# Quality control for nephelometers

REAL USER EXPERIENCE

2026/03/12

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INSTITUTE OF CHEMICAL PROCESS FUNDAMENTALS OF THE ASCR

CzechGlobe

ACTRIS Czech Republic

ACTRIS

WMO GAW

GEO GOS4M
GLOBAL OBSERVATION SYSTEM FOR MERCURY

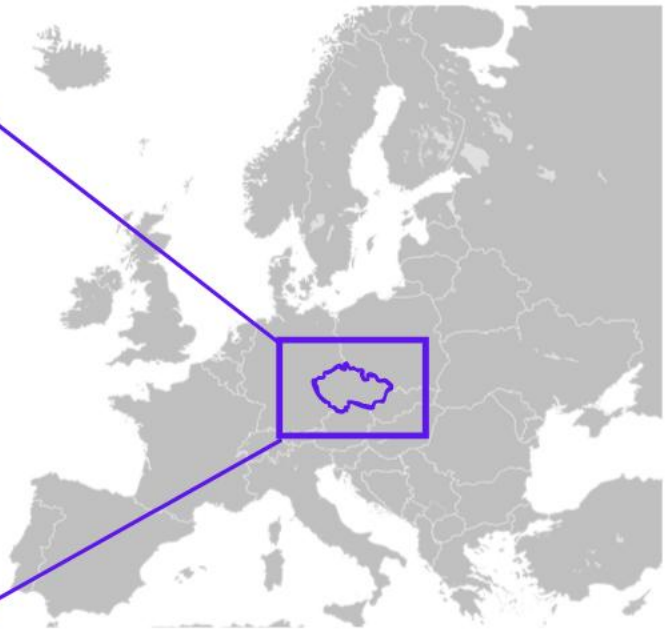
# National Atmospheric Observatory Košetice

ICOS INTEGRATED CARBON OBSERVATION SYSTEM

emep

GMOS
Global Mercury Observation System





CHMI

CzechGlobe

MUNI | RECETOX

# National Atmospheric Observatory Košetice

| Component type | Labelling status |
|---|---|
| Aerosol in situ measurements | Initially accepted in December 2022 |
| Aerosol remote sensing | Initially accepted in June 2025 |
| Reactive trace gases in situ measurements | Initially accepted in September 2025 |




**Ecotech Integrating nephelometer AURORA 3000**

TSI Integrating nephelometer 3563

https://ebas-submit.nilu.no/temps

EBAS
Data Submission Manual

y Lists

| Category | Template |
|---|---|
| Aerosol | EC/OC |
| | Aerosol Optical Depth |
| | Particulate Mass Concentration, online |
| | Particulate Mass Concentration, gravimetric |
| | Cloud Condensation Nucleus Counter |
| | Differential / Scanning Mobility Particle Sizer |
| | Condensation Particle Counter |
| | Filter Absorption Photometer |
| | Particulate chemical composition, online (ACSM) |
| | Integrating Nephelometer |
| | Coarse mode particle size distribution |
| | Bioaerosols (Pollen, Spores) |
| | Inorganic air/aerosol chemistry (filter-based) |

# Quality control

Joining datasets → Level 0 → Level 1 → Level 2 → EBAS

```
# # # # # # # # # # # # # # # # #NAOK 2025 # # # # # # # # # # # # # # # # # # # # # # # # # # # # # # # # # # #
library(lubridate)
directory.data="C:/Users/user/Desktop/EBAS/AURORA_EBAS/NAOK/2025/original_data/AURORA_NAOK_2025"
files = list.files(path = directory.data)
setwd(directory.data)
data_list = lapply(files, read.table, header = TRUE, row.names = NULL, skip = 0, fill = TRUE)
NAOK_2025 = do.call(rbind,data_list) # final data.frame
```

aurora_190287__20250907T000000.txt – Poznámkový blok

Soubor Úpravy Formát Zobrazení Nápověda

| time | pres_int | temp_int | temp_enc | rh_int | status | state_major | state_major_hex | state_dio | state_dio_hex | sca_450 | sca_525 | sca_635 | bsca_450 | bsca_525 | bsca_635 | numflag | C001 | E559 | E110 | E999 | E980 | E640 | date |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2025-09-07T00:00:25Z | | | 960.726 | 299.727 | 299.49699999999996 | 32.78 | 0x0007 | 0 | 00 | 7 | 07 | 11.918 | 7.235 | 5.2 | 0.977 | 1.752 | 0.921 | 0.0 | False | False | False | False | False | False | 2025-09-06 |
| 2025-09-07T00:01:25Z | | | 960.743 | 299.729 | 299.49699999999996 | 32.76 | 0x0007 | 0 | 00 | 7 | 07 | 10.303 | 7.94 | 3.114 | 0.989 | 0.019 | 2.57 | 0.0 | False | False | False | False | False | False | 2025-09-06 |
| 2025-09-07T00:02:25Z | | | 960.726 | 299.727 | 299.48199999999997 | 32.739 | 0x0007 | 0 | 00 | 7 | 07 | 11.654 | 7.123 | 4.56 | 5.518 | 3.722 | -0.436 | 0.0 | False | False | False | False | False | False | 2025-09-06 |
| 2025-09-07T00:03:26Z | | | 960.726 | 299.74899999999997 | 299.48299999999995 | 32.741 | 0x0007 | 0 | 00 | 7 | 07 | 11.092 | 8.239 | 5.252 | -0.212 | 0.291 | 2.361 | 0.0 | False | False | False | False | False | False | 2025-09-06 |
| 2025-09-07T00:04:25Z | | | 960.726 | 299.74899999999997 | 299.491 | 32.718 | 0x0007 | 0 | 00 | 7 | 07 | 11.548 | 6.955 | 3.39 | 1.106 | 1.399 | 1.683 | 0.0 | False | False | False | False | False | False | 2025-09-06 |
| 2025-09-07T00:05:25Z | | | 960.726 | 299.74899999999997 | 299.489 | 32.72 | 0x0007 | 0 | 00 | 7 | 07 | 13.531 | 7.818 | 6.125 | 2.268 | 0.256 | 0.412 | 0.0 | False | False | False | False | False | False | 2025-09-06 |
| 2025-09-07T00:06:26Z | | | 960.743 | 299.74899999999997 | 299.495 | 32.741 | 0x0007 | 0 | 00 | 7 | 07 | 11.972 | 5.985 | 5.744 | 2.157 | 0.341 | -0.31 | 0.0 | False | False | False | False | False | False | 2025-09-06 |
| 2025-09-07T00:07:26Z | | | 960.726 | 299.75 | 299.5 | 32.762 | 0x0007 | 0 | 00 | 7 | 07 | 12.358 | 6.496 | 5.005 | 2.25 | 1.448 | 2.337 | 0.0 | False | False | False | False | False | False | 2025-09-06 |
| 2025-09-07T00:08:26Z | | | 960.692 | 299.768 | 299.50699999999995 | 32.739 | 0x0007 | 0 | 00 | 7 | 07 | 13.375 | 9.686 | 3.628 | 1.69 | 0.245 | 0.799 | 0.0 | False | False | False | False | False | False | 2025-09-06 |
| 2025-09-07T00:09:26Z | | | 960.692 | 299.76599999999996 | 299.51 | 32.743 | 0x0007 | 0 | 00 | 7 | 07 | 10.185 | 7.056 | 6.038 | 0.632 | 1.849 | 1.601 | 0.0 | False | False | False | False | False | False | 2025-09-06 |
| 2025-09-07T00:10:26Z | | | 960.692 | 299.768 | 299.51099999999997 | 32.76 | 0x0007 | 0 | 00 | 7 | 07 | 11.787 | 9.959 | 5.961 | 3.393 | 0.914 | 1.048 | 0.0 | False | False | False | False | False | False | 2025-09-06 |

# Templates for Integrating-Nephelometer-Data on different levels

Please note, you can validate your **level 0** and **level 1** data using the EBAS submission tool. If you experience problems with uploading your data, please contact us at ebas@nilu.no.

**Levels**

Level 0

Level 1

Level 2

| Data Level | Description | | Used For |
|---|---|---|---|
| 0 | • Annotated raw data<br>• Format instrument specific<br>• Contains all parameters provided by instrument as provided<br>• Contains all parameters / info needed for processing to final value.<br>• "Native" time resolution | | • Advanced data reporting<br>• Near-Real-Time (NRT) data reporting |
| 1 | • Data processed to final parameter<br>• Invalid data & calibration episodes removed<br>• "Native" time resolution<br>• Format property specific<br>• Correction to standard temperature & pressure cond. (273.15 K, 1013.25 hPa) if necessary | | • Advanced data reporting<br>• Intercomparisons |
| 1.5 | • Data aggregated to hourly averages<br>• Atmospheric variability quantified by standard deviation or percentiles | auto-processed | Near-Real-Time (NRT) data processing |
| 2 | • Format property specific | manual quality assurance | Regular, annual data reporting |

https://ebas-submit.nilu.no/templates/Integrating-Nephelometer-Data

# Quality control

Joining datasets → **Level 0 Flagging** → Level 1 → Level 2 → EBAS

| **Group 0: Valid data** | | |
|---|---|---|
| **Flag** | **Validity** | **Description** |
| **000** | V | Valid measurement |
| **Group 1: Exception flags for accepted, irregular data** | | |
| **Flag** | **Validity** | **Description** |
| **111** | V | Irregular data checked and accepted by data originator. Valid measurement |
| **Group 5: Chemical problem** | | |
| **Flag** | **Validity** | **Description** |
| **559** | V | Unspecified contamination or local influence, but considered valid |
| **Group 6: Mechanical or instrumental problem** | | |
| **Flag** | **Validity** | **Description** |
| **640** | V | Instrument internal relative humidity above 40% |
| **686** | I | Invalid due to zero check. Used for Level 0. |
| **687** | I | Invalid due to span check. Used for Level 0. |
| **Group 9: Missing flags** | | |
| **Flag** | **Validity** | **Description** |
| **999** | M | Missing measurement, unspecified reason |

# Quality control

Joining datasets → **Level 0 Flagging** → Level 1 → Level 2 → EBAS

## Missing values

```
NAOK_AURORA_2025$p_int[is.na(NAOK_AURORA_2025$p_int)] = 9999.99
NAOK_AURORA_2025$T_int[is.na(NAOK_AURORA_2025$T_int)] = 9999.99
NAOK_AURORA_2025$T_enc[is.na(NAOK_AURORA_2025$T_enc)] = 9999.99
NAOK_AURORA_2025$RH_int[is.na(NAOK_AURORA_2025$RH_int)] = 9999.99
NAOK_AURORA_2025$sc450[is.na(NAOK_AURORA_2025$sc450)] = 999999.999999
NAOK_AURORA_2025$sc525[is.na(NAOK_AURORA_2025$sc525)] = 999999.999999
NAOK_AURORA_2025$sc635[is.na(NAOK_AURORA_2025$sc635)] = 999999.999999
NAOK_AURORA_2025$bsc450[is.na(NAOK_AURORA_2025$bsc450)] = 999999.999999
NAOK_AURORA_2025$bsc525[is.na(NAOK_AURORA_2025$bsc525)] = 999999.999999
NAOK_AURORA_2025$bsc635[is.na(NAOK_AURORA_2025$bsc635)] = 999999.999999
NAOK_AURORA_2025$numflag[is.na(NAOK_AURORA_2025$numflag)] = 0.9990000000000000
```

## Threshold of relative humidity

```
NAOK_AURORA_2025$numflag[NAOK_AURORA_2025$RH_int > 40 & NAOK_AURORA_2025$RH_int < 101] <-  0.640000000000000000
```

## Instrument status – calibration/checks

```
NAOK_AURORA_2025$numflag[NAOK_AURORA_2025$state_major == 1] <-  0.687000000000000000
NAOK_AURORA_2025$numflag[NAOK_AURORA_2025$state_major == 2] <-  0.686000000000000000
NAOK_AURORA_2025$numflag[NAOK_AURORA_2025$state_major == 3] <-  0.687000000000000000
NAOK_AURORA_2025$numflag[NAOK_AURORA_2025$state_major == 4] <-  0.686000000000000000
NAOK_AURORA_2025$numflag[NAOK_AURORA_2025$state_major == 5] <-  0.686000000000000000
NAOK_AURORA_2025$numflag[NAOK_AURORA_2025$state_major == 6] <-  0.980000000000000000
NAOK_AURORA_2025$numflag[NAOK_AURORA_2025$state_major == 7] <-  0.980000000000000000
```

## Manual checking of detailed logbook notes

### State_major

| | |
|---|---|
| 0 | Normal Monitoring. |
| 1 | Span calibration (adjusts calibration curve). |
| 2 | Zero calibration (adjusts calibration curve). |
| 3 | Span check. |
| 4 | Zero check. |
| 5 | Zero offset adjust (adjusts calibration curve). |
| 6 | System calibration / startup. |
| 7 | Environmental calibration. |

# Quality control

Joining datasets → **Level 0 Flagging** → Level 1 → Level 2 → EBAS

## Missing values

```
NAOK_AURORA_2025$p_int[is.na(NAOK_AURORA_2025$p_int)] = 9999.99
NAOK_AURORA_2025$T_int[is.na(NAOK_AURORA_2025$T_int)] = 9999.99
NAOK_AURORA_2025$T_enc[is.na(NAOK_AURORA_2025$T_enc)] = 9999.99
NAOK_AURORA_2025$RH_int[is.na(NAOK_AURORA_2025$RH_int)] = 9999.99
NAOK_AURORA_2025$sc450[is.na(NAOK_AURORA_2025$sc450)] = 999999.999999
NAOK_AURORA_2025$sc525[is.na(NAOK_AURORA_2025$sc525)] = 999999.999999
NAOK_AURORA_2025$sc635[is.na(NAOK_AURORA_2025$sc635)] = 999999.999999
NAOK_AURORA_2025$bsc450[is.na(NAOK_AURORA_2025$bsc450)] = 999999.999999
NAOK_AURORA_2025$bsc525[is.na(NAOK_AURORA_2025$bsc525)] = 999999.999999
NAOK_AURORA_2025$bsc635[is.na(NAOK_AURORA_2025$bsc635)] = 999999.999999
NAOK_AURORA_2025$numflag[is.na(NAOK_AURORA_2025$numflag)] = 0.9990000000000000
```

## Threshold of relative humidity

```
NAOK_AURORA_2025$numflag[NAOK_AURORA_2025$RH_int > 40 & NAOK_AURORA_2025$RH_int < 101] <-  0.640000000000000000
```

## Instrument status – calibration/checks

```
NAOK_AURORA_2025$numflag[NAOK_AURORA_2025$state_major == 1] <-  0.687000000000000000
NAOK_AURORA_2025$numflag[NAOK_AURORA_2025$state_major == 2] <-  0.686000000000000000
NAOK_AURORA_2025$numflag[NAOK_AURORA_2025$state_major == 3] <-  0.687000000000000000
NAOK_AURORA_2025$numflag[NAOK_AURORA_2025$state_major == 4] <-  0.686000000000000000
NAOK_AURORA_2025$numflag[NAOK_AURORA_2025$state_major == 5] <-  0.686000000000000000
NAOK_AURORA_2025$numflag[NAOK_AURORA_2025$state_major == 6] <-  0.980000000000000000
NAOK_AURORA_2025$numflag[NAOK_AURORA_2025$state_major == 7] <-  0.980000000000000000
```

## Manual checking of detailed logbook notes

### State_major

| | |
|---|---|
| 0 | Normal Monitoring. |
| 1 | Span calibration (adjusts calibration curve). |
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Search or jump to... ctrl+k
Home › Dashboards › Aurora4000_pg_1.0
Add
2026-02-25 14:00:00 to 2026-02-25 19:00:00 UTC
averaging time
10s
Data source
datasource_nrt_naok_ground
Database
aurora_190287
Time
2026-03-10 20:09:36 +00:00
Flags
687 687 686
Instrument state
State
normal
span check
norma
span
zero
normal
14:00 14:10 14:20 14:30 14:40 14:50 15:00 15:10 15:20 15:30 15:40 15:50 16:00 16:10 16:20 16:30 16:40 16:50 17:00 17:10 17:20 17:30 17:40 17:50 18:00 18:10 18:20 18:30 18:40 18:50 19:0
- normal span check span zero
Scattering coefficents
40
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sca_B sca_G sca_R bsca_B bsca_G bsca_R
Temperature, pressure and humidity
300
298
296
20
15
10
5
0
14:00 14:10 14:20 14:30 14:40 14:50 15:00 15:10 15:20 15:30 15:40 15:50 16:00 16:10 16:20 16:30 16:40 16:50 17:00 17:10 17:20 17:30 17:40 17:50 18:00 18:10 18:20 18:30 18:40 18:50 19:00


This is where the fun begins.

# Quality control

**Group 0: Valid data**

| Flag | Validity | Description |
|---|---|---|
| **000** | V | Valid measurement |

**Group 1: Exception flags for accepted, irregular data**

| Flag | Validity | Description |
|---|---|---|
| **111** | V | Irregular data checked and accepted by data originator. Valid measurement |

**Group 5: Chemical problem**

| Flag | Validity | Description |
|---|---|---|
| **559** | V | Unspecified contamination or local influence, but considered valid |

**Group 6: Mechanical or instrumental problem**

| Flag | Validity | Description |
|---|---|---|
| **640** | V | Instrument internal relative humidity above 40% |
| **686** | I | Invalid due to zero check. Used for Level 0. |
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**Group 9: Missing flags**

| Flag | Validity | Description |
|---|---|---|
| **999** | M | Missing measurement, unspecified reason |

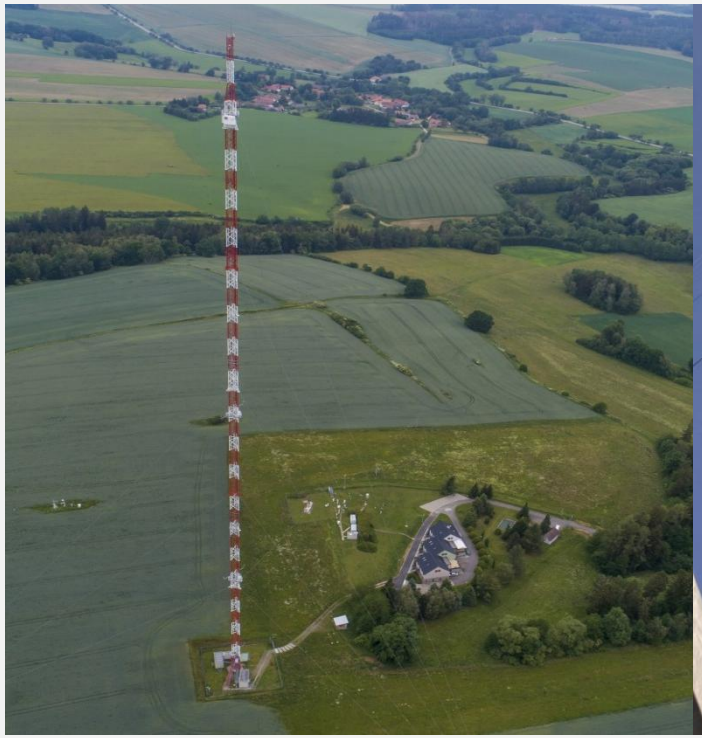
# Quality control

Joining datasets → **Level 0** Influences → Level 1 → Level 2 → EBAS

Elevator activity

Construction work

Other influences (e.g., lawn mowing)



# Quality control

Joining datasets → **Level 0** Influences → Level 1 → Level 2 → EBAS

**Elevator activity**

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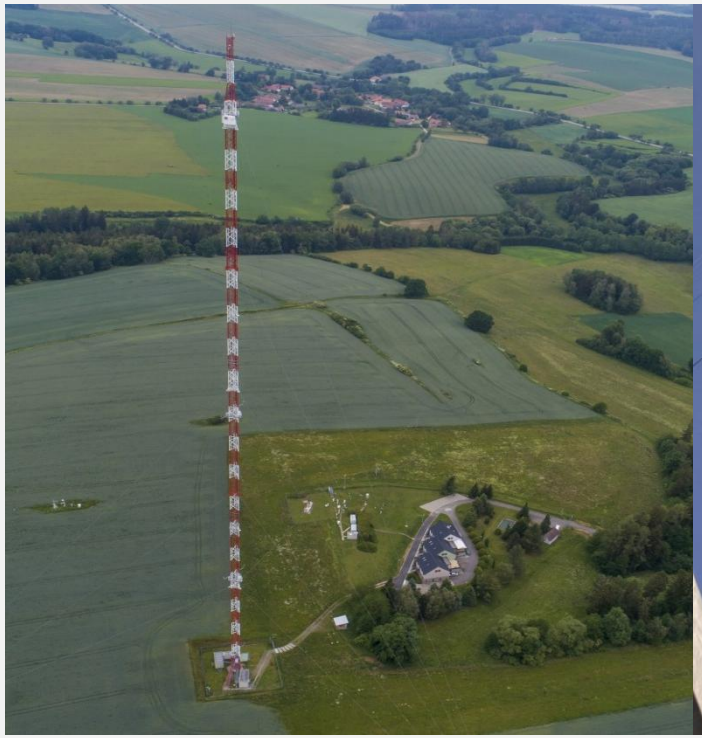


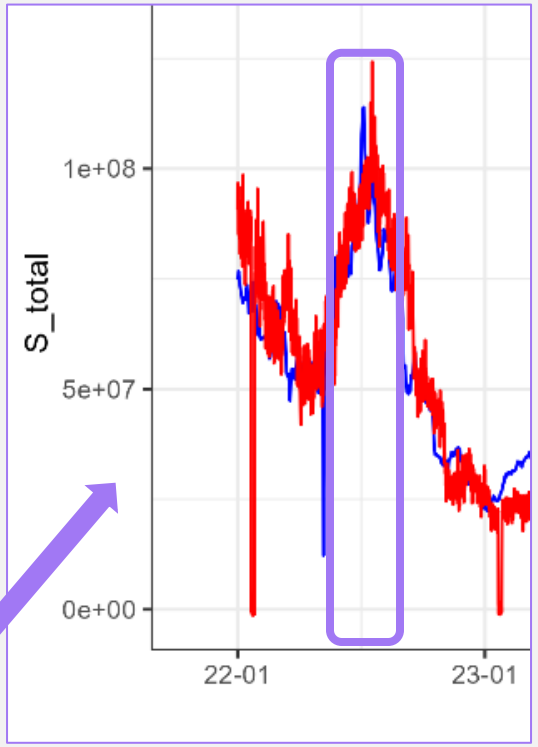
# Total surface area vs. Scattering
## Weekly/biweekly

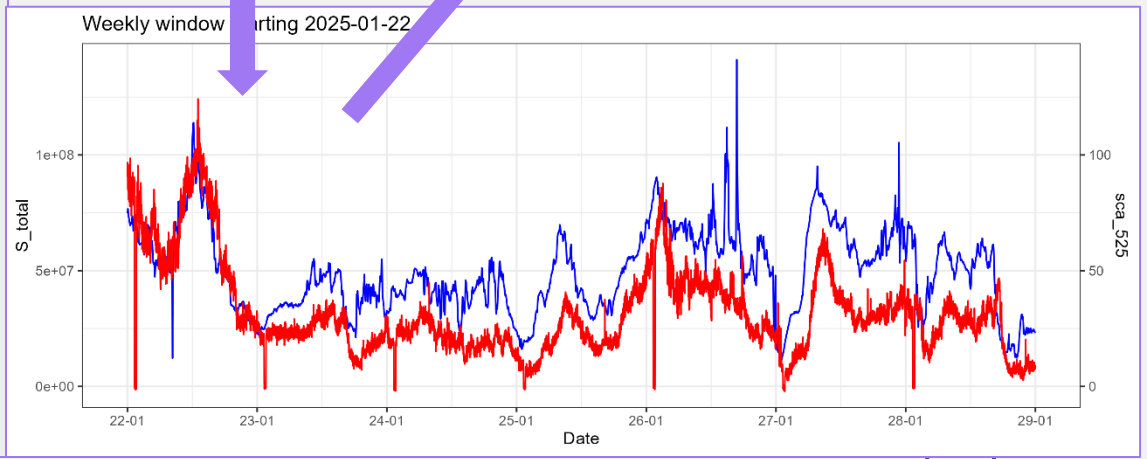
```python
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from matplotlib.colors import LogNorm


df = pd.read_csv(
    'C:/Users/suchankova.l/OneDrive/Plocha/ÚCHP/Dual_neph/smps_NAOK_2025_FINAL.csv',
    sep=';',
    decimal=',',
    parse_dates=['date']
)

df

bins = [f'bin_{i:02d}' for i in range(1, 72)]

df[bins] = df[bins].apply(pd.to_numeric, errors='coerce')

# Example diameter array (nm) corresponding to bins
# Replace with your actual diameters per bin
diameters = np.array([
8.955,9.209,9.74,10.302,10.896,11.526,12.192,12.897,13.644,14.435,15.273,16.16,17.1,18.096,19.151,
20.269,21.454,22.711,24.044,25.457,26.957,28.548,30.237,32.03,33.934,35.992,38.106,40.392,42.822,
45.408,48.161,51.092,54.216,57.546,61.098,64.89,68.941,73.271,77.904,82.864,88.181,93.884,100.008,
106.592,113.678,121.315,129.556,138.461,148.097,158.541,169.878,182.205,195.63,210.278,226.288,243.816,
263.304,284.163,307.406,333.025,361.303,392.558,427.146,465.461,507.944,555.086,607.433,665.592,730.241,802.139,841.087])

bins

diameters

cols = df.columns[df.columns.str.startswith("bin")]

df[cols] = df[cols].apply(pd.to_numeric, errors="coerce")

# ========================
# 2️⃣ Calculate particle volume per bin
# V = (pi/6) * D^3 * N  [nm^3/cm^3]
# ========================
df_volume = df.copy()
for i, col in enumerate(bins):
    df_volume[col] = (np.pi/6) * (diameters[i]**3) * df_volume[col]

df_volume['V_total'] = df_volume[bins].sum(axis=1, skipna=True)

df_volume

df[bins].isna().sum()

# ========================
# 3️⃣ Calculate particle surface area per bin
# S = pi * D^2 * N  [nm^2/cm^3]
# ========================

df_surface = df.copy()

for i, col in enumerate(bins):
    df_surface[col] = np.pi * (diameters[i]**2) * df_surface[col]

# Total surface area
df_surface['S_total'] = df_surface[bins].sum(axis=1)

df_surface.to_csv(r"C:\Users\suchankova.l\OneDrive\Plocha\ÚCHP\Dual_neph\smps_2025_surface_1.csv",sep=";",index=True)

```

## Elevator activity

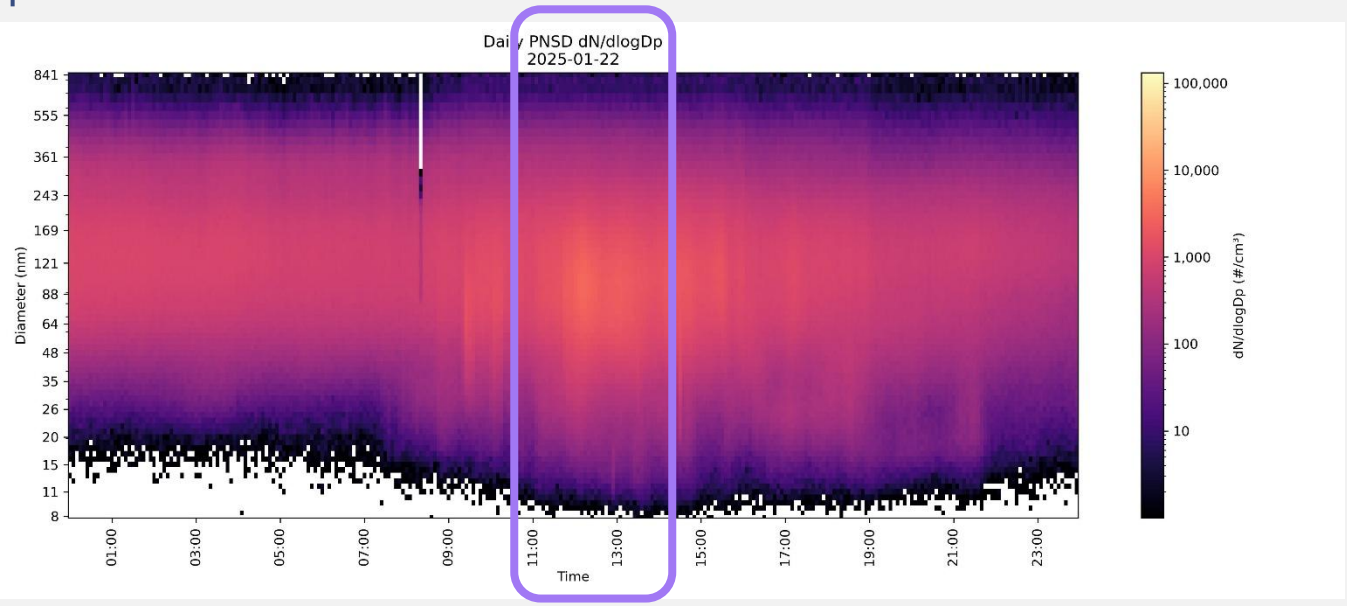
## Flag 559

| | A | B | C |
|---|---|---|---|
| 1 | Datum | Od_UTC | Do_UTC |
| 2 | 08.01.2025 | 11:20 | 11:45 |
| 3 | 08.01.2025 | 14:07 | 14:25 |
| 4 | [illegible] | [illegible] | [illegible] |
| 5 | 22.01.2025 | 11:53 | 12:16 |
| 6 | 22.01.2025 | 13:01 | 13:20 |
| 7 | 05.02.2025 | 11:41 | 12:05 |
| 8 | 05.02.2025 | 12:36 | 12:52 |
| 9 | 05.02.2025 | 13:02 | 13:06 |
| 10 | 26.02.2025 | 11:26 | 11:53 |
| 11 | 26.02.2025 | 13:48 | 14:08 |
| 12 | 05.03.2025 | 11:53 | 12:15 |
| 13 | 05.03.2025 | 14:10 | 14:20 |
| 14 | 05.03.2025 | 14:26 | 14:32 |
| 15 | 05.03.2025 | 15:12 | 15:16 |



# PNSD heatmap




## Elevator activity

| | A | B | C |
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| 1 | Datum | Od_UTC | Do_UTC |
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| 8 | 05.02.2025 | 12:36 | 12:52 |
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| 10 | 26.02.2025 | 11:26 | 11:53 |
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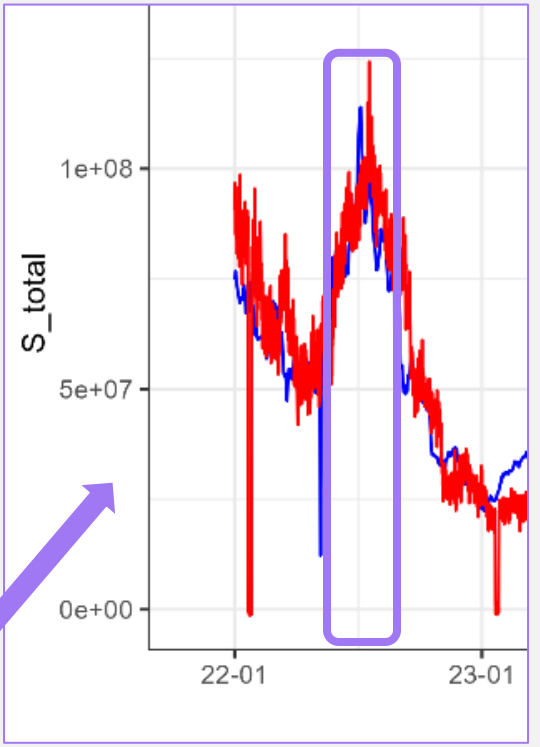
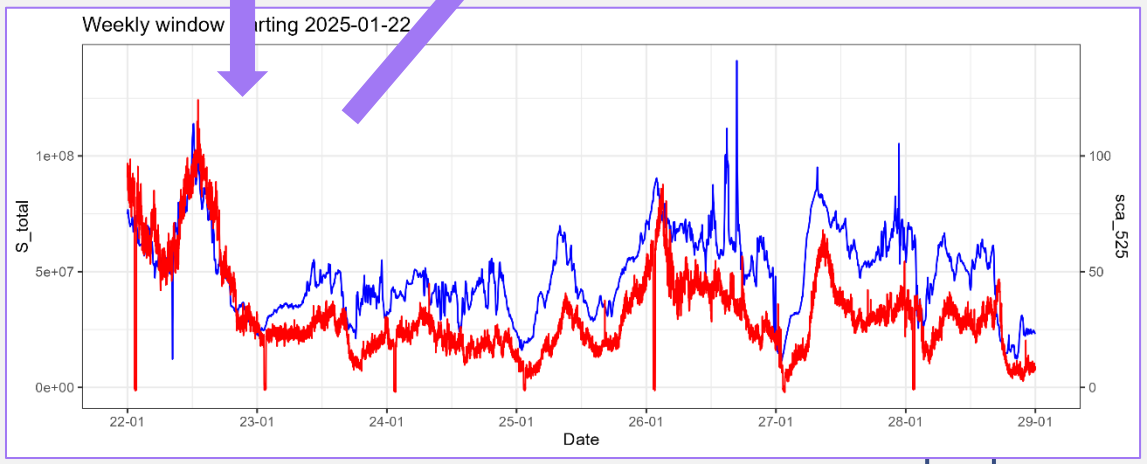
| 12 | 05.03.2025 | 11:53 | 12:15 |
| 13 | 05.03.2025 | 14:10 | 14:20 |
| 14 | 05.03.2025 | 14:26 | 14:32 |
| 15 | 05.03.2025 | 15:12 | 15:16 |

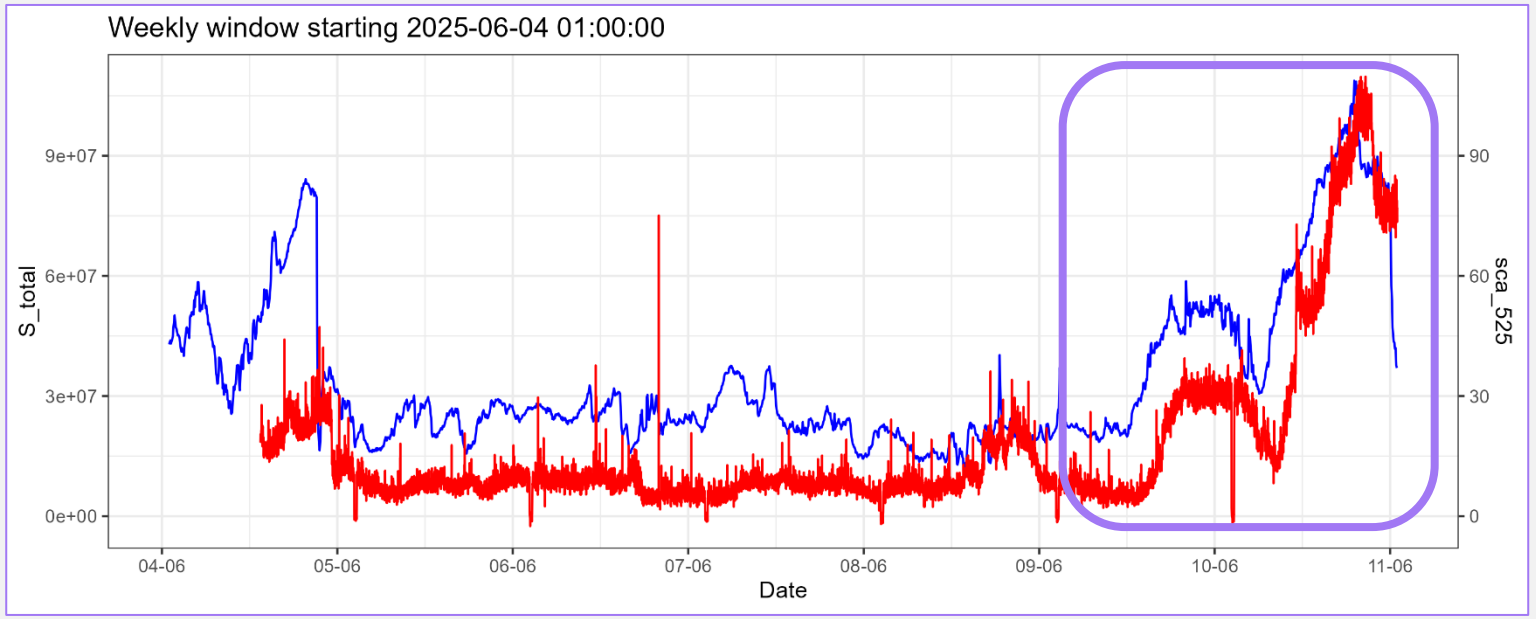
## Flag 559

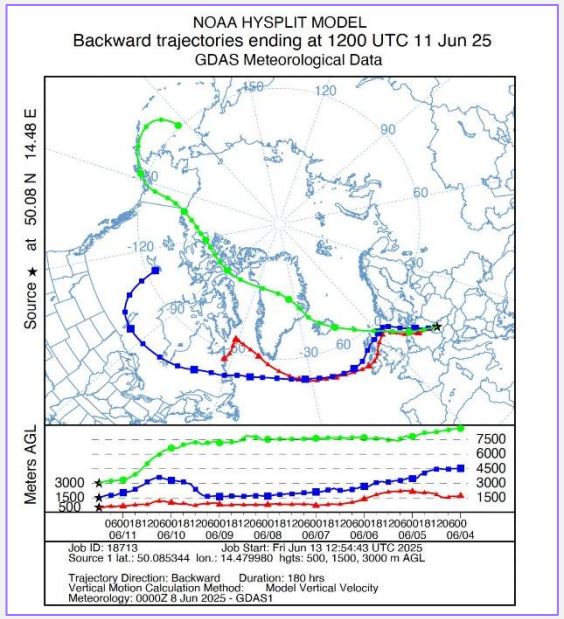


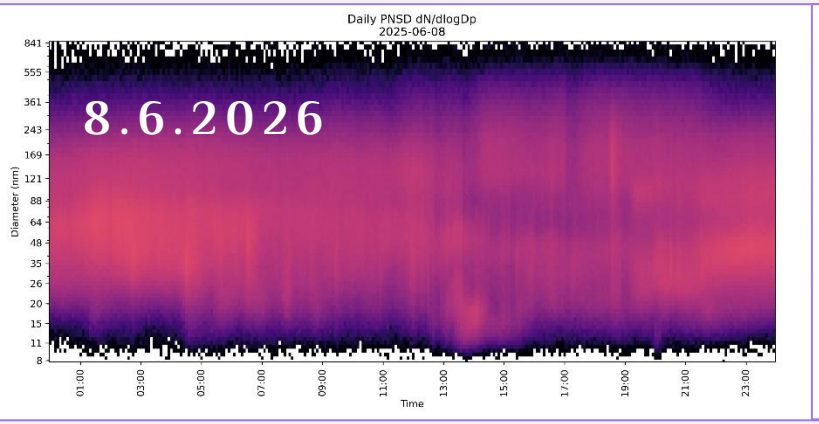



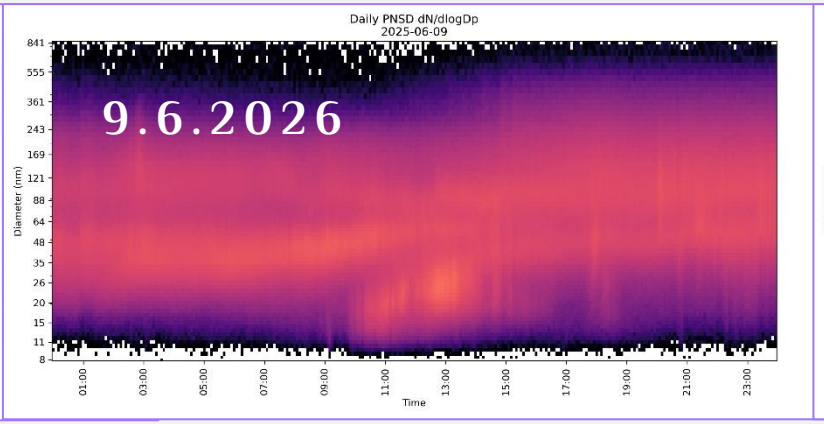
# Canadian fires (9.-10.6.2025)

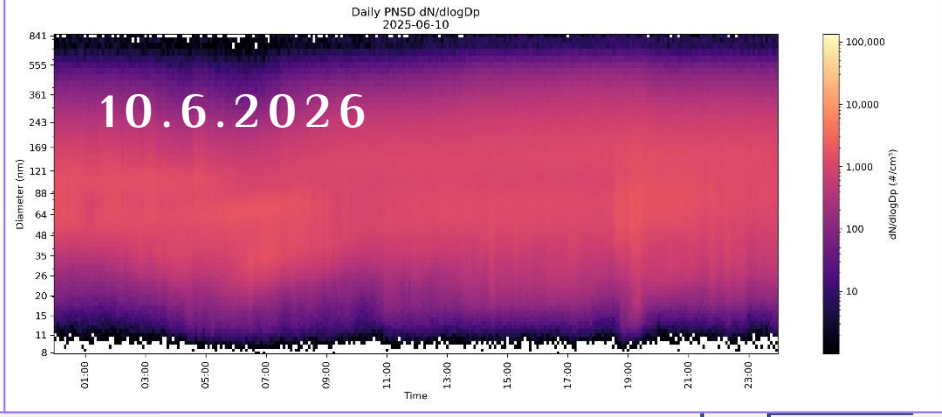
## Flag 559



Login

TSI3563_pg_1.0 - Dashboards - Gr

localhost:3000/d/fe876daf-11ee-47a4-a266-510831983d55/tsi3563-pg-1-0?orgId=1&refresh=10s&var-avg_time=10s&var-data_source=b3d19eab-c999-4b5c-a3ce-...

Search or jump to... ctrl+k

Home › Dashboards › TSI3563_pg_1.0

Add | Last 30 days | 10s

averaging time: 10s | Data source: datasource_nrt_naok230 | Database: tsi3563_71207144

Time

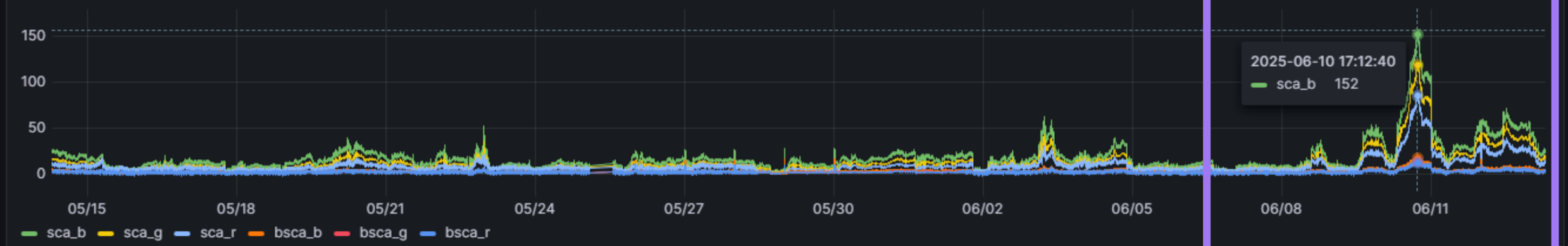
2025-06-13 07:00:04 +00:00

Instrument state

Data does not have a time field

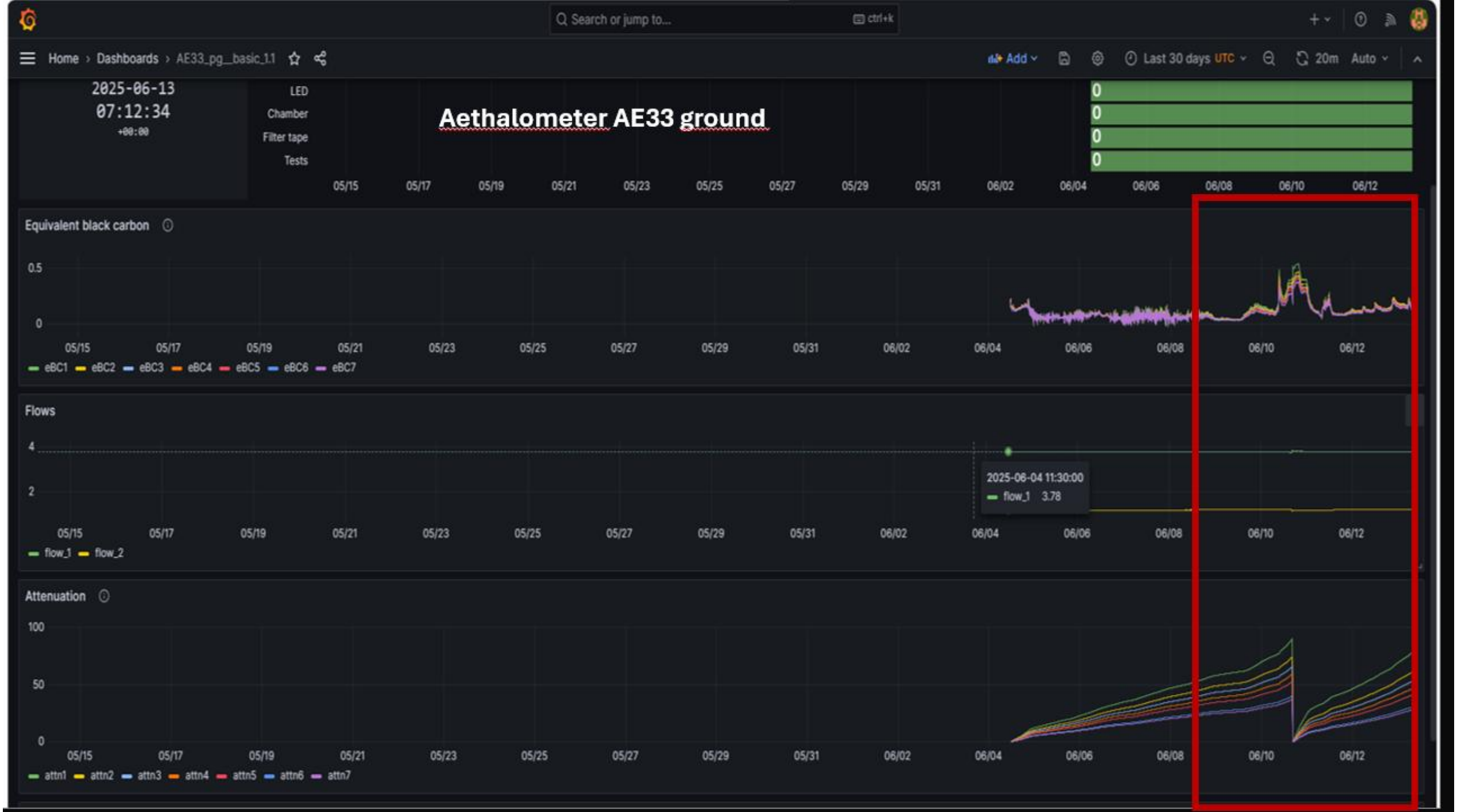
# Integrating nephelometer TSI 3563 230 m

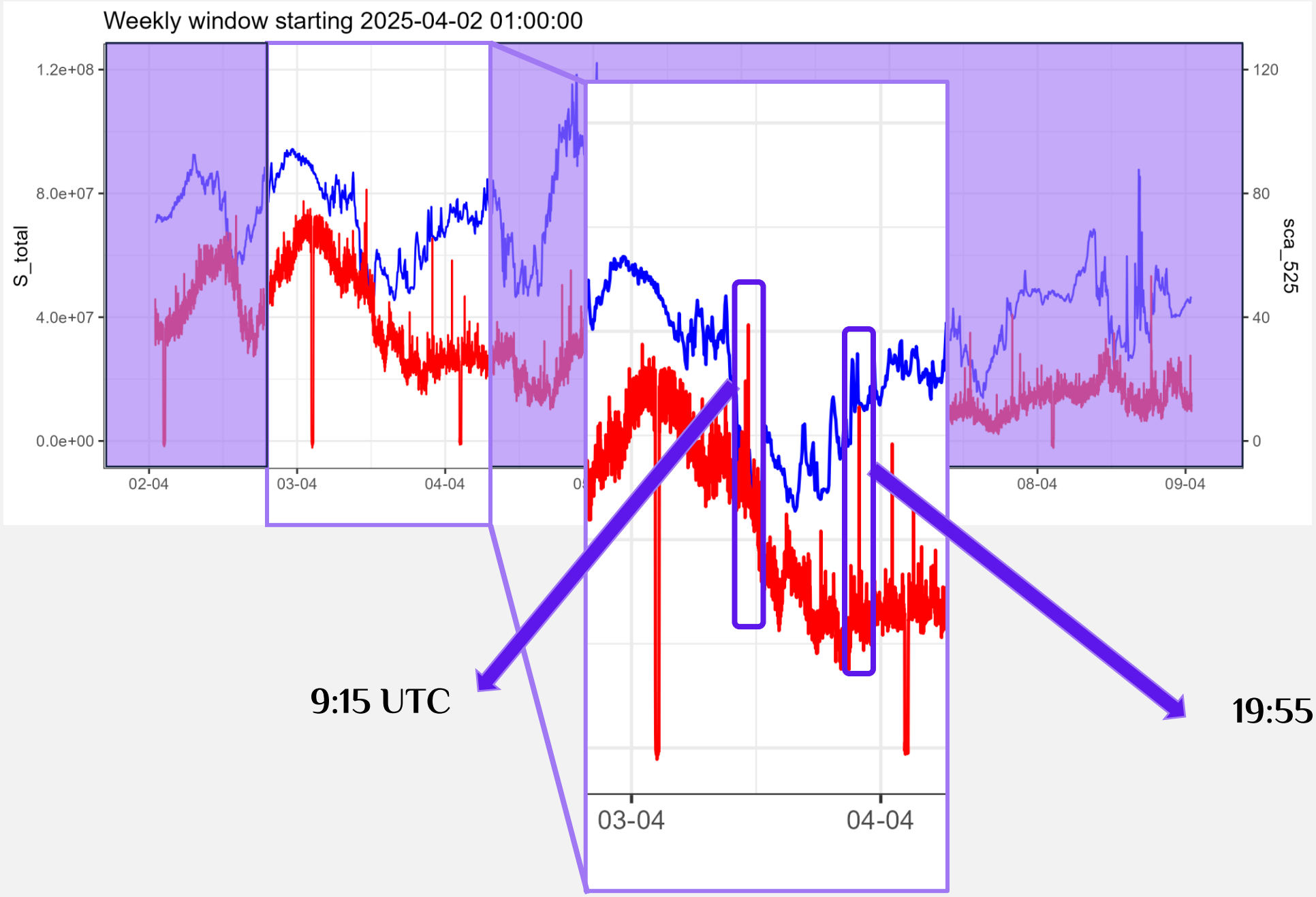
Scattering coefficents




Temperature, pressure and humidity

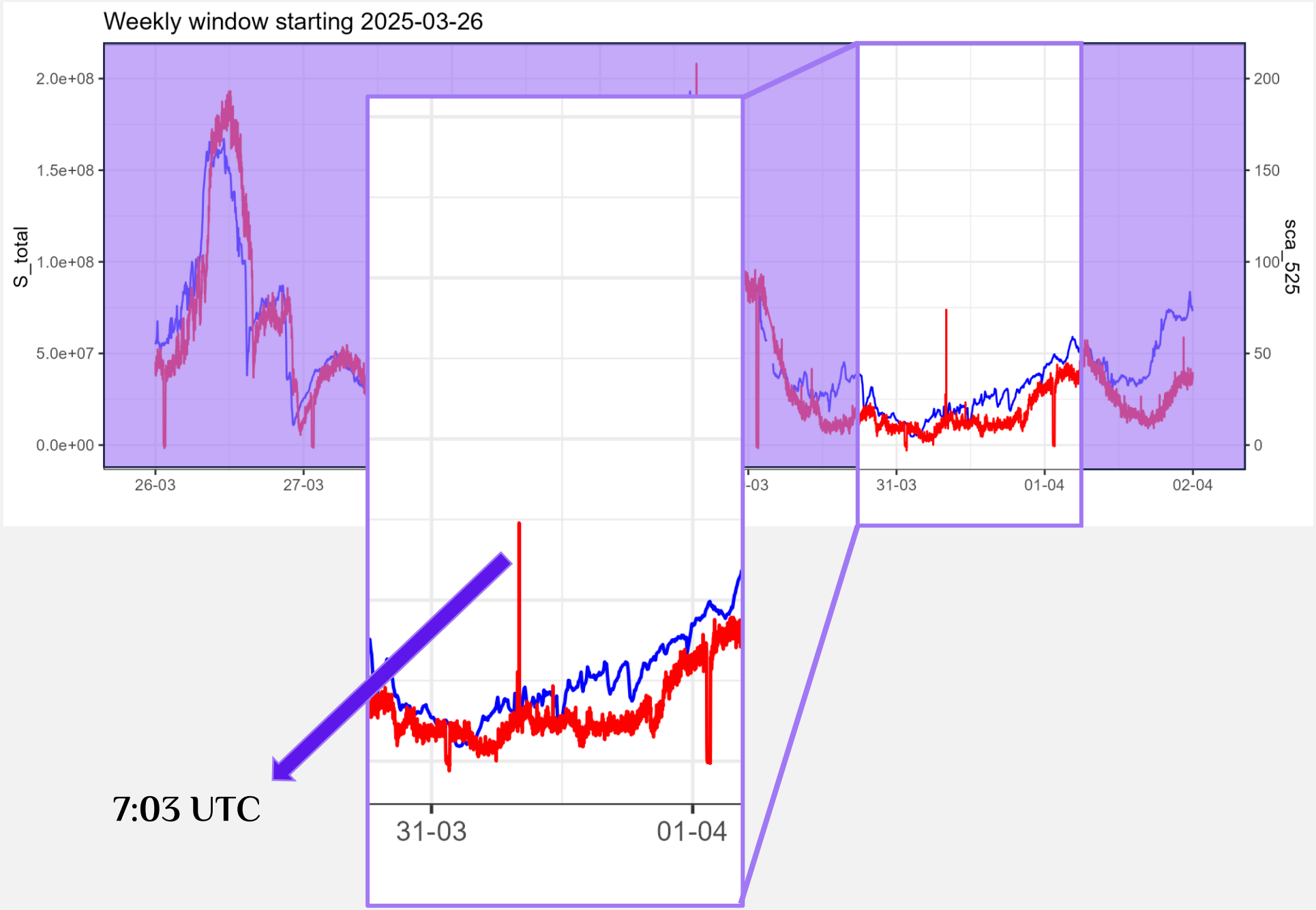

AE33_pg__basic_1.1 - Dashboards
localhost:3000/d/b7c49347-398f-480f-b55f-378583079ff8/ae33-pg-basic-1-1?orgId=1&var-avg_time=10m&var-data_source=a601e3e7-4ef7-4a2f-8dfa-8f73a80835e6&var-table=ae33_sn813&from...
Search or jump to...
Home › Dashboards › AE33_pg__basic_1.1
Add
Last 30 days UTC
Averaging
10m
Data source
datasource_nrt_kosetice230
Table
ae33_sn813
Aethalometer AE33 230 m
Time
2025-06-13
06:54:58
+00:00
Instrument status
Operation
Flow
LED
Chamber
Filter tape
Tests
05/15
05/17
05/19
05/21
05/23
05/25
05/27
05/29
05/31
06/02
06/04
06/06
06/08
06/10
06/12
Equivalent black carbon
eBC1
eBC2
eBC3
eBC4
eBC5
eBC6
eBC7
Flows
flow_1
flow_2
2025-05-18 11:50:00
flow_2 1.17
Attenuation
attn1
attn2
attn3
attn4
attn5
attn6
attn7
Compensation parameter
k1
k2
k3
k4
k5
k6
k7
ENG
6:54 AM
6/13/2025


Search or jump to...
ctrl+k
Home › Dashboards › AE33_pg__basic_1.1
Add
Last 30 days UTC
20m
Auto
2025-06-13
07:12:34
+00:00
LED
Chamber
Filter tape
Tests
Aethalometer AE33 ground
0
0
0
0
05/15 05/17 05/19 05/21 05/23 05/25 05/27 05/29 05/31 06/02 06/04 06/06 06/08 06/10 06/12
Equivalent black carbon
0.5
0
eBC1 eBC2 eBC3 eBC4 eBC5 eBC6 eBC7
Flows
4
2
2025-06-04 11:30:00
flow_1 3.78
flow_1 flow_2
Attenuation
100
50
0
attn1 attn2 attn3 attn4 attn5 attn6 attn7




## Flag 111

Irregular data checked and accepted by data originator.
Valid measurement




7:03 UTC

## Flag 111

Irregular data checked and accepted by data originator.
Valid measurement

# Templates for Integrating-Nephelometer-Data on different levels

Please note, you can validate your **level 0** and **level 1** data using the EBAS submission tool. If you experience problems with uploading your data, please contact us at ebas@nilu.no.

**Levels**

Level 0

Level 1

Level 2

| Data Level | Description | | Used For |
|---|---|---|---|
| 0 | • Annotated raw data<br>• Format instrument specific<br>• Contains all parameters provided by instrument as provided<br>• Contains all parameters / info needed for processing to final value.<br>• "Native" time resolution | | • Advanced data reporting<br>• Near-Real-Time (NRT) data reporting |
| 1 | • Data processed to final parameter<br>• Invalid data & calibration episodes removed<br>• "Native" time resolution<br>• Format property specific<br>• Correction to standard temperature & pressure cond. (273.15 K, 1013.25 hPa) if necessary | | • Advanced data reporting<br>• Intercomparisons |
| 1.5 | • Data aggregated to hourly averages<br>• Atmospheric variability quantified by standard deviation or percentiles | auto-processed | Near-Real-Time (NRT) data processing |
| 2 | • Format property specific | manual quality assurance | Regular, annual data reporting |

https://ebas-submit.nilu.no/templates/Integrating-Nephelometer-Data

# Quality control

Joining datasets → Level 0 → **Level 1 Correction** → Level 2 → EBAS

Invalid data, calibrations and missing periods removed

```
AURORA_lvl1$numflag=as.numeric(AURORA_lvl1$numflag)
AURORA_lvl1_2=AURORA_lvl1[AURORA_lvl1$numflag != 0.686 & AURORA_lvl1$numflag != 0.999 & AURORA_lvl1$numflag != 0.687 & AURORA_lvl1$numflag != 0.980, ]
```

Scattering Ångström exponent (alphaX)

```
#-----------------------------------------------
# Calculation of scattering Angström exponent
#-----------------------------------------------
AURORA_lvl0$alpha1 = - log10(AURORA_lvl0$sc450 / AURORA_lvl0$sc525 ) / log10(450 / 525)
AURORA_lvl0$alpha2 = - log10(AURORA_lvl0$sc450 / AURORA_lvl0$sc635 ) / log10(450 / 635)
AURORA_lvl0$alpha3 = - log10(AURORA_lvl0$sc525 / AURORA_lvl0$sc635 ) / log10(525 / 635)
```

alpha1 = B/G
alpha2 = B/R
alpha3 = G/R

Y = wavelength of light of interest

Correction factors (C.Y.alphaX)

```
#---------------------------------------
# Calculation of correction factor for AURORA (Muller et al., 2011)
#---------------------------------------
AURORA_lvl0$C.450.alpha1 = 1.455 - 0.189 * AURORA_lvl0$alpha1
AURORA_lvl0$C.525.alpha2 = 1.434 - 0.176 * AURORA_lvl0$alpha2
AURORA_lvl0$C.635.alpha3 = 1.403 - 0.156 * AURORA_lvl0$alpha3

#---------------------------------------
AURORA_lvl0$C.450.alpha1 = 1.213 - 0.060 * AURORA_lvl0$alpha1
AURORA_lvl0$C.525.alpha2 = 1.207 - 0.061 * AURORA_lvl0$alpha2
AURORA_lvl0$C.635.alpha3 = 1.176 - 0.053 * AURORA_lvl0$alpha3
```

alphaX<2
(no cut)

alphaX>2
(sub)

Müller et al., 2011

# Quality control

Joining datasets → Level 0 → **Level 1** Correction Final parameter → Level 2 → EBAS

## Corrected total/back scattering coefficients

```
AURORA_lvl0$sc450.cor = AURORA_lvl0$sc450 * AURORA_lvl0$C.450.alpha1
AURORA_lvl0$sc525.cor = AURORA_lvl0$sc525 * AURORA_lvl0$C.525.alpha2
AURORA_lvl0$sc635.cor = AURORA_lvl0$sc635 * AURORA_lvl0$C.635.alpha3
```

```
#alpha1/alpha2/alpha3 < 2
AURORA_lvl0$bsc450.cor = AURORA_lvl0$bsc450 * 0.963
AURORA_lvl0$bsc525.cor = AURORA_lvl0$bsc525 * 0.971
AURORA_lvl0$bsc635.cor = AURORA_lvl0$bsc635 * 0.968
#alpha1/alpha2/alpha3 > 2
AURORA_lvl0$bsc450.cor = AURORA_lvl0$bsc450 * 0.932
AURORA_lvl0$bsc525.cor = AURORA_lvl0$bsc525 * 0.935
AURORA_lvl0$bsc635.cor = AURORA_lvl0$bsc635 * 0.935
```

alphaX<2 (no cut)

alphaX>2 (sub)

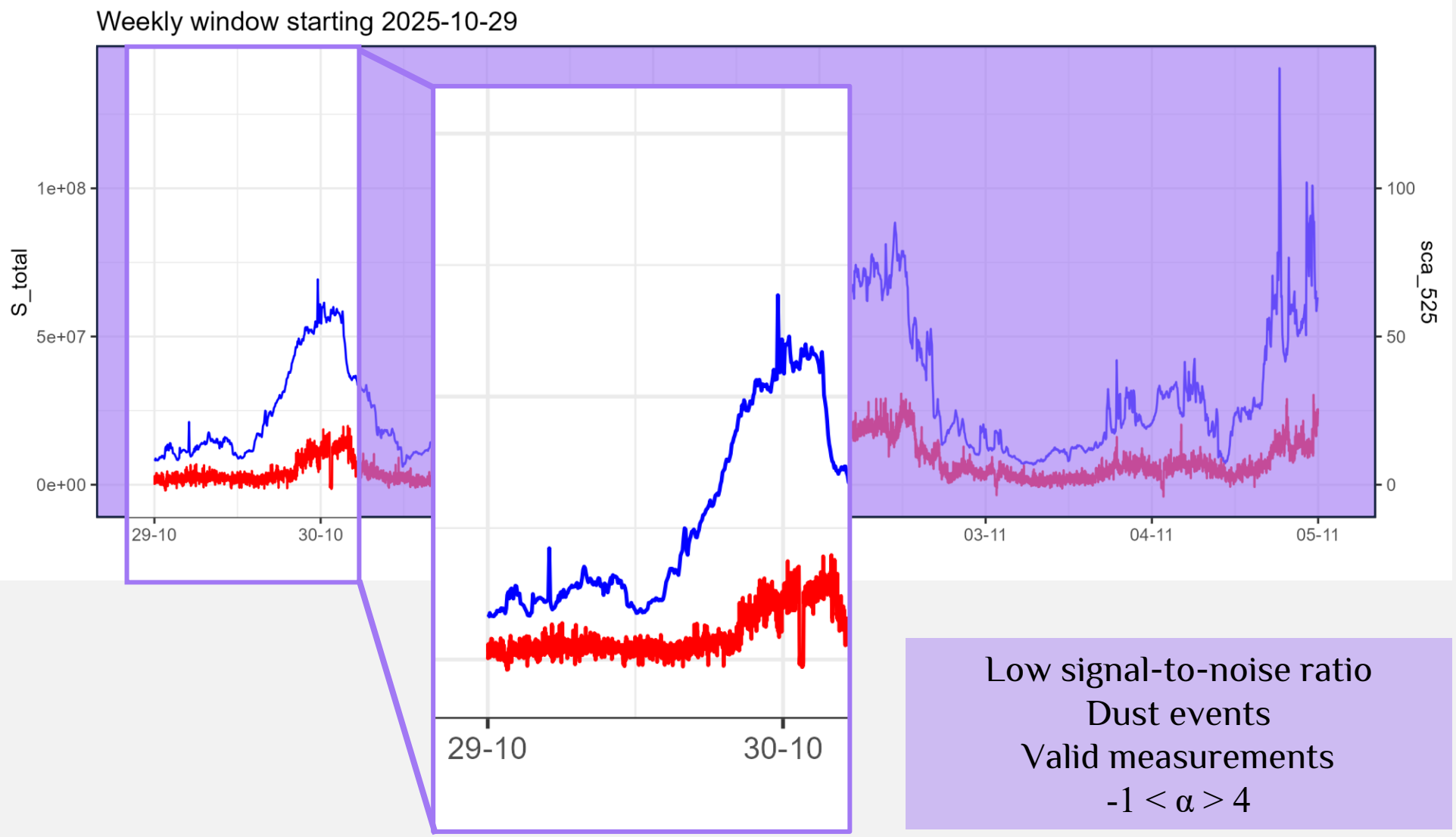
## STP standardization (273.15 K, 1013.25 hPa)

```
parameters = c("sc450.cor", "sc525.cor", "sc635.cor", "bsc450.cor", "bsc525.cor", "bsc635.cor")
parameters.st = c("sc450.st", "sc525.st", "sc635.st", "bsc450.st", "bsc525.st", "bsc635.st")


for (i in 1:6){
  par = which(names(AURORA_lvl0) == parameters[i])
  par.st = which(names(AURORA_lvl0) == parameters.st[i])
  AURORA_lvl0[,par.st] = AURORA_lvl0[,par] * AURORA_lvl0$T_int * 1013.25 / (AURORA_lvl0$p_int * 273.15)
}
```

Müller et al., 2011

# What if the Scattering Ångström exponent is outside of the range?




## Flag 111

Irregular data checked and accepted by data originator.
Valid measurement

Low signal-to-noise ratio
Dust events
Valid measurements
$-1 < \alpha > 4$

# Templates for Integrating-Nephelometer-Data on different levels

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**Levels**

Level 0

Level 1

Level 2

| Data Level | Description | | Used For |
|---|---|---|---|
| 0 | • Annotated raw data<br>• Format instrument specific<br>• Contains all parameters provided by instrument as provided<br>• Contains all parameters / info needed for processing to final value.<br>• "Native" time resolution | | • Advanced data reporting<br>• Near-Real-Time (NRT) data reporting |
| 1 | • Data processed to final parameter<br>• Invalid data & calibration episodes removed<br>• "Native" time resolution<br>• Format property specific<br>• Correction to standard temperature & pressure cond. (273.15 K, 1013.25 hPa) if necessary | | • Advanced data reporting<br>• Intercomparisons |
| 1.5 | • Data aggregated to hourly averages<br>• Atmospheric variability quantified by standard deviation or percentiles | auto-processed | Near-Real-Time (NRT) data processing |
| 2 | • Format property specific | manual quality assurance | Regular, annual data reporting |

https://ebas-submit.nilu.no/templates/Integrating-Nephelometer-Data

# Quality control

**Group 0: Valid data**

| Flag | Validity | Description |
|---|---|---|
| **000** | V | Valid measurement |

**Group 1: Exception flags for accepted, irregular data**

| Flag | Validity | Description |
|---|---|---|
| **111** | V | Irregular data checked and accepted by data originator. Valid measurement |

**Group 3: Flags for aggregated datasets**

| Flag | Validity | Description |
|---|---|---|
| **390** | V | Data completeness less than 50% |
| **392** | V | Data completeness less than 75% |
| **394** | V | Data completeness less than 90% |

**Group 5: Chemical problem**

| Flag | Validity | Description |
|---|---|---|
| **559** | V | Unspecified contamination or local influence, but considered valid |

**Group 6: Mechanical or instrumental problem**

| Flag | Validity | Description |
|---|---|---|
| **640** | V | Instrument internal relative humidity above 40% |

**Group 9: Missing flags**

| Flag | Validity | Description |
|---|---|---|
| **999** | M | Missing measurement, unspecified reason |

# Quality control

Joining datasets → Level 0 → Level 2 → **Level 2 Final averaging** → EBAS

```
hourly_data <- lev1 %>%
  mutate(hour = cut(date, "hour")) %>%
  group_by(hour) %>%
  summarize(
    non_na_count = sum(!is.na(p_int)),  # Number of valid values
    total_count = n(),  # Total number of observations per hour
    completeness = case_when(
      non_na_count / total_count < 0.5 ~ "390",
      non_na_count / total_count < 0.75 ~ "392",
      non_na_count / total_count < 0.9 ~ "394",
      TRUE ~ "Complete"
    ),
    p_int = mean(p_int, na.rm = TRUE),  # Now add means
    T_int = mean(T_int, na.rm = TRUE),
    T_enc = mean(T_enc, na.rm = TRUE),
    RH_int = mean(RH_int, na.rm = TRUE),
    sc450 = mean(sc450.cor, na.rm = TRUE),
    sc525 = mean(sc525.cor, na.rm = TRUE),
    sc635 = mean(sc635.cor, na.rm = TRUE),
    bsc450 = mean(bsc450.cor, na.rm = TRUE),
    bsc525 = mean(bsc525.cor, na.rm = TRUE),
    bsc635 = mean(bsc635.cor, na.rm = TRUE),
    flag = paste0(sort(unique(numflag)), collapse = "")
  ) %>%
  ungroup()


hourly_quantiles <- lev1 %>%
  mutate(hour = cut(date, breaks = "hour")) %>%
  group_by(hour) %>%
  group_map(~ summarize(.x,
                        sc450pc16 = quantile(sc450.cor, probs = 0.1587, na.rm = TRUE),
                        sc450pc84 = quantile(sc450.cor, probs = 0.8413, na.rm = TRUE),
                        sc525pc16 = quantile(sc525.cor, probs = 0.1587, na.rm = TRUE),
                        sc525pc84 = quantile(sc525.cor, probs = 0.8413, na.rm = TRUE),
                        sc635pc16 = quantile(sc635.cor, probs = 0.1587, na.rm = TRUE),
                        sc635pc84 = quantile(sc635.cor, probs = 0.8413, na.rm = TRUE),
                        bsc450pc16 = quantile(bsc450.cor, probs = 0.1587, na.rm = TRUE),
                        bsc450pc84 = quantile(bsc450.cor, probs = 0.8413, na.rm = TRUE),
                        bsc525pc16 = quantile(bsc525.cor, probs = 0.1587, na.rm = TRUE),
                        bsc525pc84 = quantile(bsc525.cor, probs = 0.8413, na.rm = TRUE),
                        bsc635pc16 = quantile(bsc635.cor, probs = 0.1587, na.rm = TRUE),
                        bsc635pc84 = quantile(bsc635.cor, probs = 0.8413, na.rm = TRUE)))   %>%
  bind_rows(.id = "hour")


result <- cbind(hourly_data, hourly_quantiles)
```

1 min → 1 hour

Statistics
(16th and 84th pc.)

Data completeness flags

Joined respective flags
(e.g. 0.640111)

Boundary checks
(default/site specific)

# Quality control


https://ebas-submit.nilu.no/templates/comments/boundary_check_neph

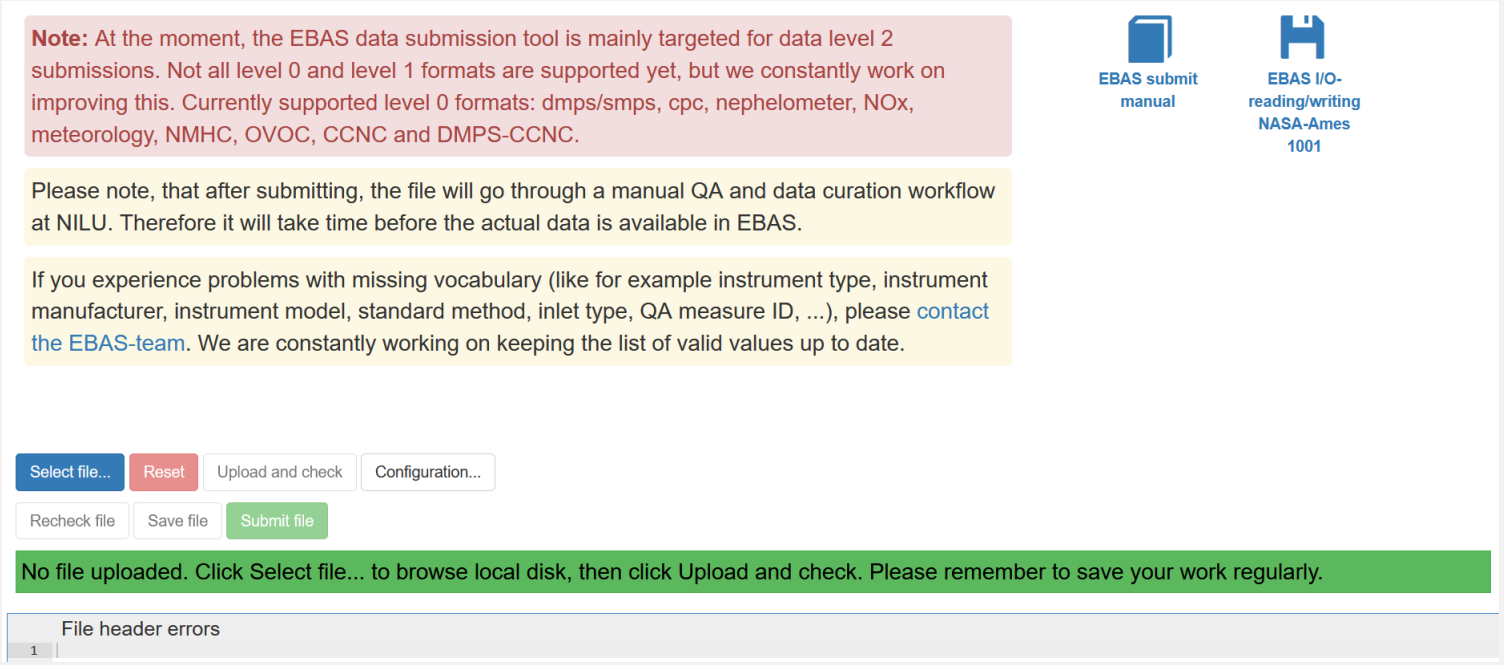
NAOK specific!

| | | | | | | |
|---|---|---|---|---|---|---|
| aerosol_light_scattering_coefficient | pm10 | CZ0003R | 2 | arithmetic mean | -0.1 1/Mm | 500.0 1/Mm |
| aerosol_light_scattering_coefficient | pm10 | CZ0003R | 2 | percentile:15.87 | -1.0 1/Mm | 500.0 1/Mm |
| aerosol_light_scattering_coefficient | pm10 | CZ0003R | 2 | percentile:84.13 | -0.1 1/Mm | 500.0 1/Mm |
| aerosol_light_backscattering_coefficient | pm10 | CZ0003R | 2 | arithmetic mean | -1.0 1/Mm | 45.0 1/Mm |
| aerosol_light_backscattering_coefficient | pm10 | CZ0003R | 2 | percentile:15.87 | -1.5 1/Mm | 50.0 1/Mm |
| aerosol_light_backscattering_coefficient | pm10 | CZ0003R | 2 | percentile:84.13 | -1.0 1/Mm | 50.0 1/Mm |

# Quality control

Joining datasets → Level 0 → Level 2 → Level 2 → EBAS

https://ebas-submit-tool.nilu.no/




**Strict and specific headers**

Specific for each level

.txt → .nas

**UTF-8 encoding** !!!

Problems with lev 0 (sftp uploading)

# THANK YOU FOR YOUR ATTENTION

https://ebas-submit.nilu.no/templates/Integrating-Nephelometer-Data

https://ebas-submit-tool.nilu.no/

2026/03/12

Lenka Suchánková
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INSTITUTE OF CHEMICAL PROCESS FUNDAMENTALS OF THE ASCR

CzechGlobe

ACTRIS Czech Republic