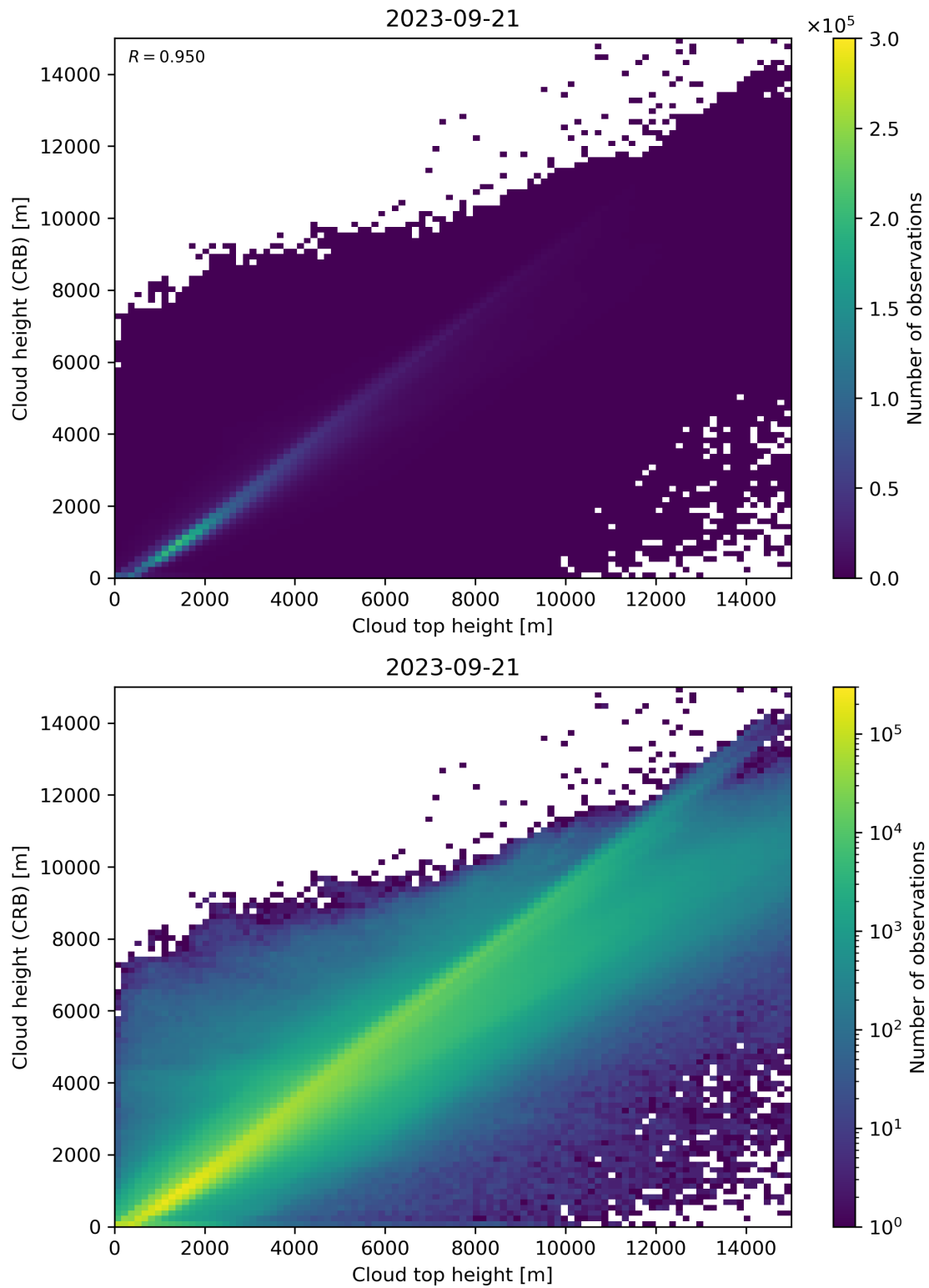


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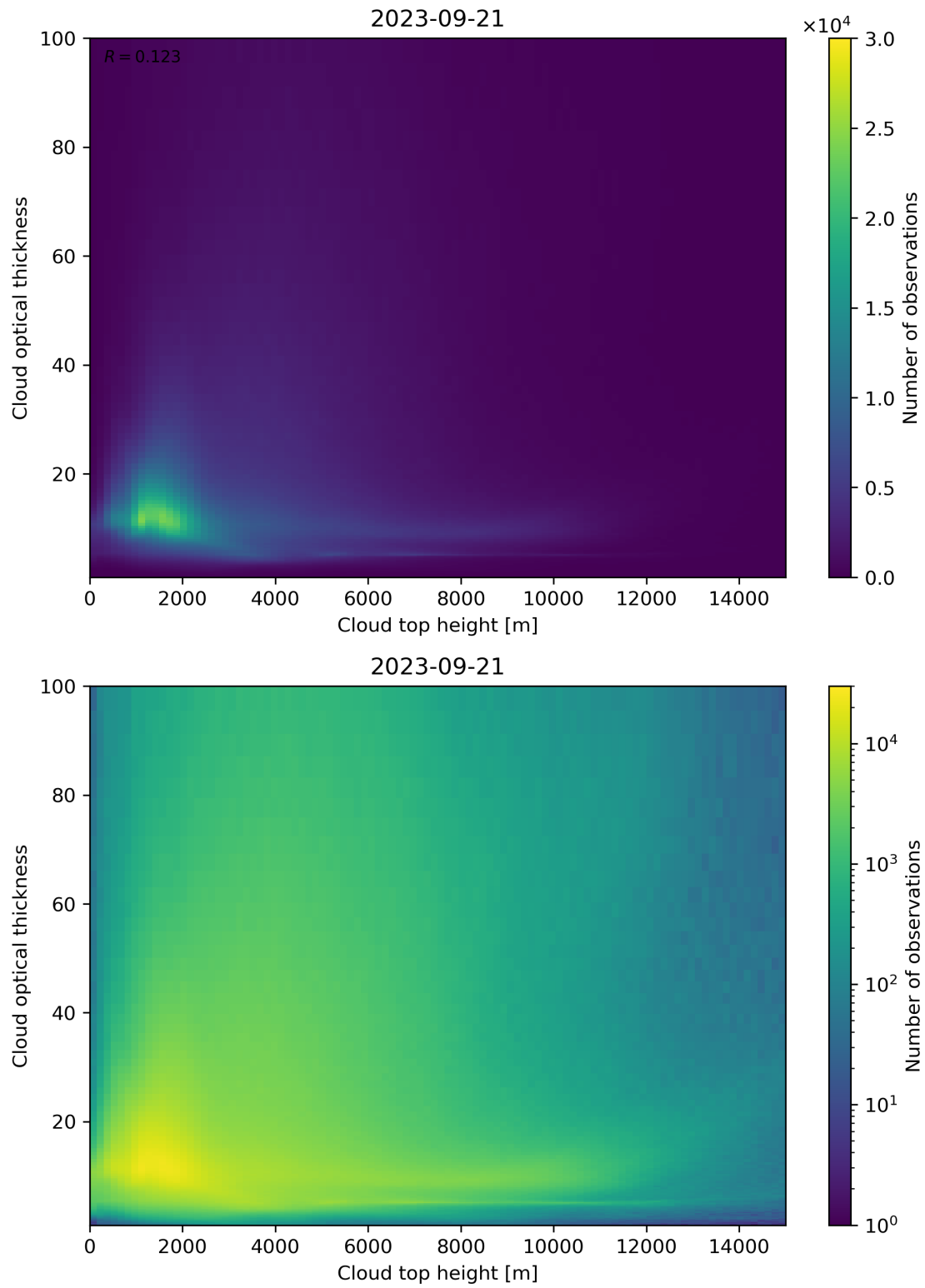


Figure 90: Scatter density plot of “Cloud top height” against “Cloud optical thickness” for 2023-09-20 to 2023-09-22.

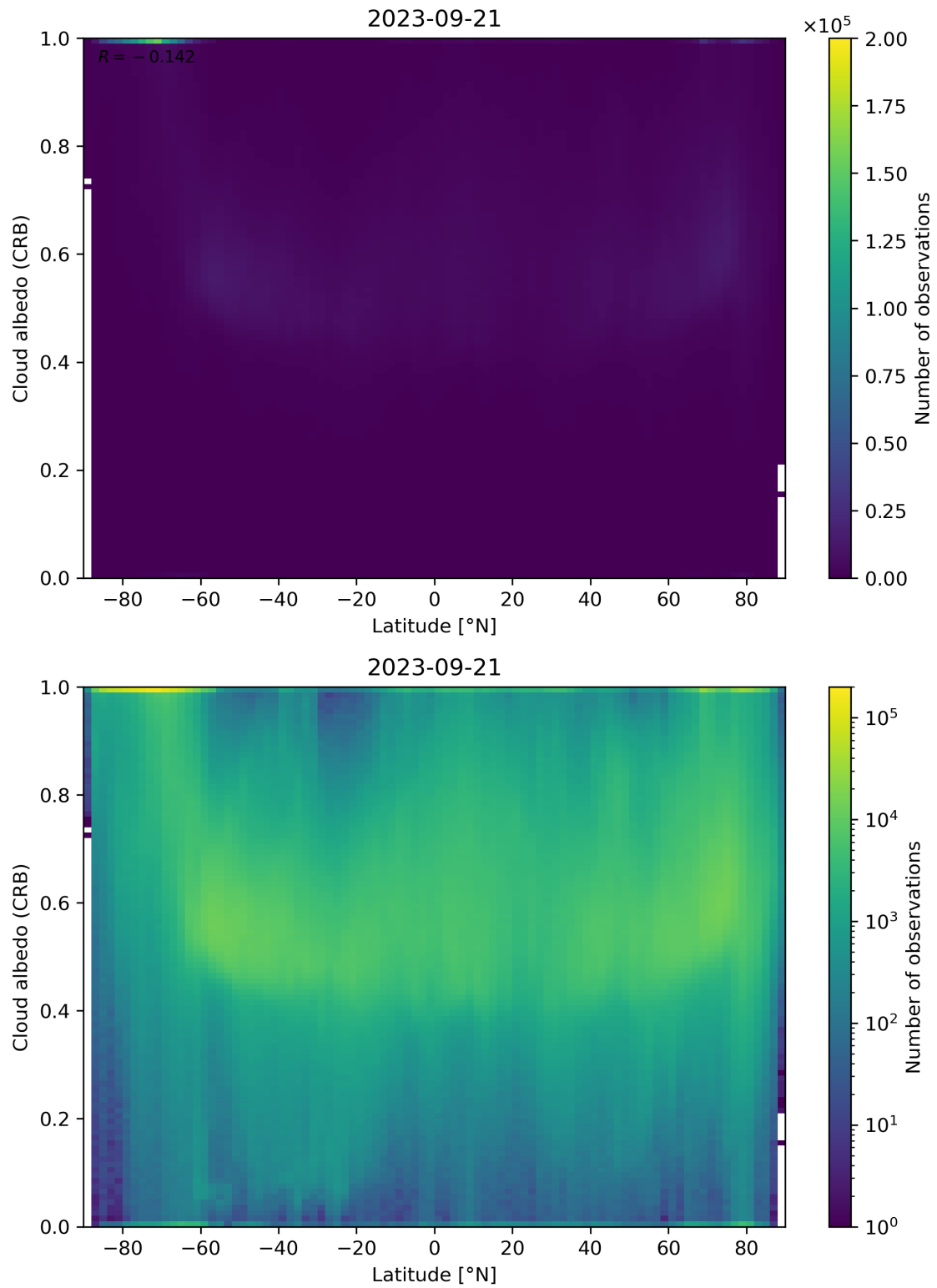


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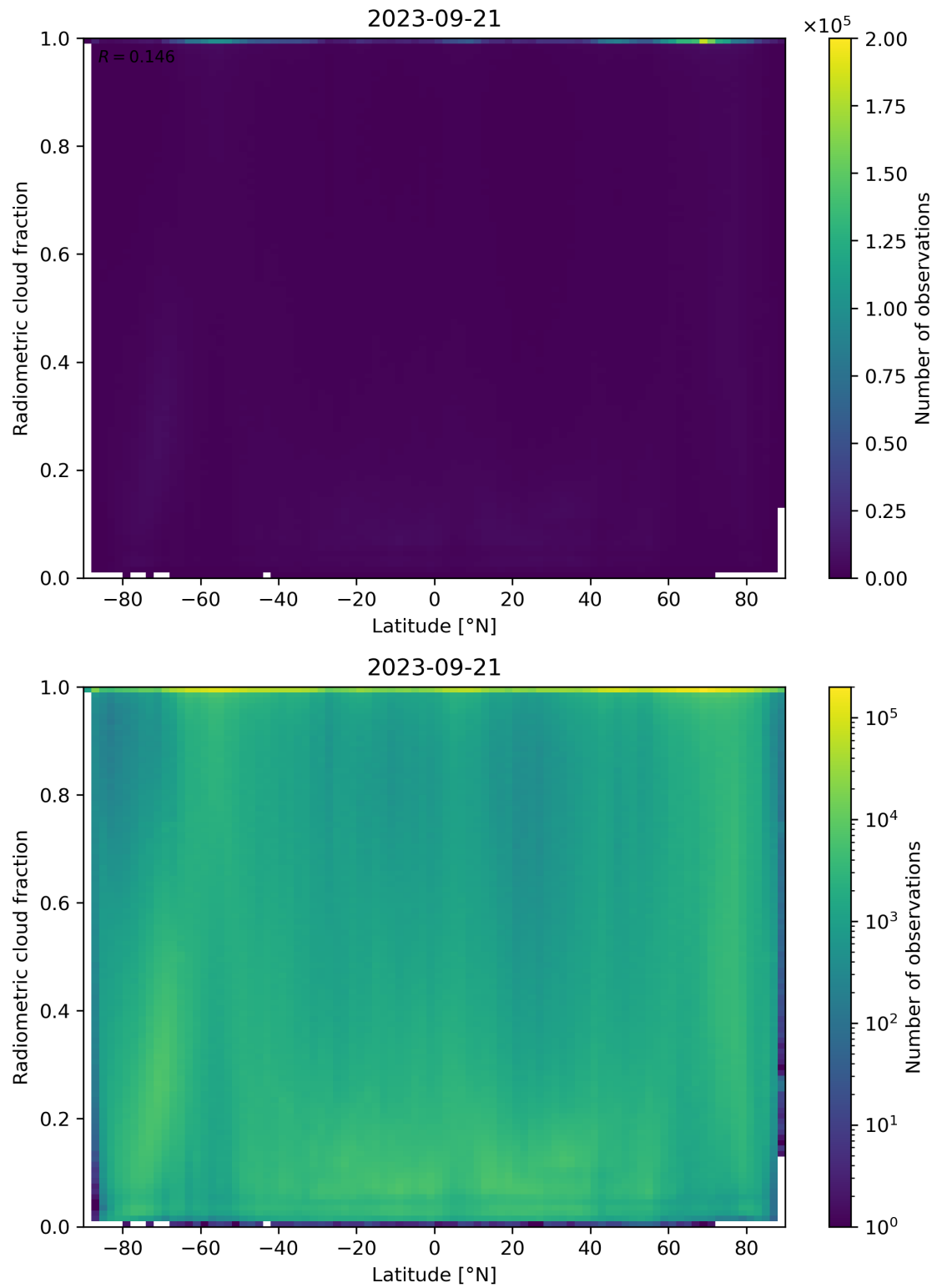


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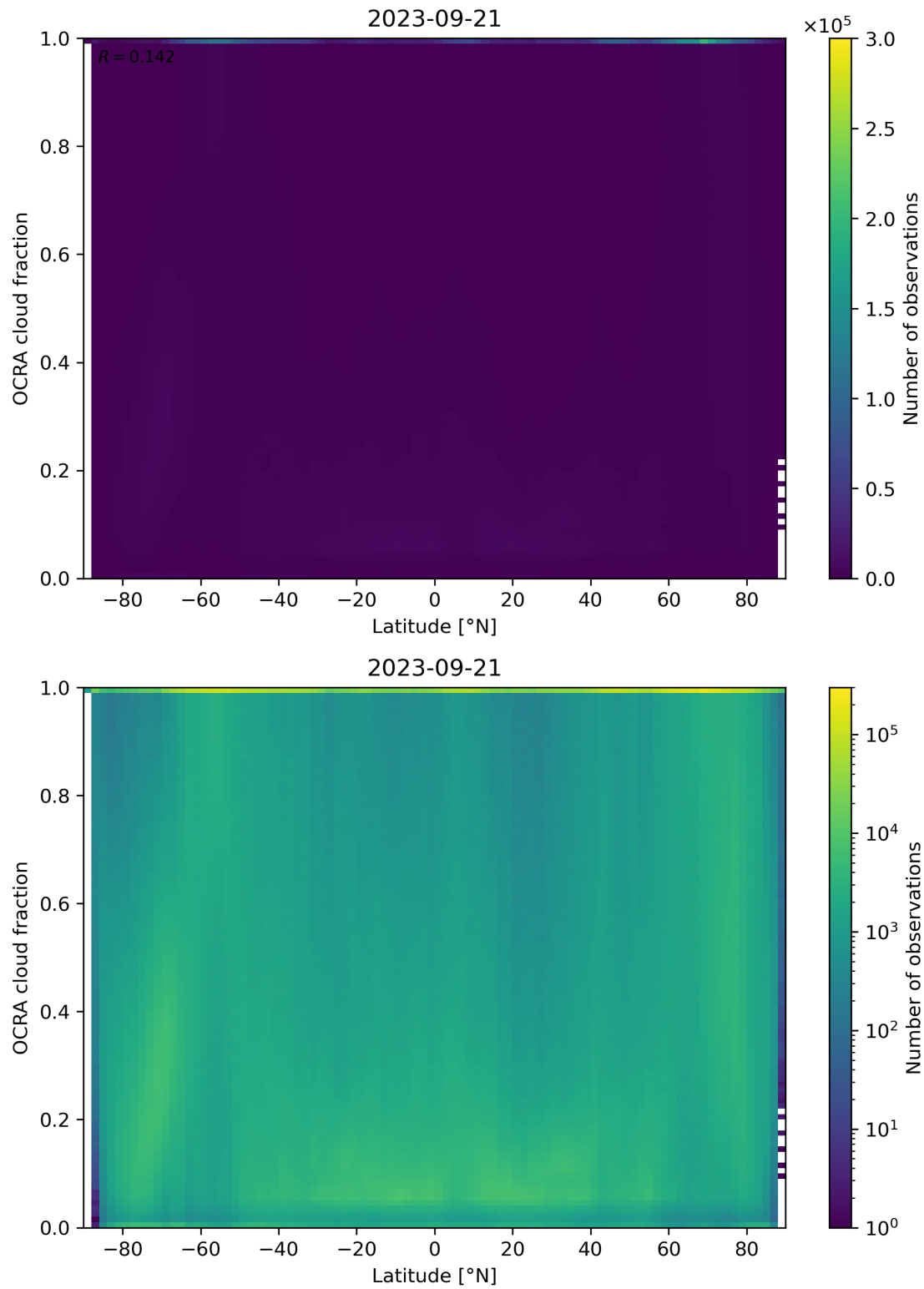


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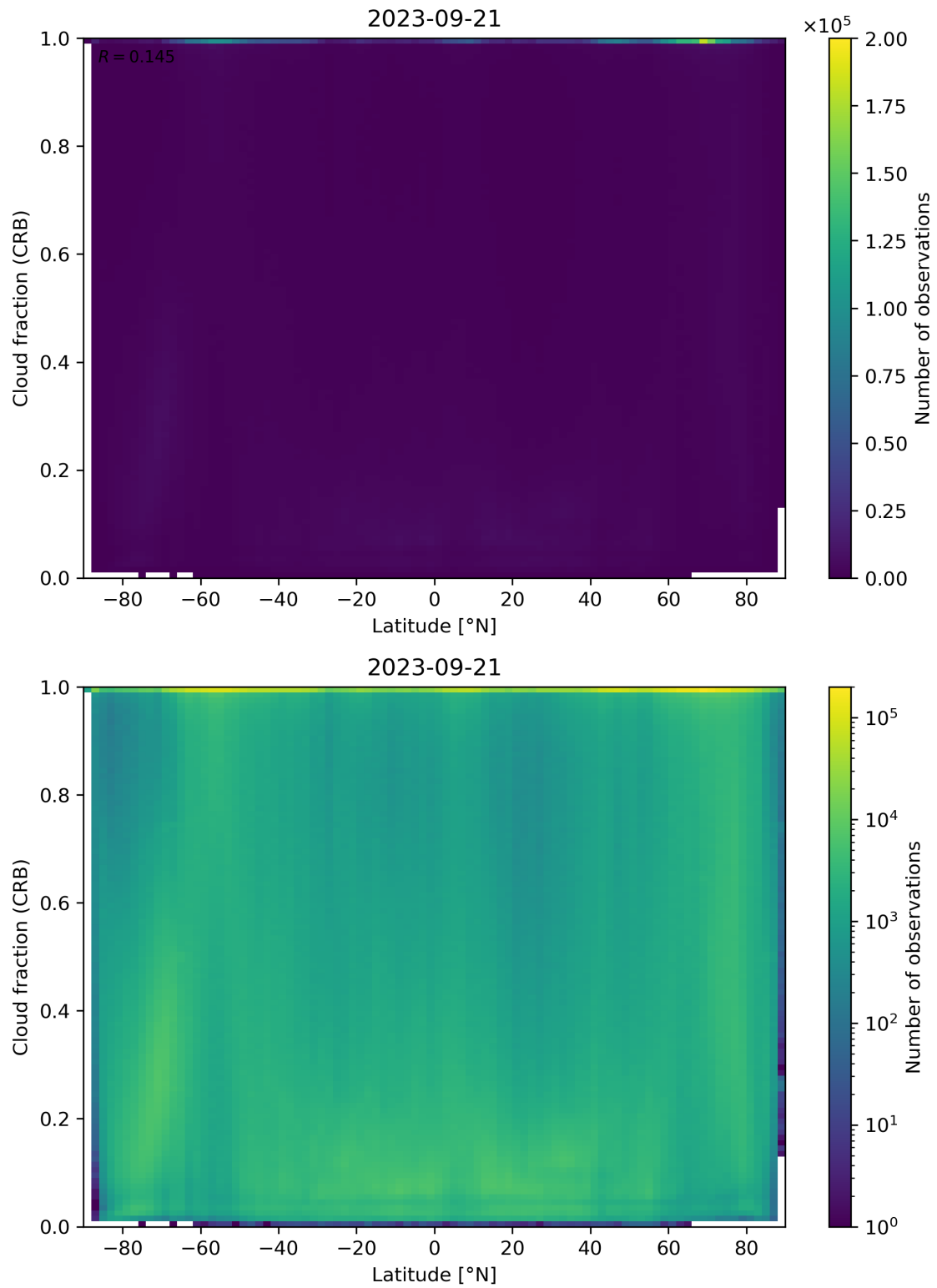


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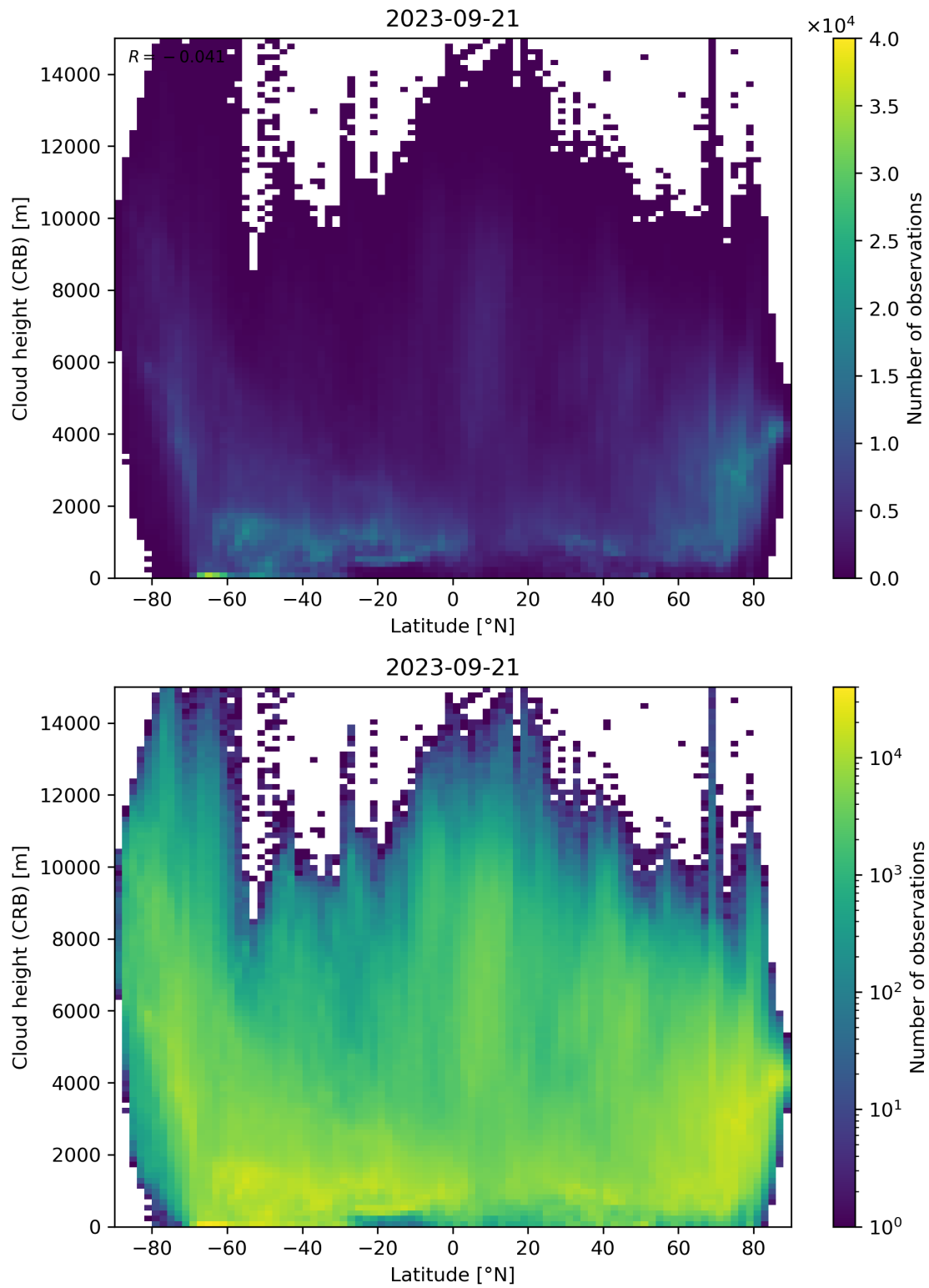


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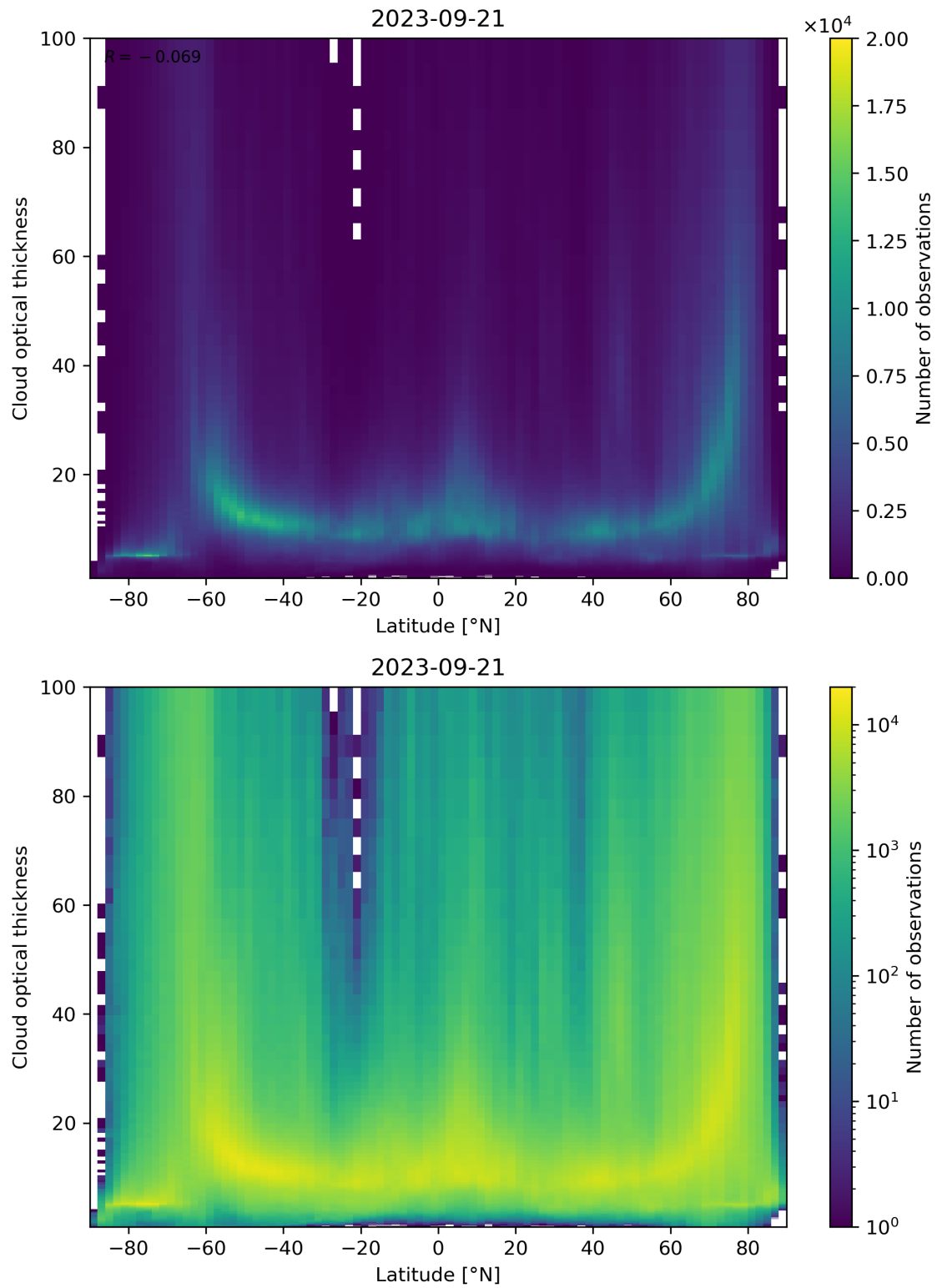


Figure 96: Scatter density plot of “Latitude” against “Cloud optical thickness” for 2023-09-20 to 2023-09-22.



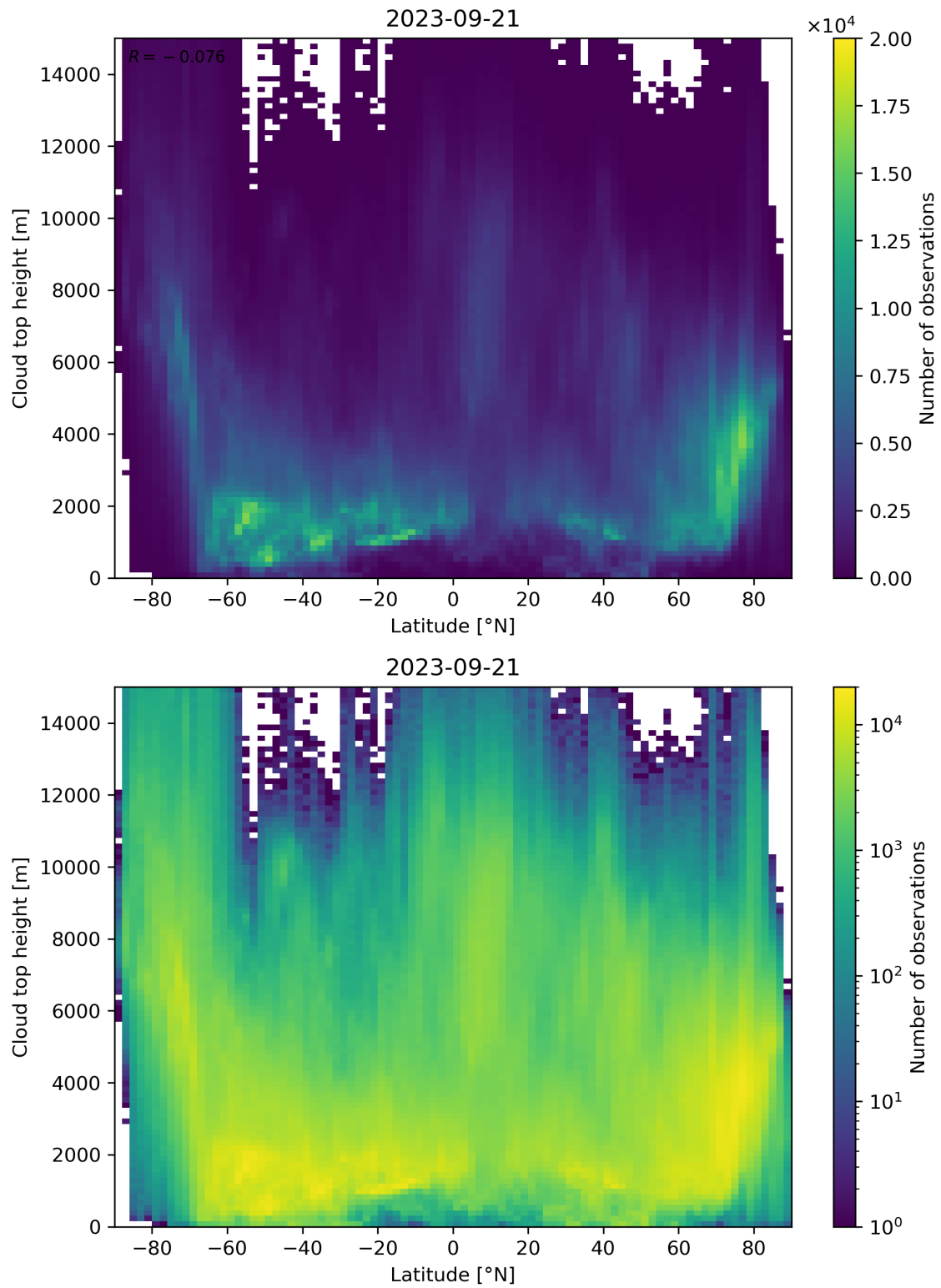


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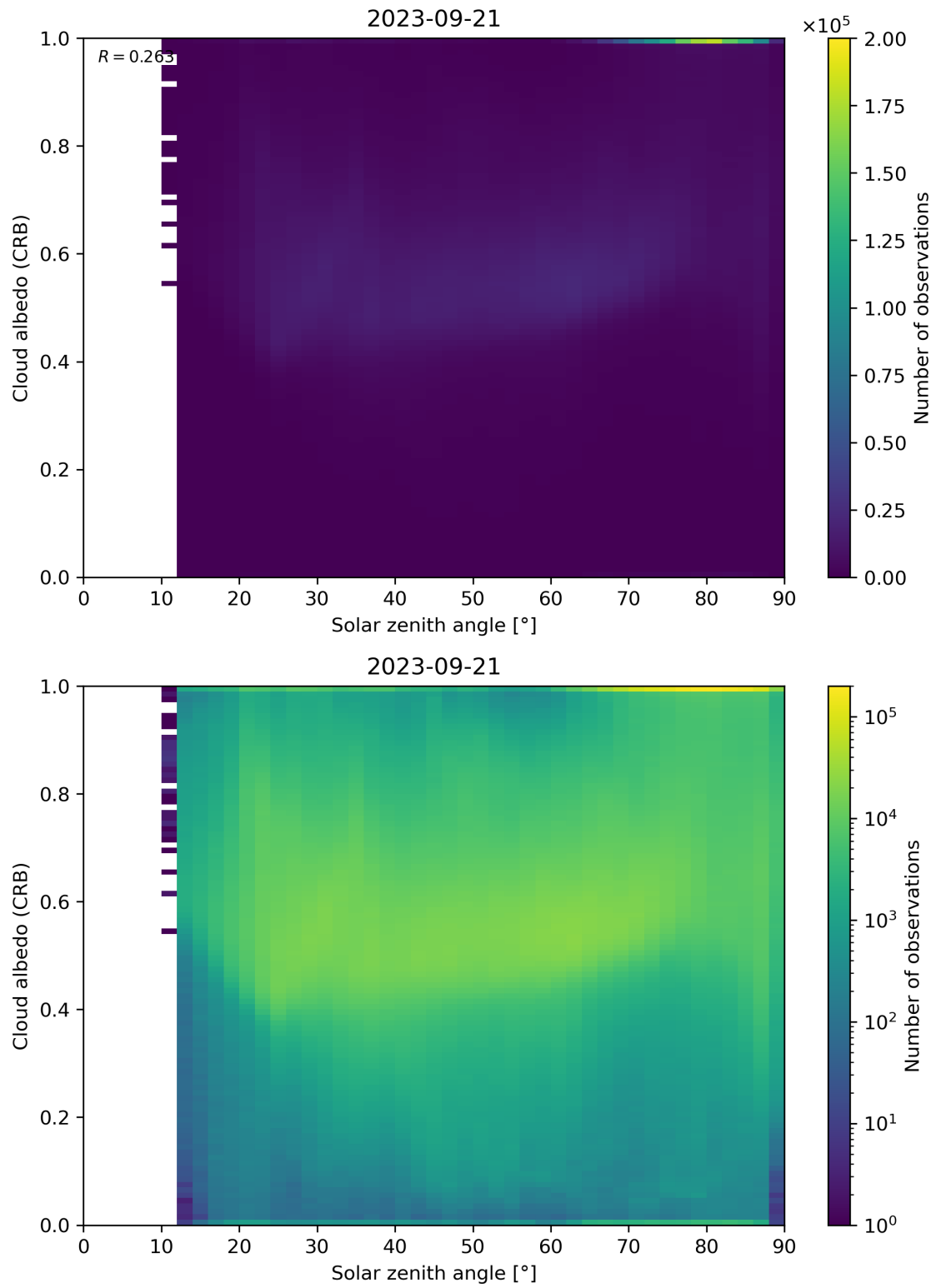


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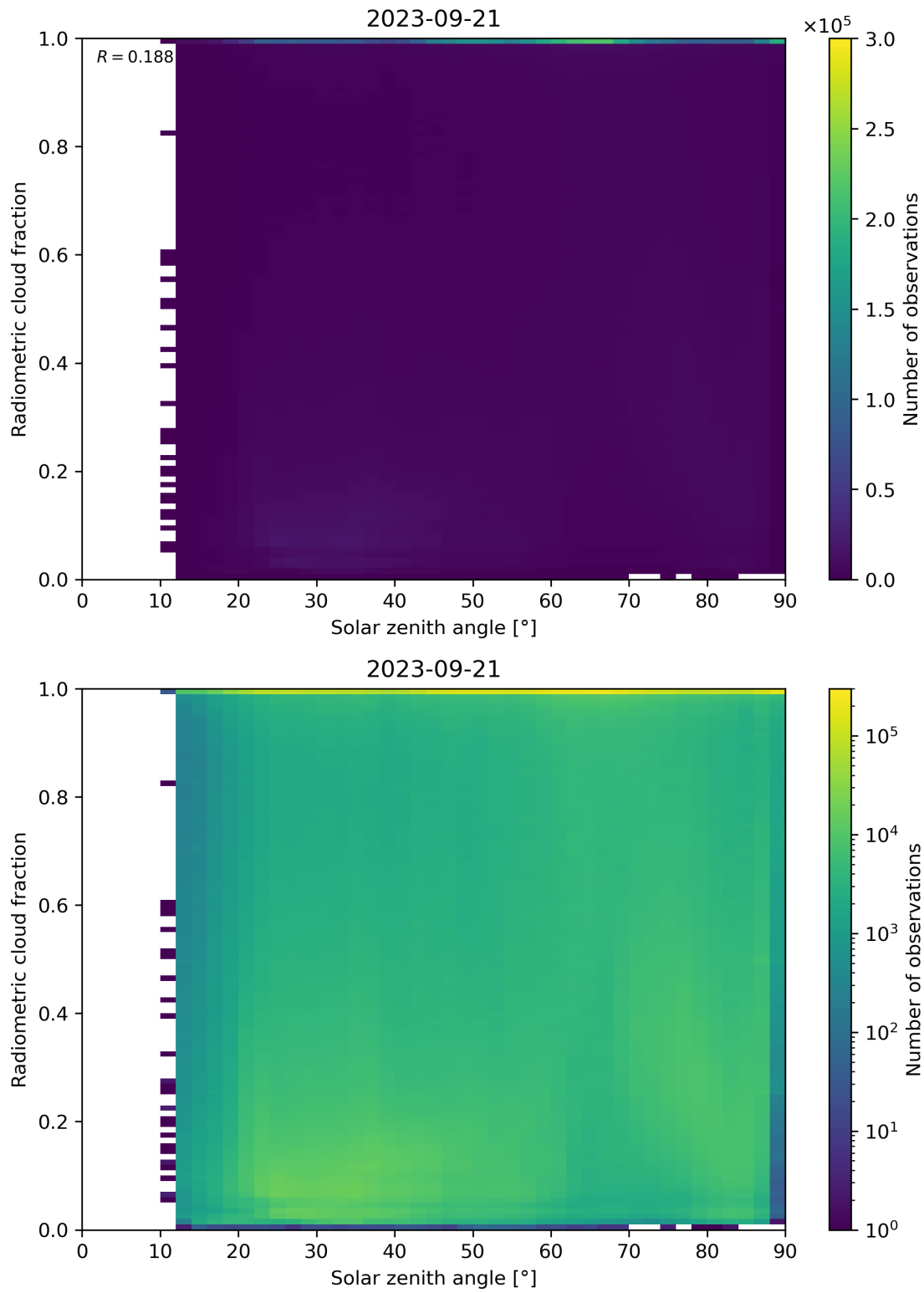


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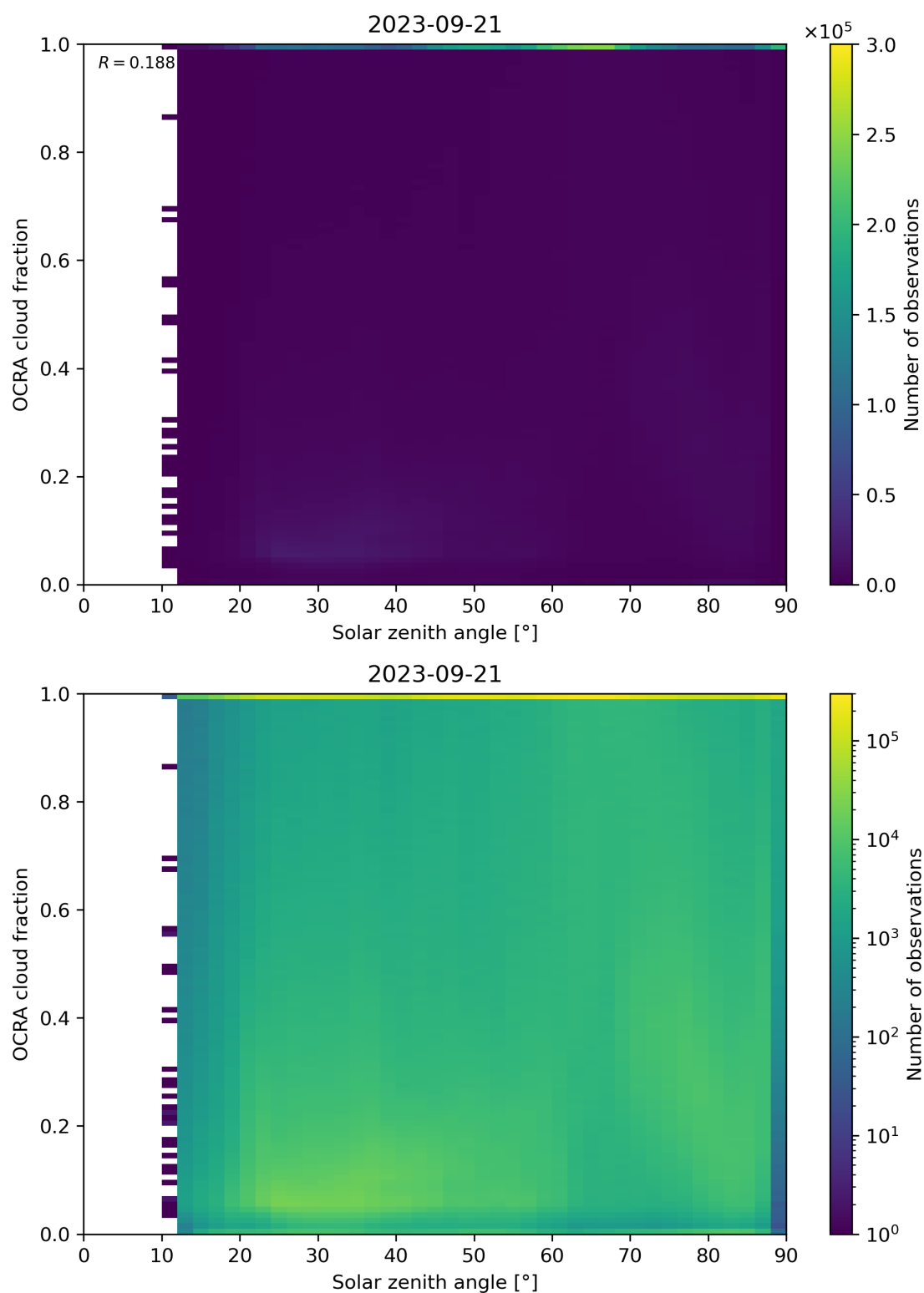


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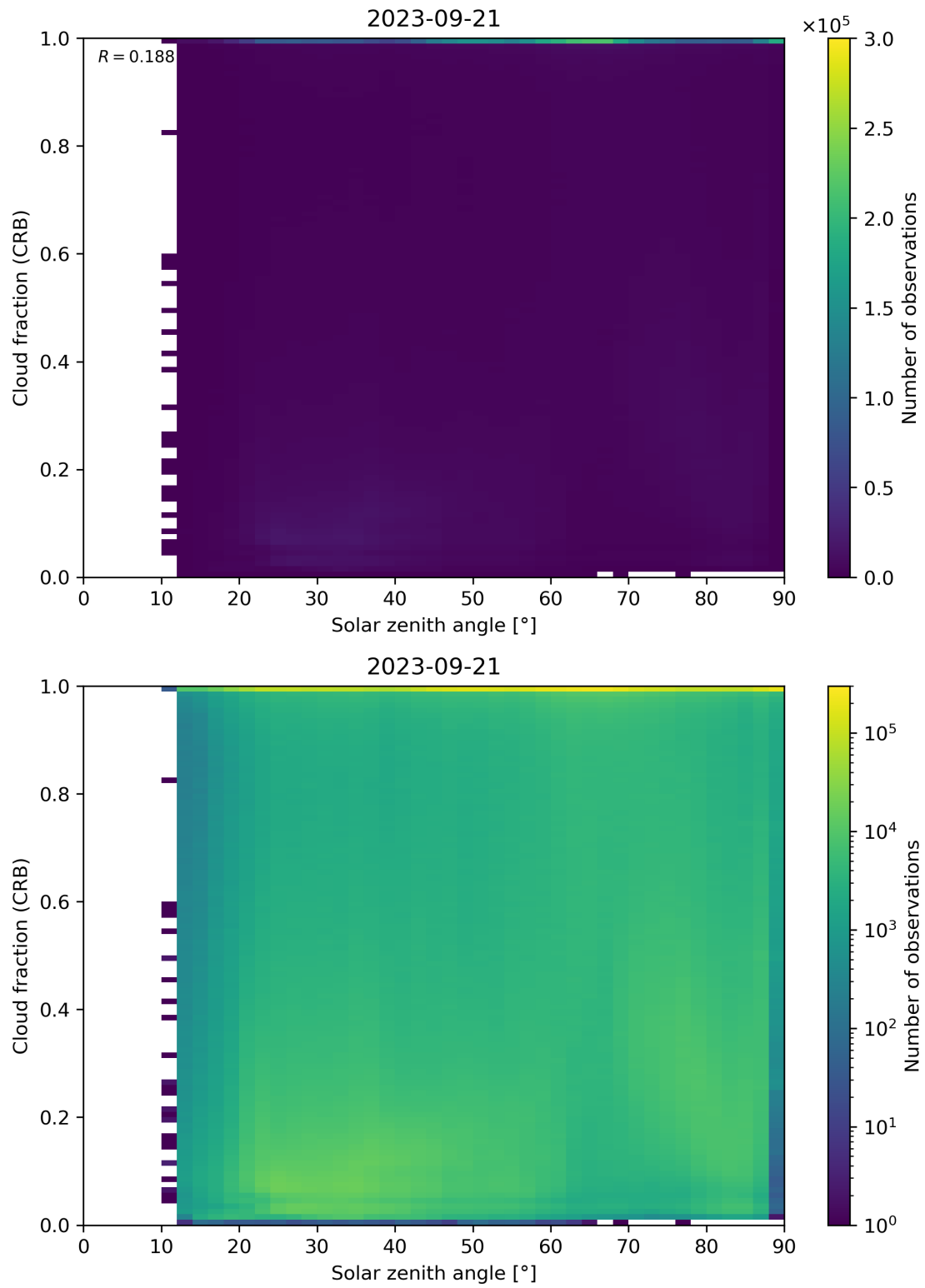


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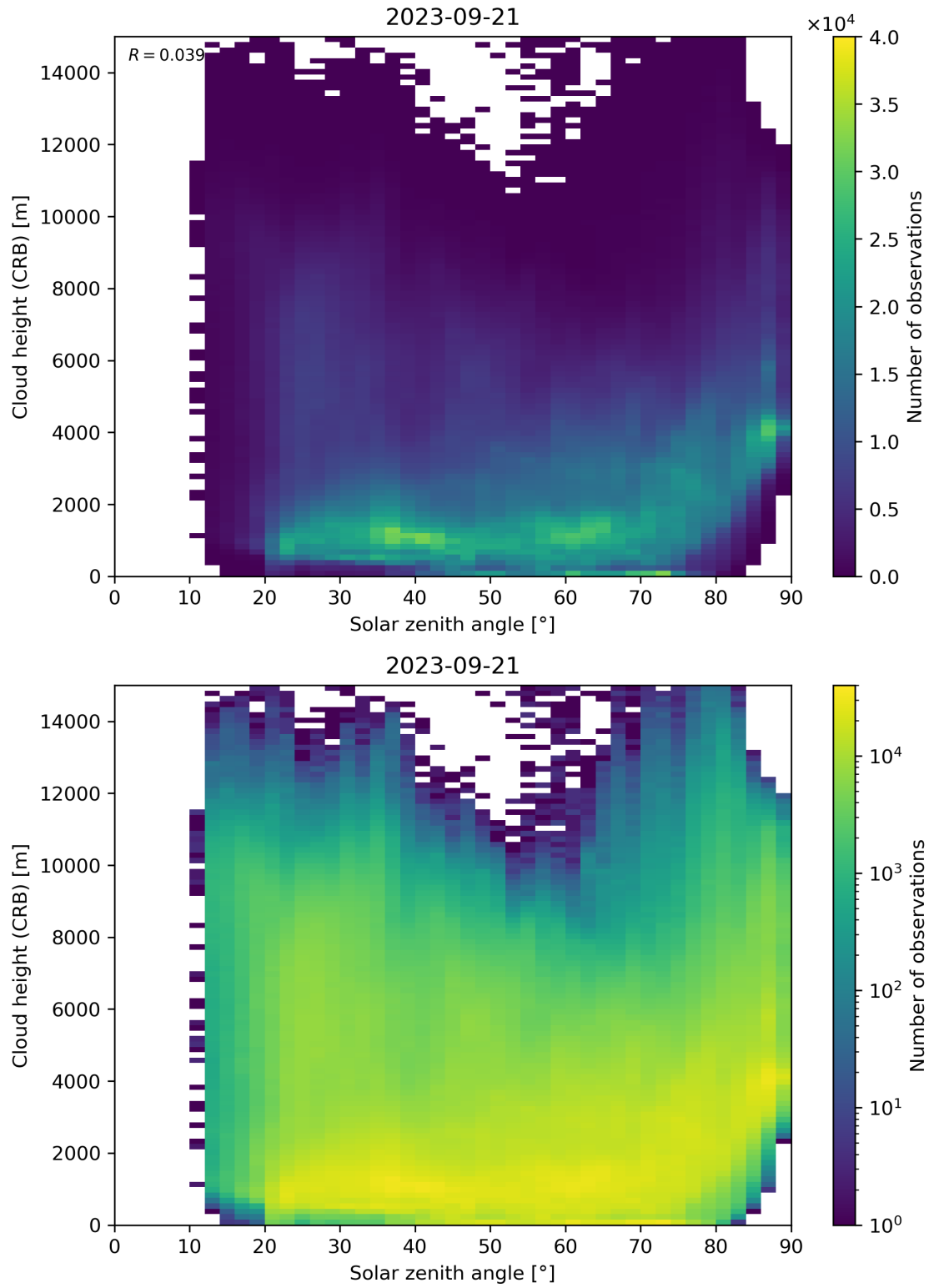


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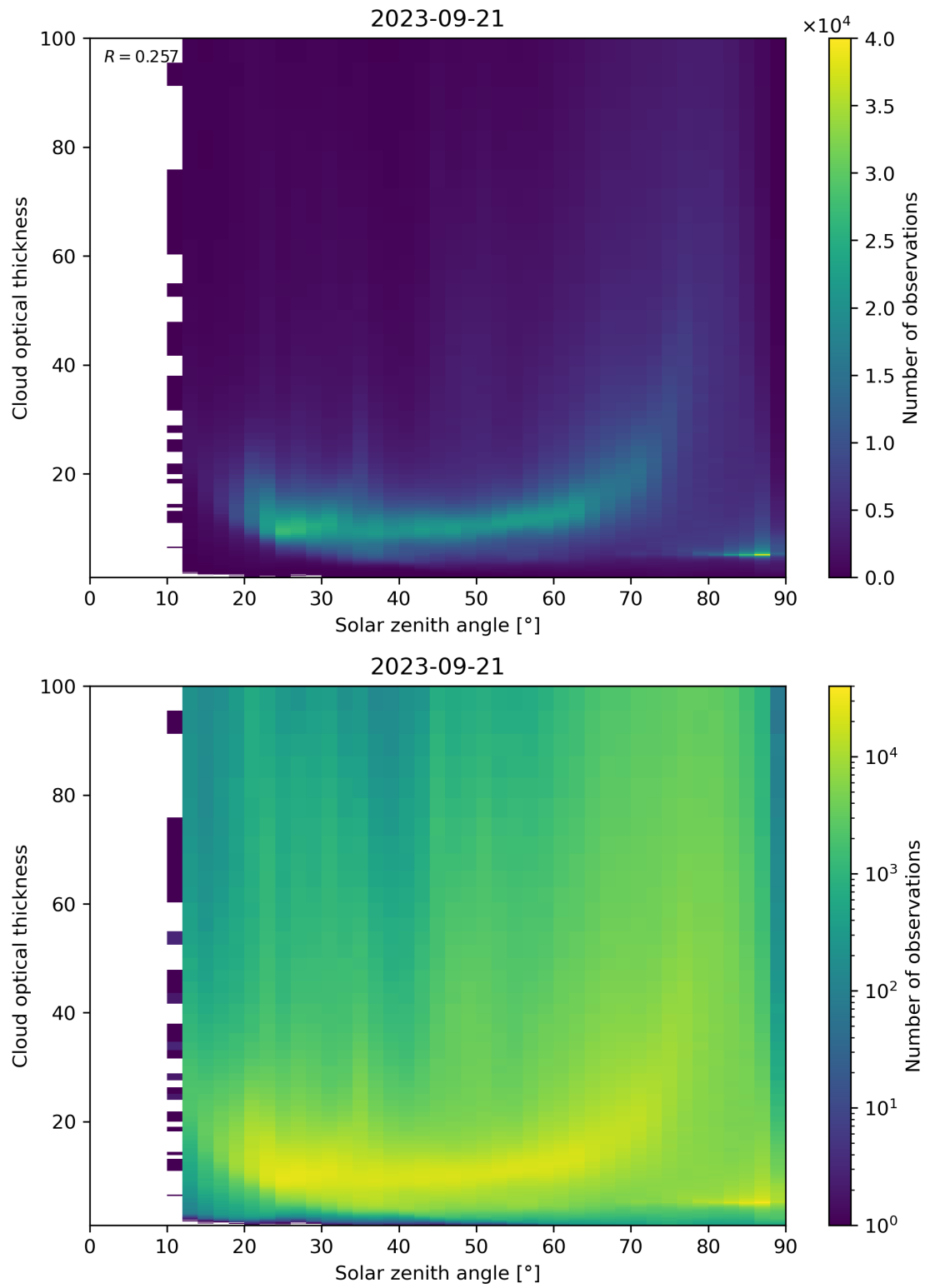


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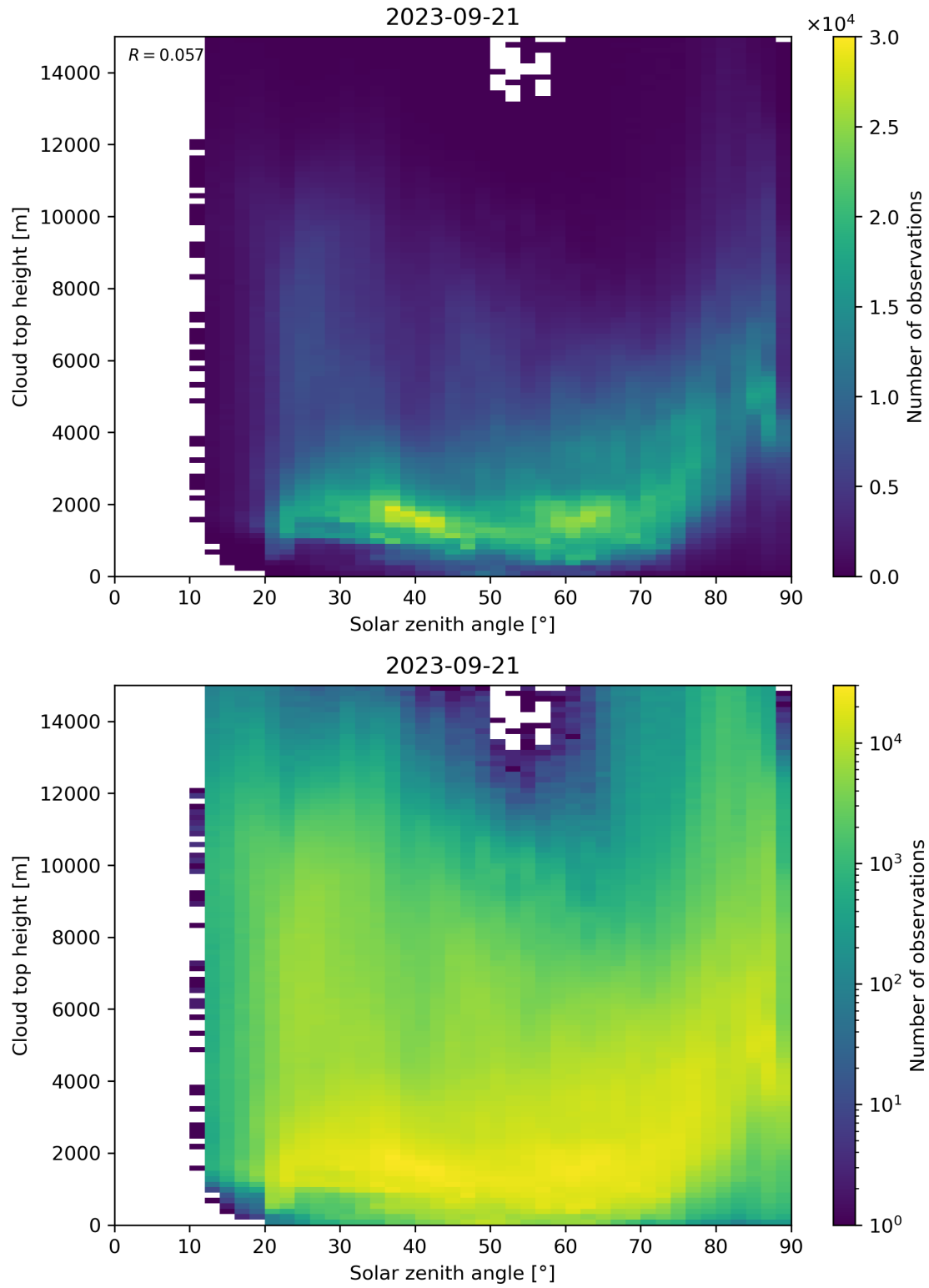


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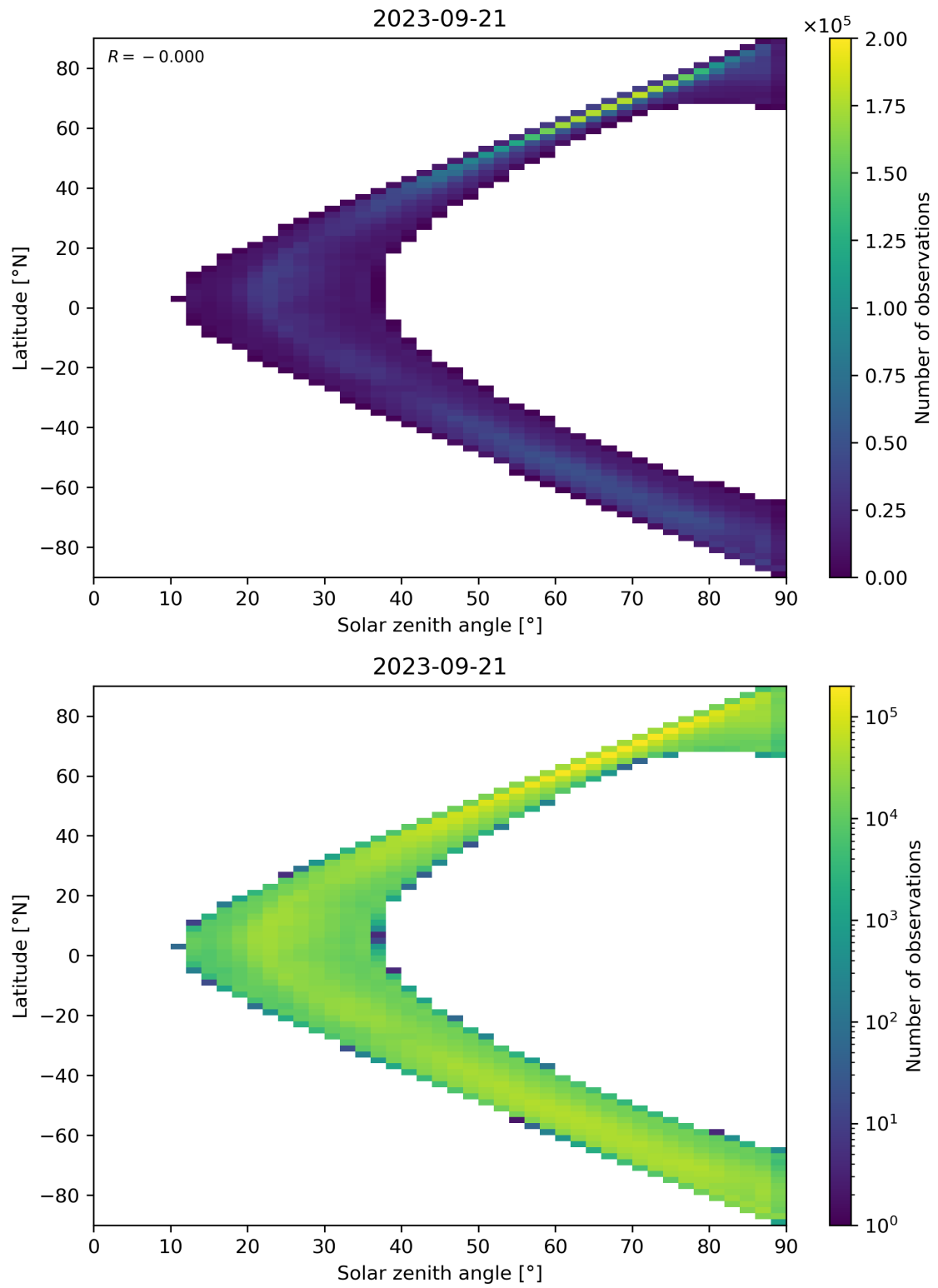


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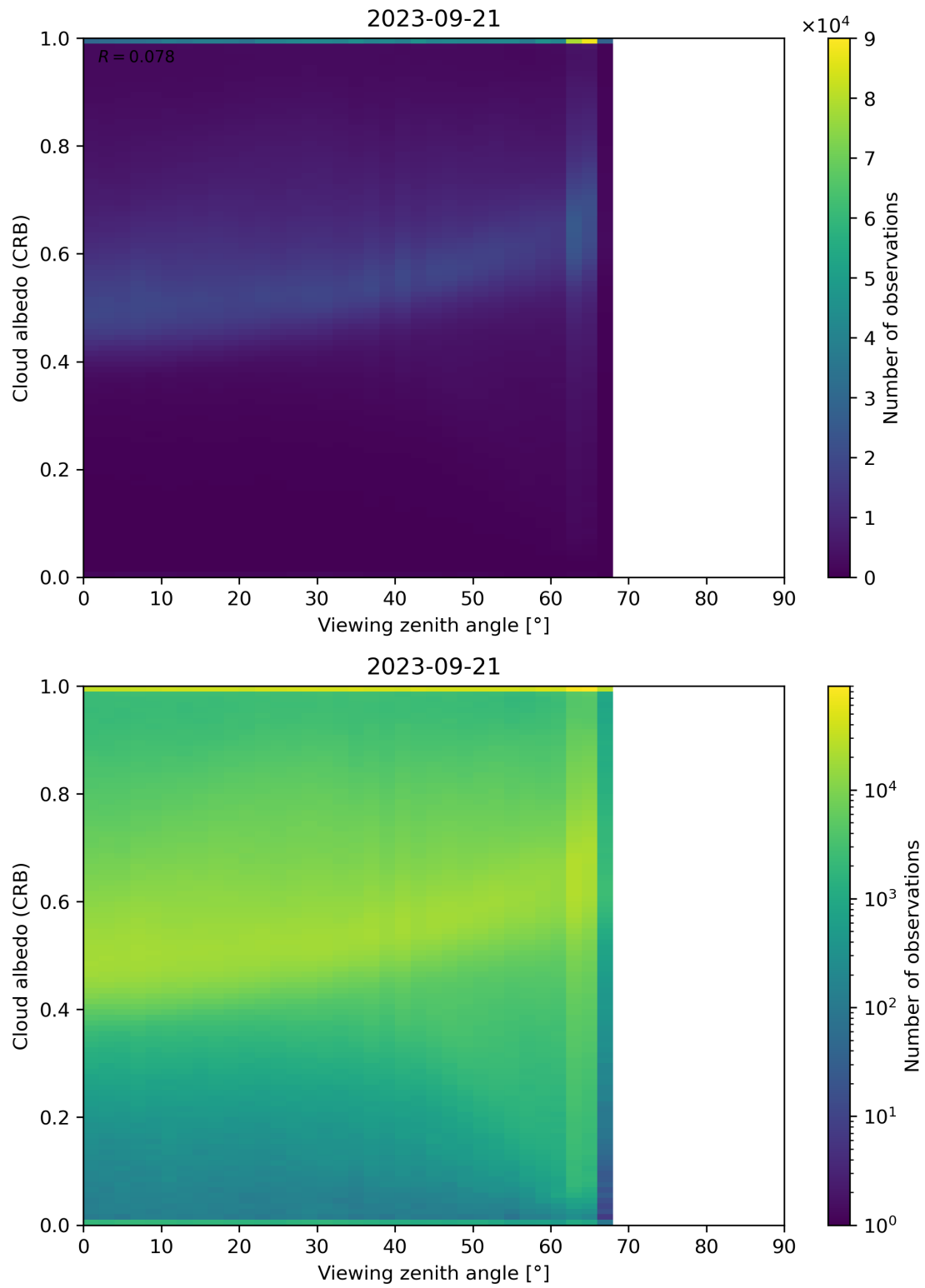


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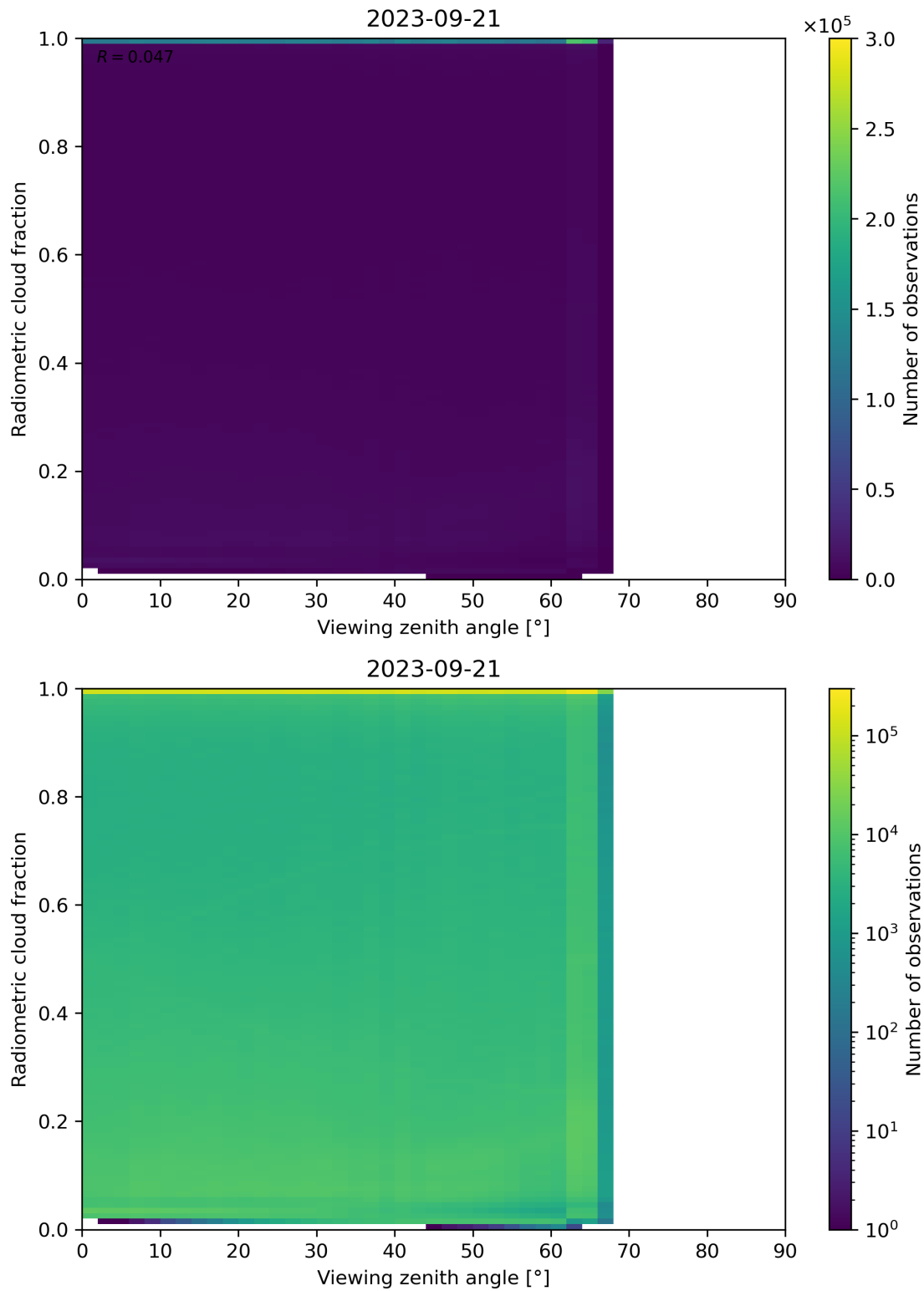


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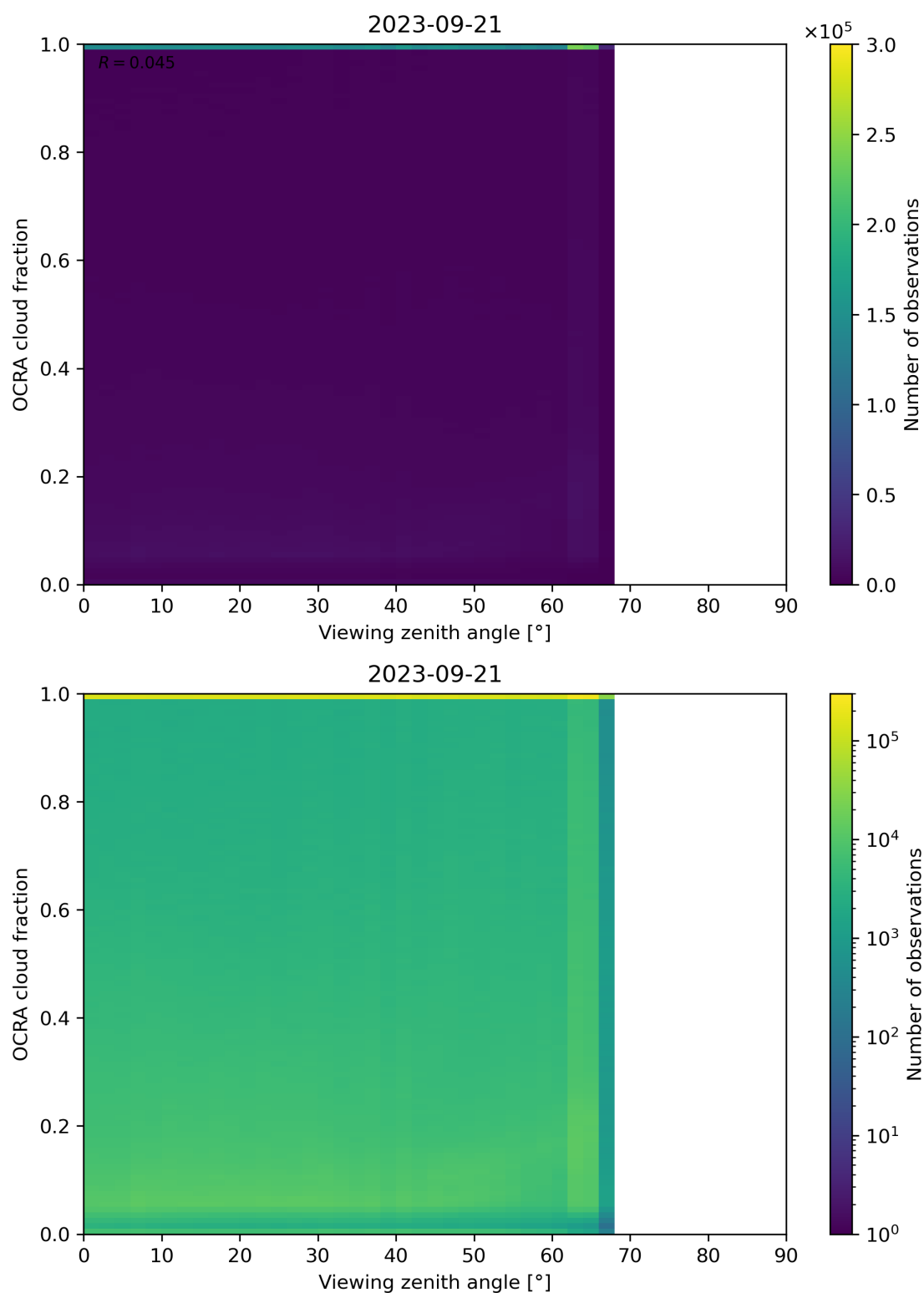


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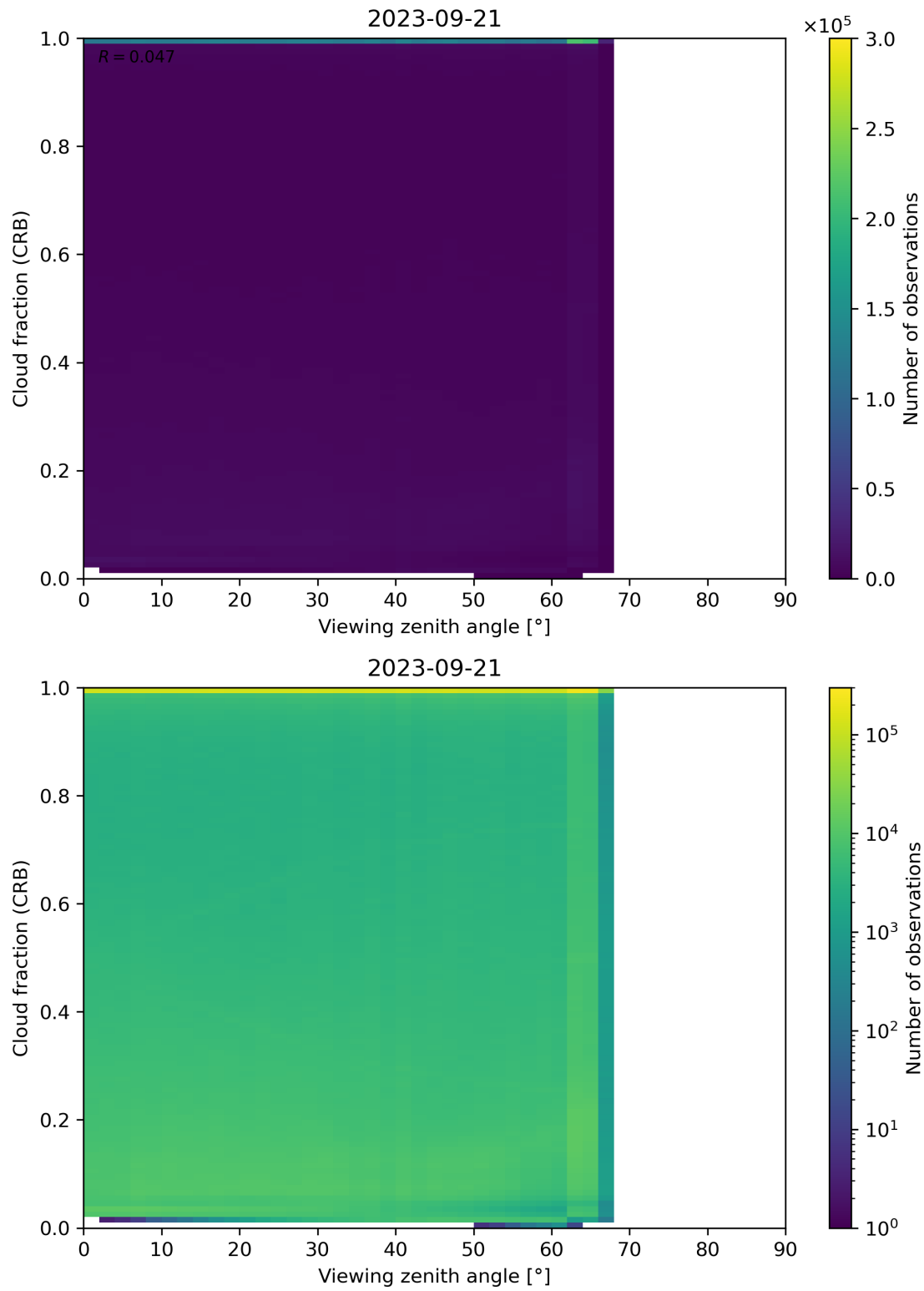


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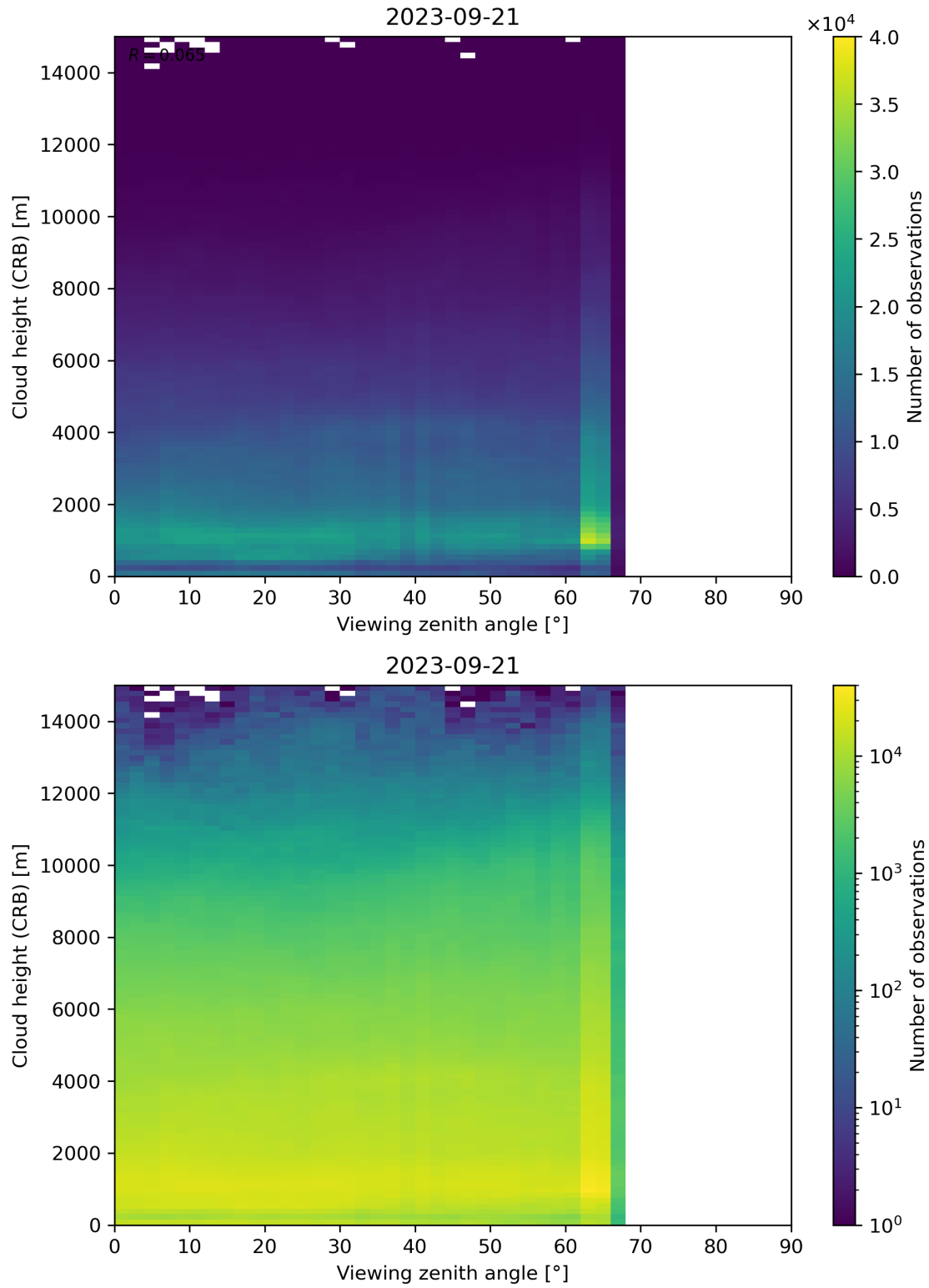


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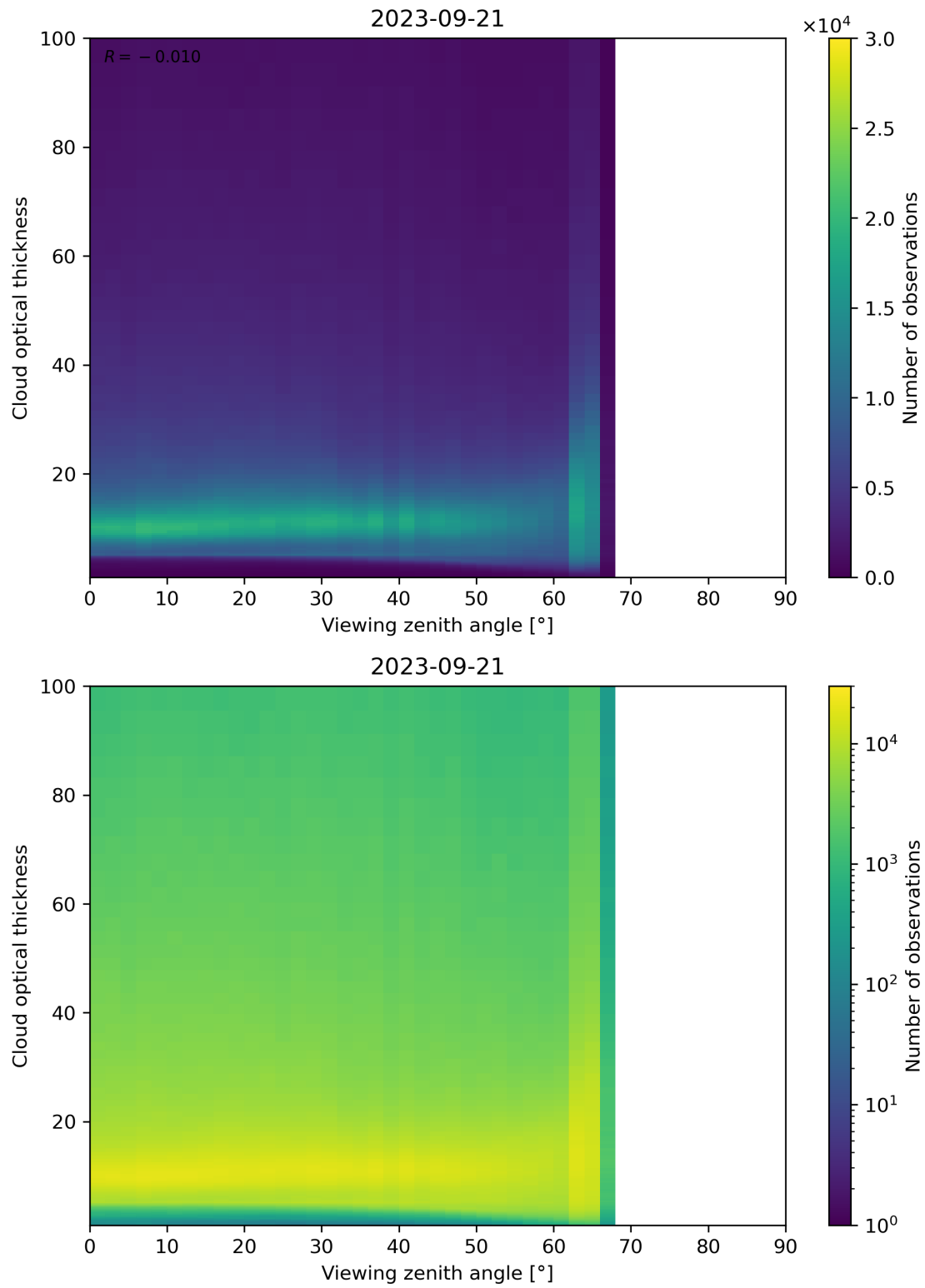


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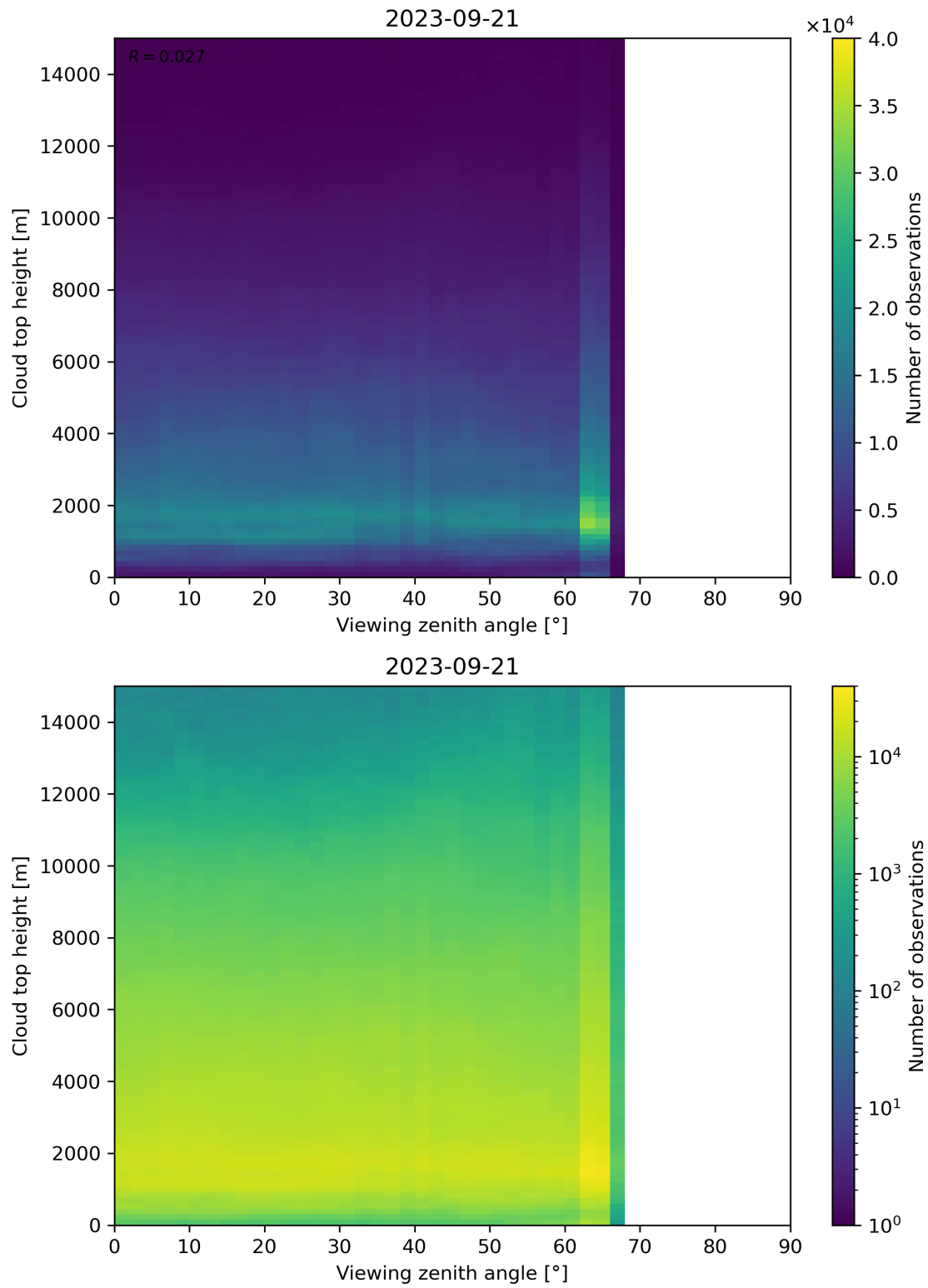


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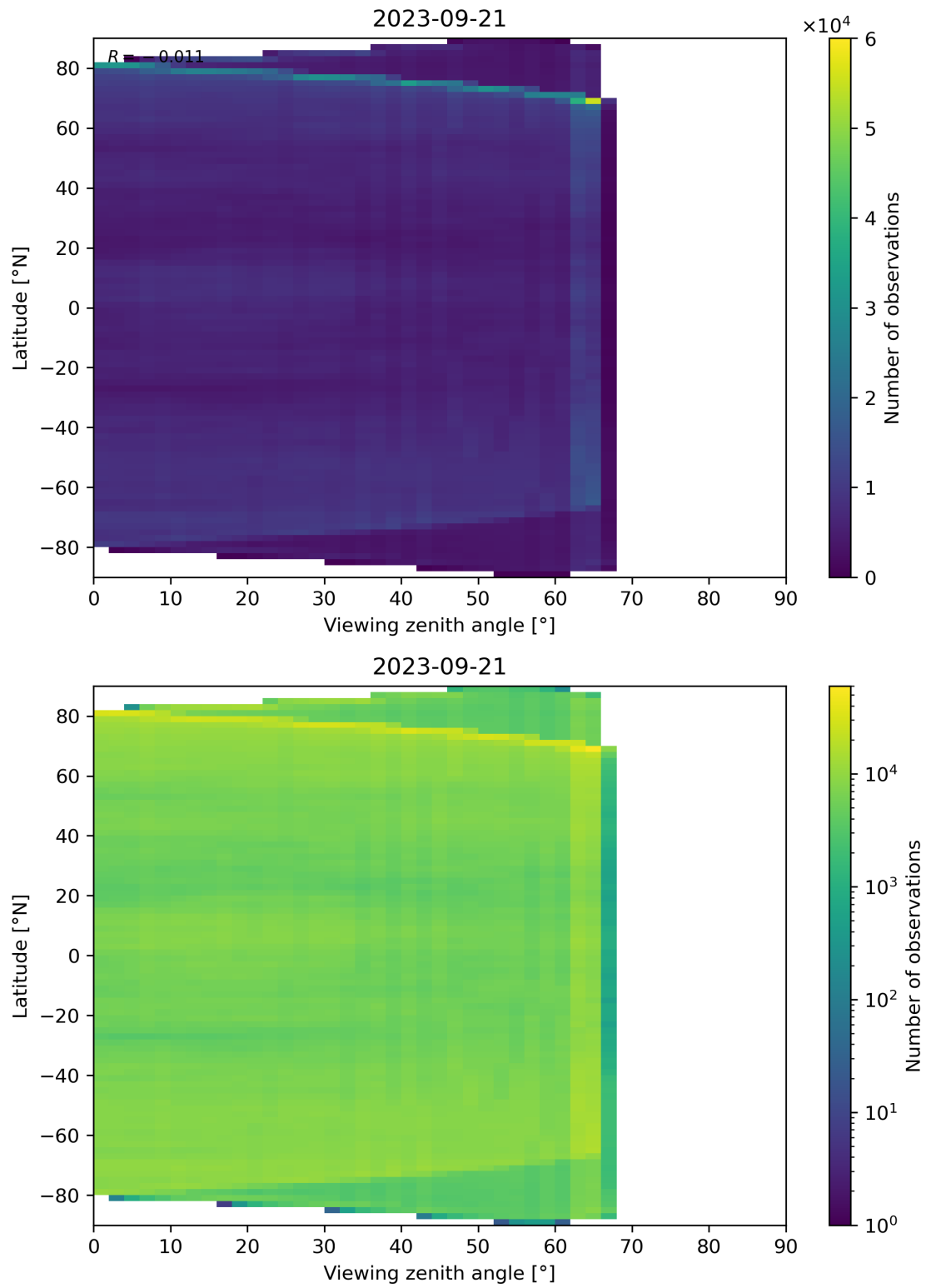


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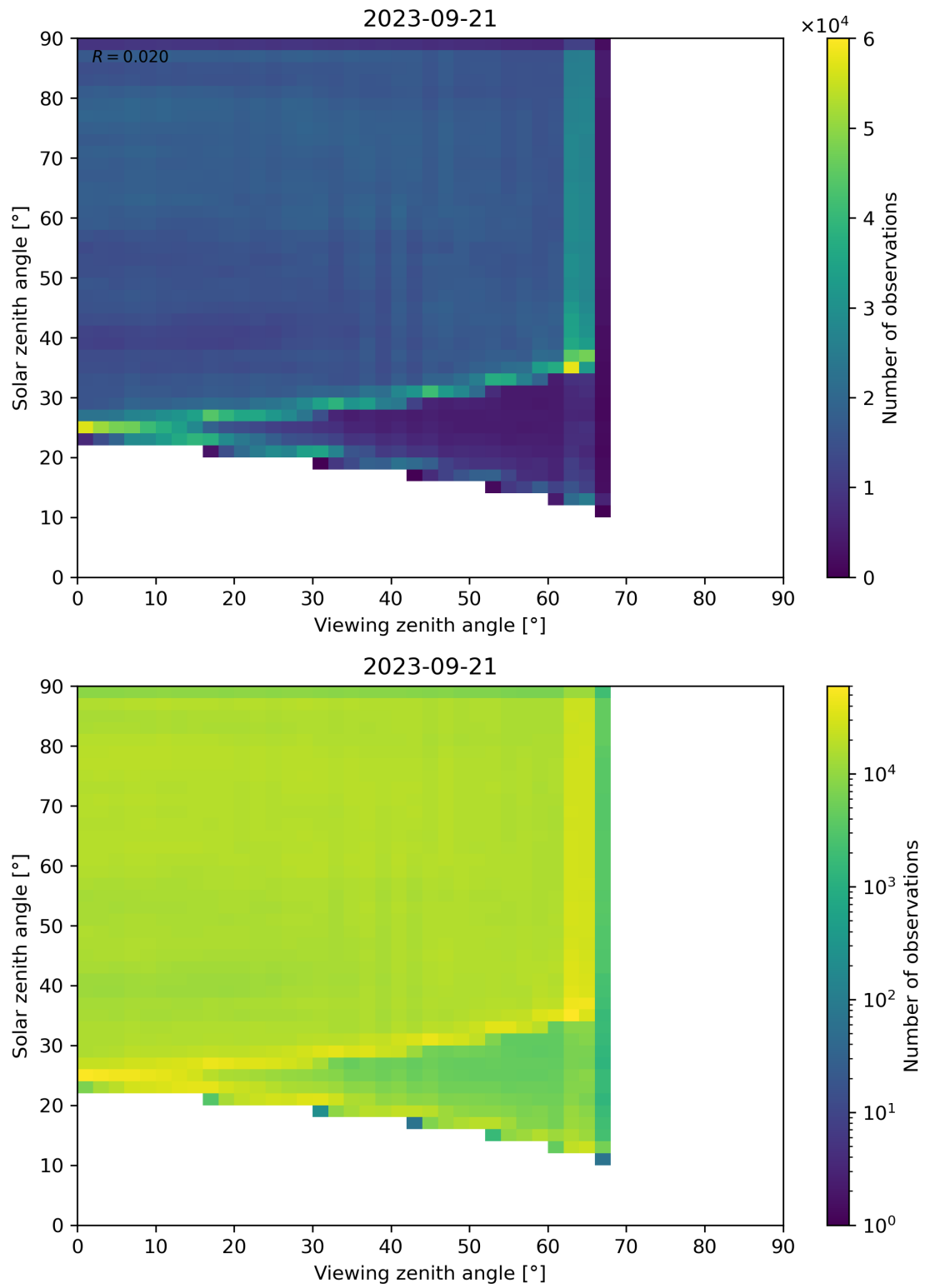


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Maarten Sneep (maarten.sneep@knmi.nl).