# Protocol of the intercomparison at Grossenzersdorf, BOKU, Austria from April 29 to May 2, 2024 with the travelling reference spectroradiometer QASUME from PMOD/WRC

Report prepared by Julian Gröbner

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Local operators: Daniel Rauter and Stana Simic

The purpose of the visit was the comparison of global solar irradiance measurements between the spectroradiometer operated by BOKU and the travel reference spectroradiometer QASUME. The measurement site is located at Grossenzersdorf; Latitude 48.200° N, Longitude 16.559° E and altitude 159 m.a.s.l.
The horizon of the measurement site is free down to at least 85° solar zenith angle (SZA). Measurements between 4:30 UT and 17:30 UT were analysed.

QASUME was installed on the roof of the measurement container of BOKU in the morning of April 29, 2024. The spectroradiometer was installed next to the entrance optic of BOKU “GSA” with the entrance optic of QASUME within less than 2 m of “GSA”. The spectroradiometer “GSA” is a double monochromator of type IDR-150 of Bentham. The intercomparison between QASUME and GSA lasted 2 1/2 days, from the afternoon of Monday April 29 to the morning of Thursday May 2.

QASUME was calibrated several times during the intercomparison period using a portable calibration system. Three lamps (T61251, T68523, and T157825) were used to obtain an absolute spectral irradiance calibration traceable to the primary reference held at PMOD/WRC, which is traceable to PTB. The daily mean responsivity of the instrument based on these calibrations varied by less than 1 % during the intercomparison period. The internal temperature of QASUME was 27.1±0.3 °C and the diffuser head was heated to a temperature of 28.9±0.6 °C.
The wavelength shifts relative to an extraterrestrial spectrum as retrieved from the matSHIC analysis were between ±50 pm in the spectral range 300 to 500 nm.

**Protocol:**

The measurement protocol was to measure one solar irradiance spectrum every 30 minutes from 290 nm to 500 nm, every 0.5 nm, and 3.0 seconds between each wavelength increment.

| DOY | Date | DAY | Weather | Comment (times are in UT) |
|---|---|---|---|---|
| 120 | 29-Apr | Monday | Clear Sky with cirrus, sahara dust, very diffuse | Installed at 8:00<br>10:00 start UV measurements<br>Calibrated at 12:15 UT |
| 121 | 30-Apr | Tuesday | Clear sky, small Cu developing in the afternoon | 11:45 Calibration |
| 122 | 01-May | Wednesday | Mix of sun and clouds, windy | Calibration at 13:45 |
| 123 | 02-May | Thursday | Overcast, rain | 7:30 UT QASUME OFF |

**Results:**

In total 64 synchronised simultaneous spectra from QASUME and GSA are available from the measurement period. Measurements between 4:30 UT and 17:30 UT have been analysed (SZA smaller than 85°).

**Conclusions:**

1. The spectral irradiances measured by GSA are on average 1.0% higher than those of QASUME for wavelengths shorter than 400 nm, and 2.7% higher at wavelengths longer than 400 nm.
2. The temporal variation of the spectra between GSA and QASUME was very stable, to within 2% for wavelengths shorter than 400 nm. At longer wavelengths, a diurnal variation of up to 5% could be seen in the SZA range between approximately 50° and 75°, which could be due to a non accounted cosine error.
3. The wavelength shifts of GSA relative to the high spectral resolution solar spectrum TSIS-1 HSRS are between ±50 pm in the spectral range 300 nm to 500 nm.
4. The signal to noise ratio at wavelengths shorter than about 305 nm decreases with increasing SZA.

**Comparison to previous QASUME site visits**

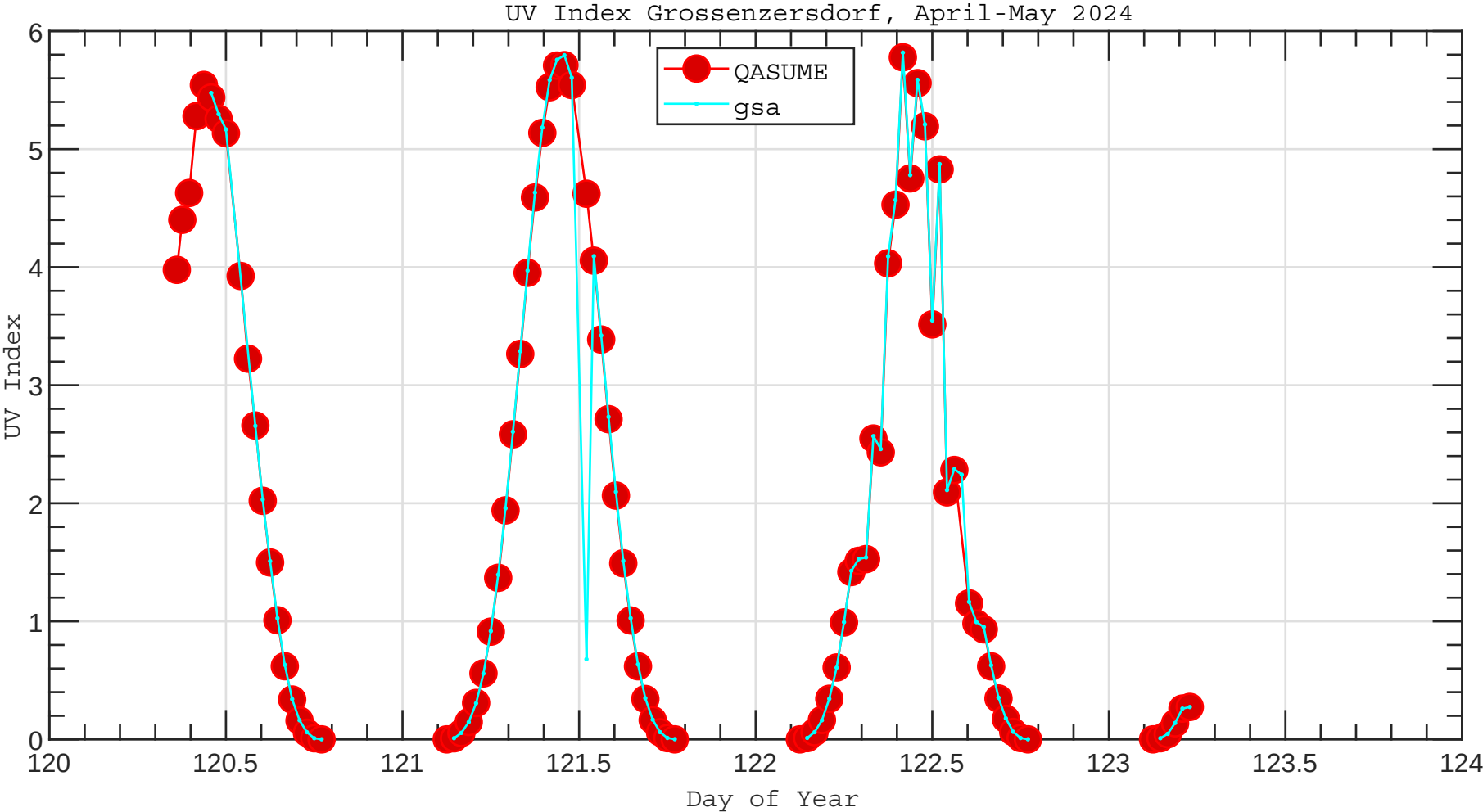
The previous QASUME visit was in 2004, see report at https://www.pmodwrc.ch/wcc_uv/qasume_audit/reports/2004_05_austria_grossenzersdorf_ATW1.pdf

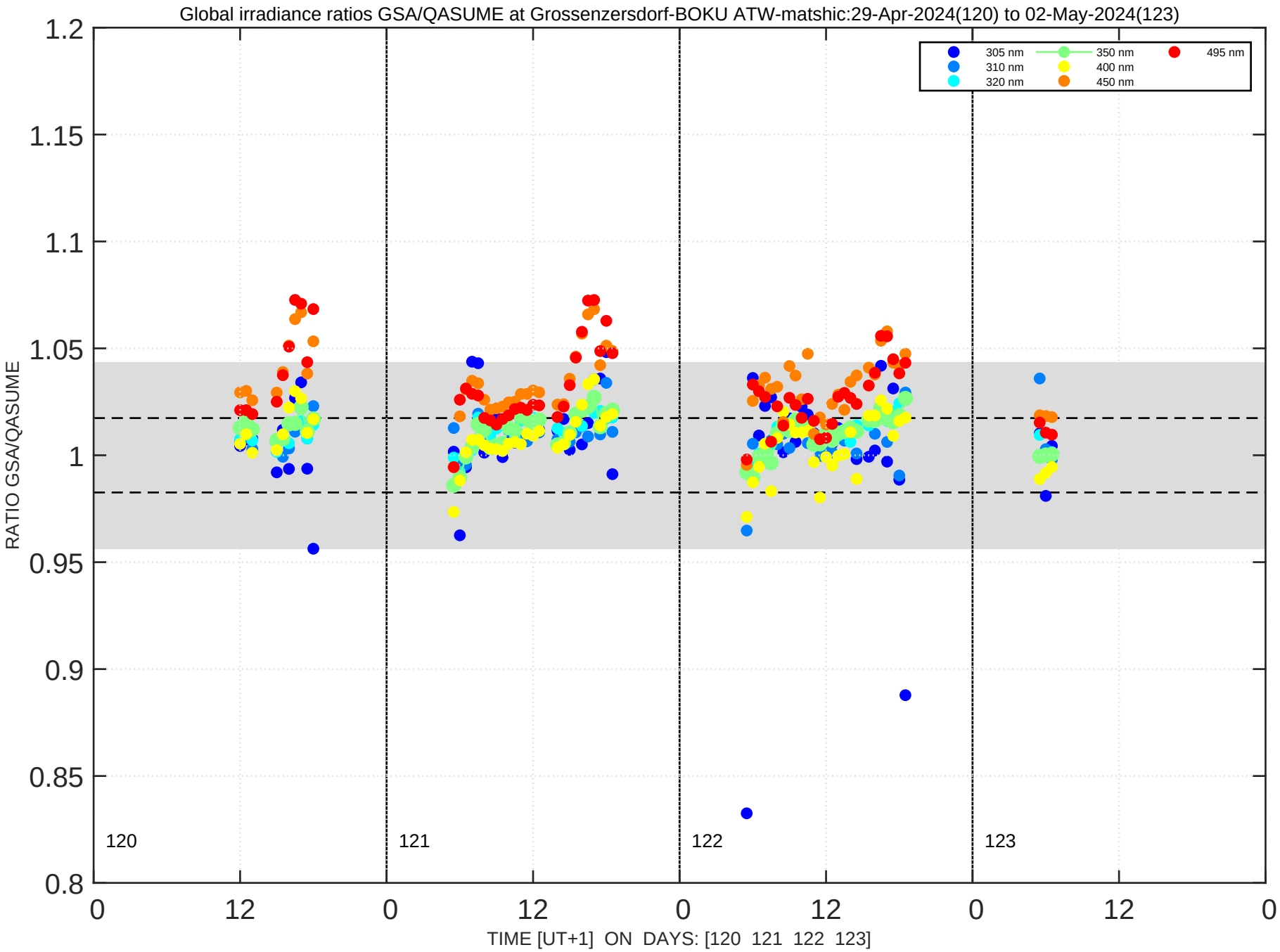
**Comments from the operator:**

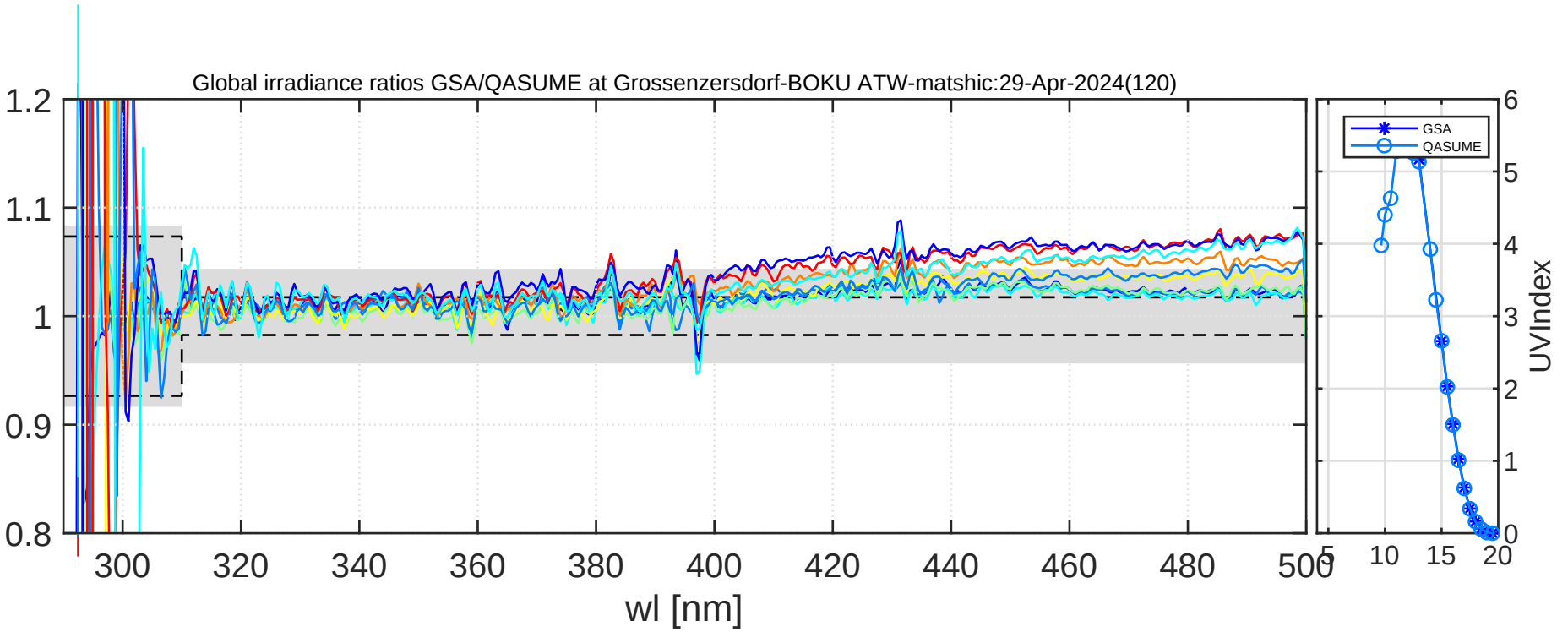
The BOKU GSA instrument was calibrated before the QASUME intercomparison using the primary standard and twice during the campaign using the secondary standard.
BOKU-Met uses a NIST 1000 W FEL primary standard for calibrations and a 1000 W secondary standard for more regular (monthly) calibrations.
The secondary standard lamp sits inside a self-built housing which fits on top of the entrance optics, so distance, temperature stabilisation and shielding from outside light is provided.
Lamps are powered with a high precision power supply and temperature stabilisation is provided by holding a constant of voltage (+/- 0.05 mV DC) on a shunt resistor.

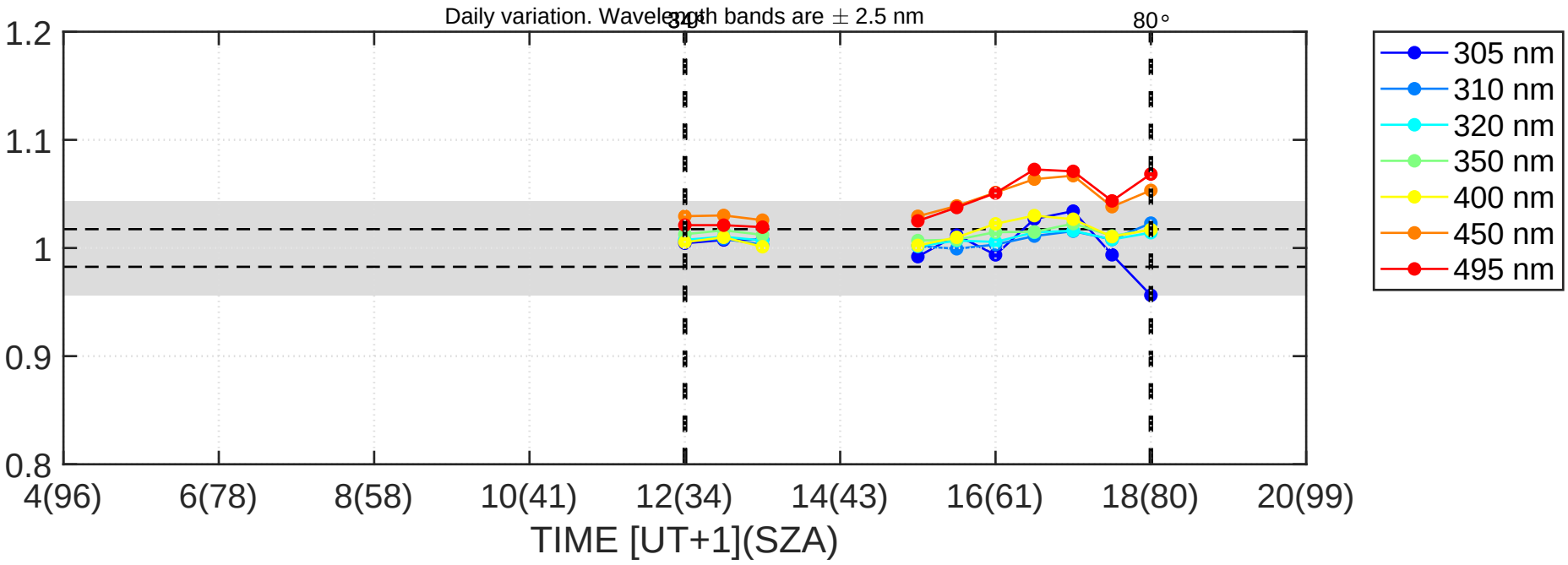
After a defect of the HV power supply of the instrument, it was sent to GB for repairs and upgrade (from DM-150 to IDR-150). Since 2022 it is again in continuous operation.

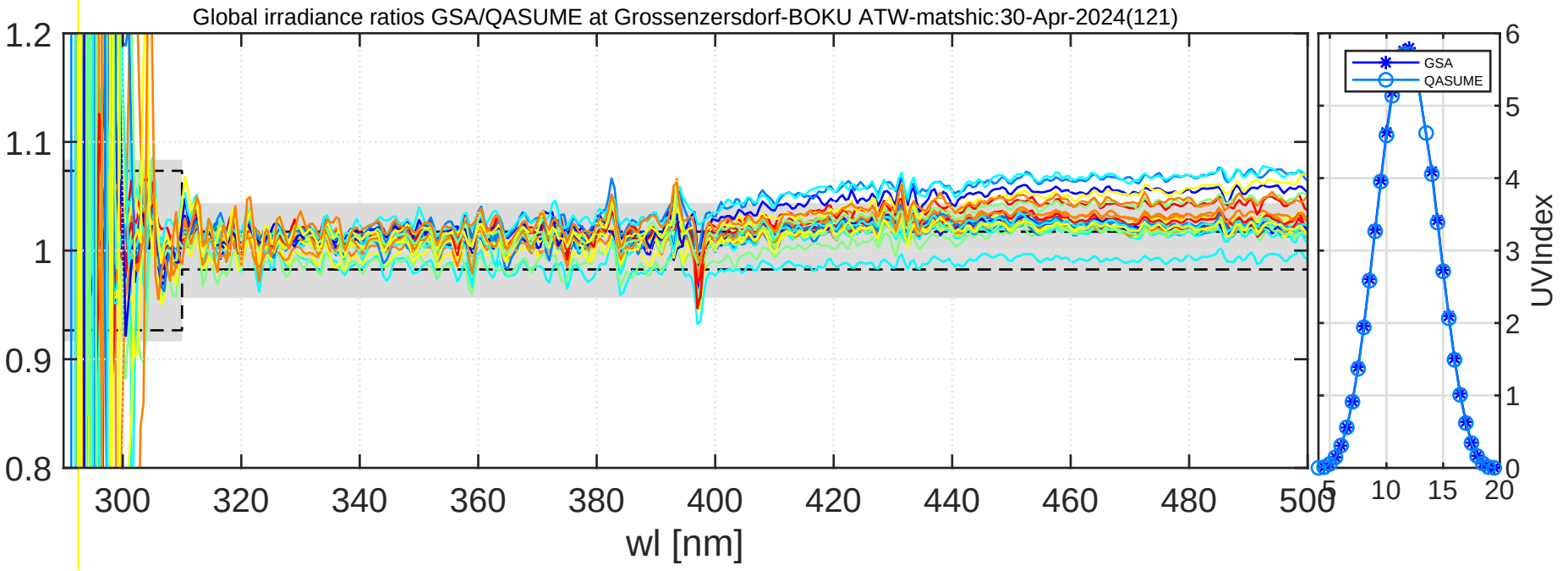
The instrument is located inside a container which is temperature stabilised to approximately ± 2.5 °C.
The envirobox of the instrument is cooled with a high-precision cooling system (heat exchanger), custom built for BOKU-Met.
Thus the PMT temperature is stabilised to 20 ± 0.2 °C.

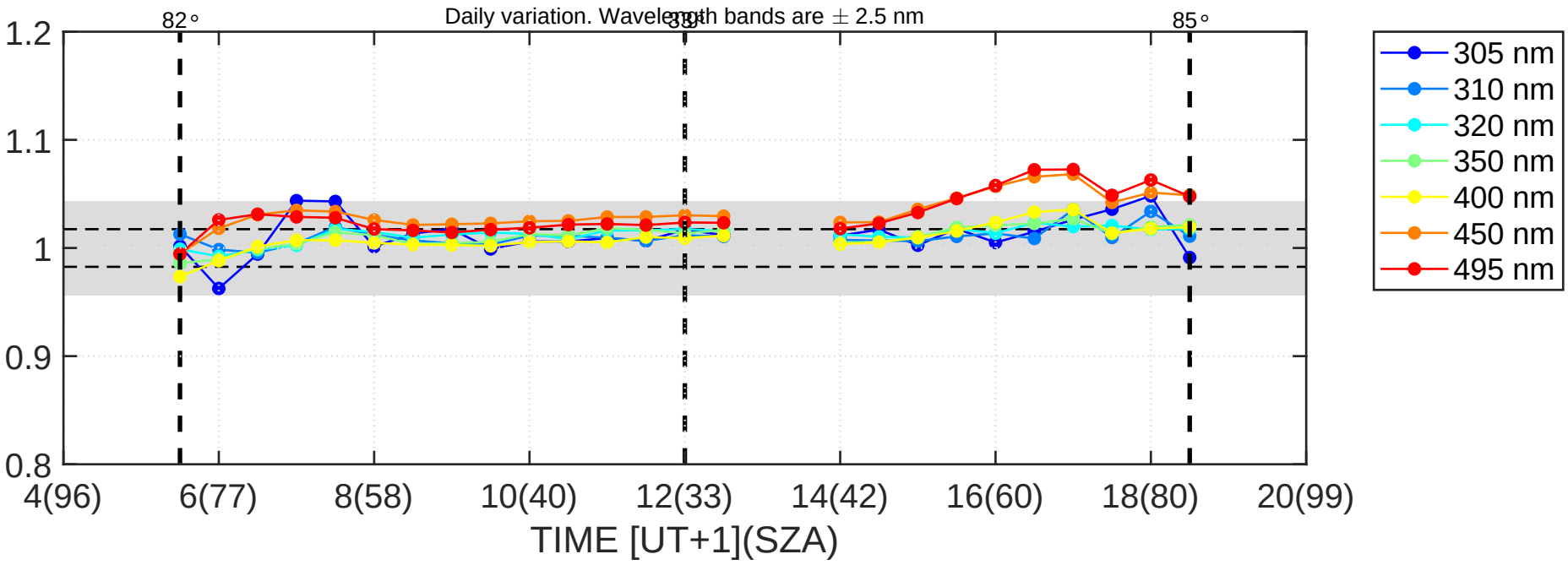

UV Index Grossenzersdorf, April-May 2024
QASUME
gsa
UV Index
Day of Year
0
1
2
3
4
5
6
120
120.5
121
121.5
122
122.5
123
123.5
124

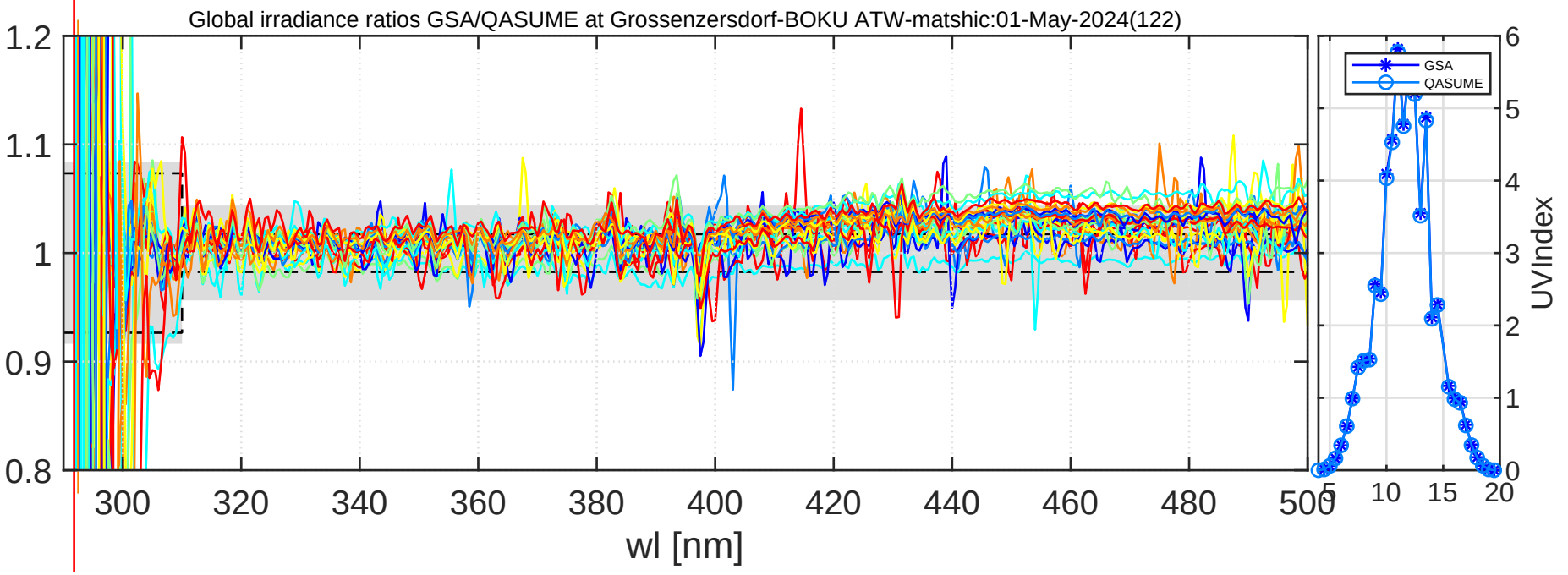

Global irradiance ratios GSA/QASUME at Grossenzersdorf-BOKU ATW-matshic:29-Apr-2024(120) to 02-May-2024(123)
305 nm
310 nm
320 nm
350 nm
400 nm
450 nm
495 nm
RATIO GSA/QASUME
1.2
1.15
1.1
1.05
1
0.95
0.9
0.85
0.8
120
121
122
123
0
12
0
12
0
12
0
12
0
TIME [UT+1] ON DAYS: [120 121 122 123]

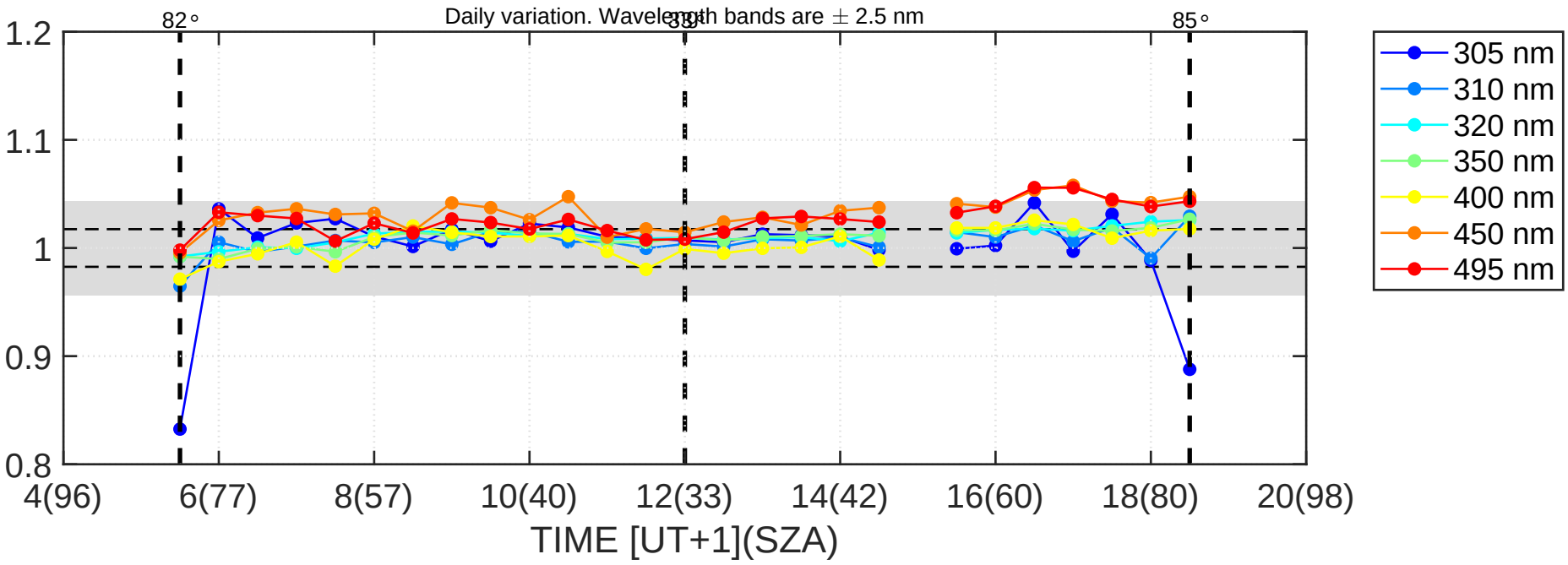

Global irradiance ratios GSA/QASUME at Grossenzersdorf-BOKU ATW-matshic:29-Apr-2024(120)
1.2
1.1
1
0.9
0.8
300
320
340
360
380
400
420
440
460
480
500
wl [nm]
GSA
QASUME
6
5
4
3
2
1
0
5
10
15
20
UVIndex

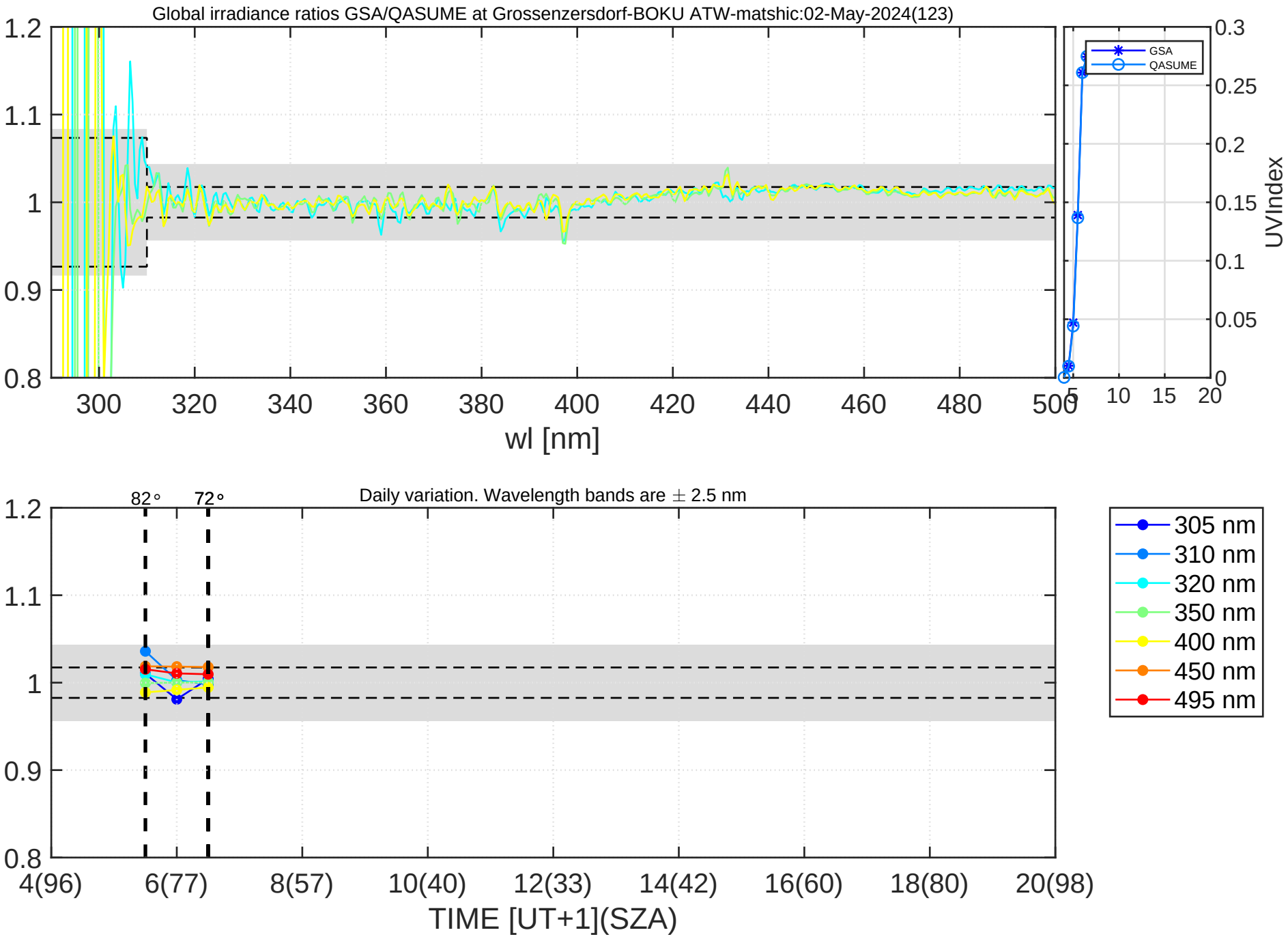

Daily variation. Wavelength bands are ± 2.5 nm
30°
80°
1.2
1.1
1
0.9
0.8
4(96)
6(78)
8(58)
10(41)
12(34)
14(43)
16(61)
18(80)
20(99)
TIME [UT+1](SZA)
305 nm
310 nm
320 nm
350 nm
400 nm
450 nm
495 nm

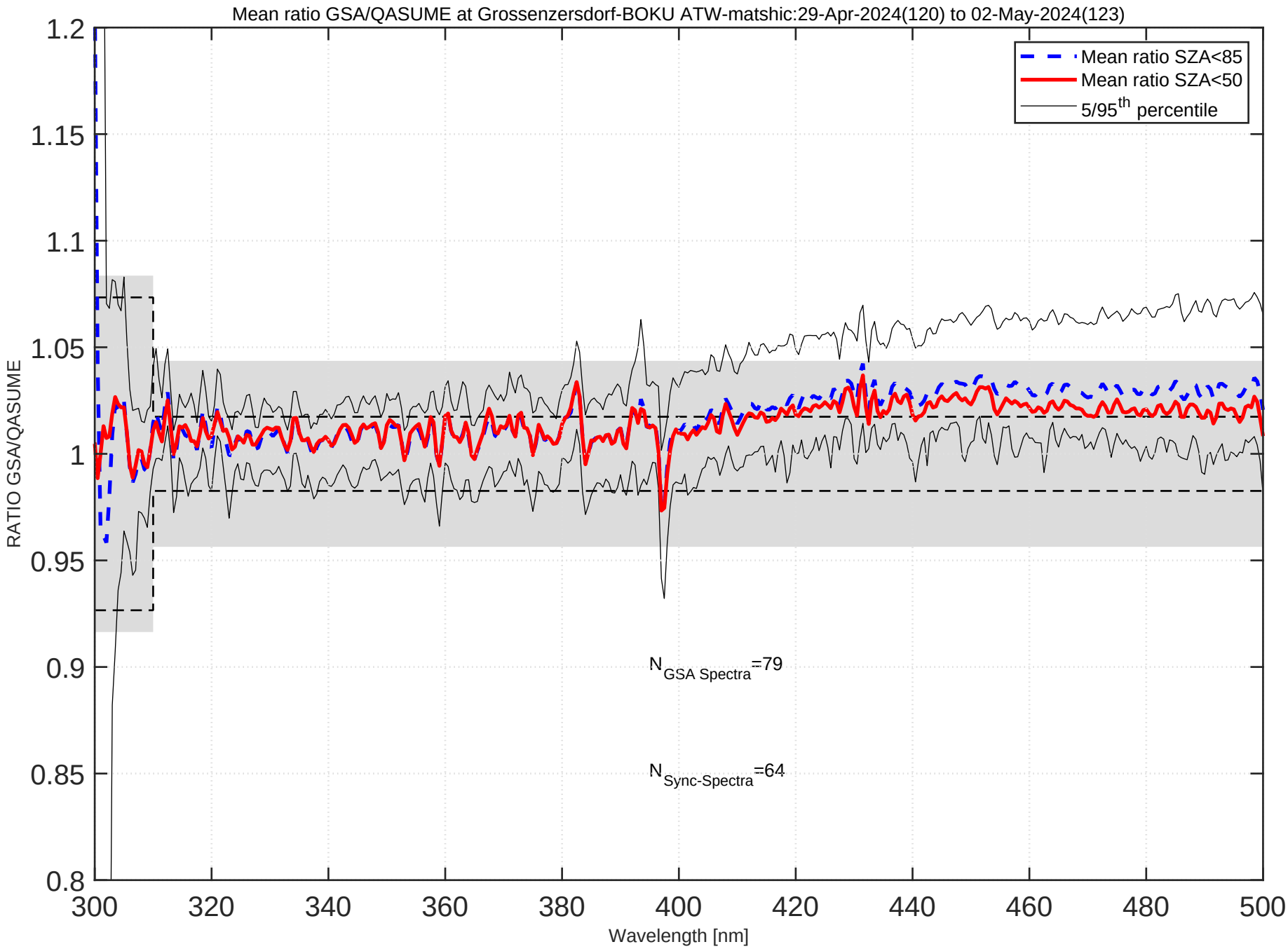

Global irradiance ratios GSA/QASUME at Grossenzersdorf-BOKU ATW-matshic:30-Apr-2024(121)
1.2
1.1
1
0.9
0.8
300
320
340
360
380
400
420
440
460
480
500
wl [nm]
GSA
QASUME
6
5
4
3
2
1
0
5
10
15
20
UVIndex

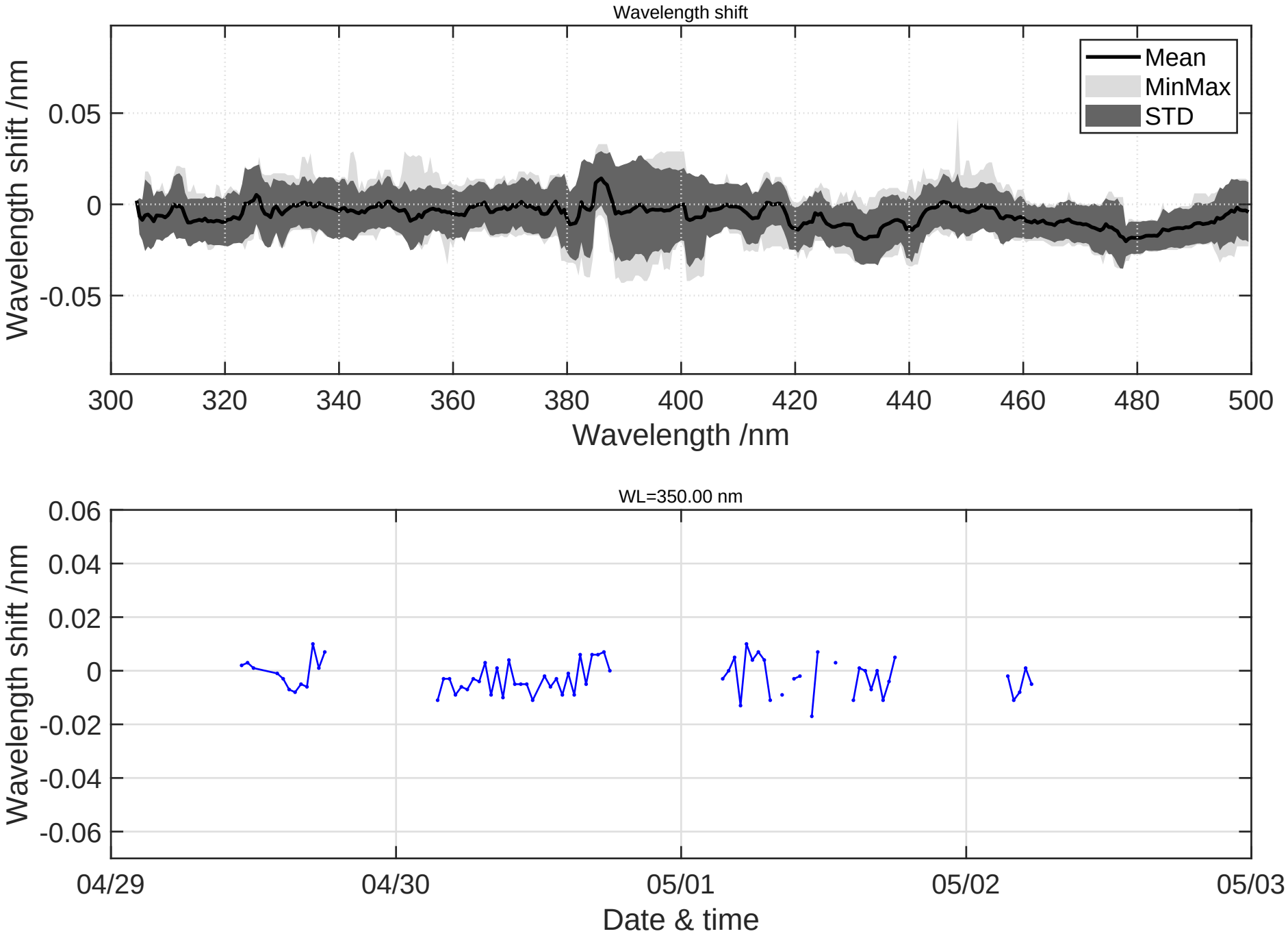

Daily variation. Wavelength bands are ± 2.5 nm
82°
85°
1.2
1.1
1
0.9
0.8
4(96)
6(77)
8(58)
10(40)
12(33)
14(42)
16(60)
18(80)
20(99)
TIME [UT+1](SZA)
305 nm
310 nm
320 nm
350 nm
400 nm
450 nm
495 nm

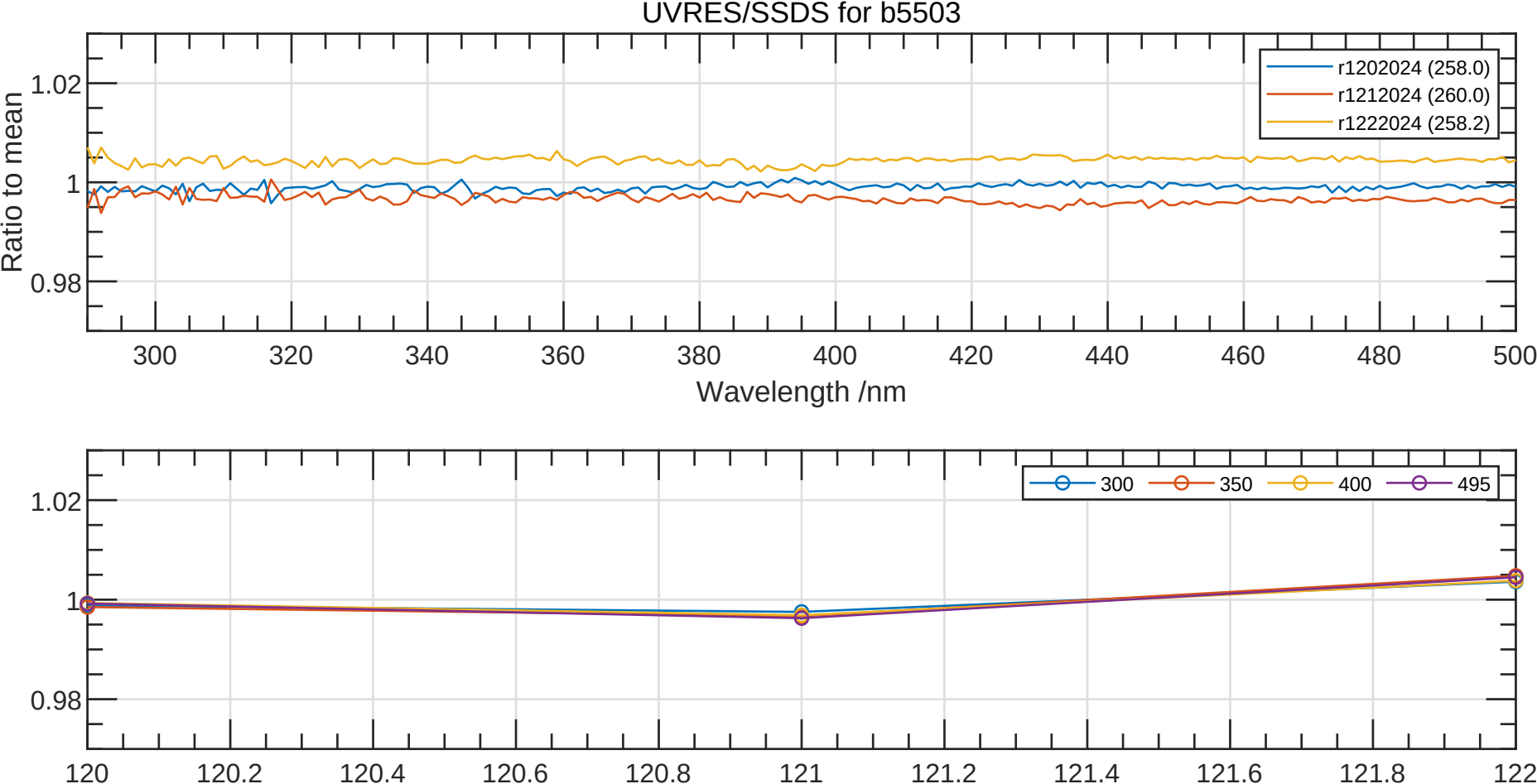

Global irradiance ratios GSA/QASUME at Grossenzersdorf-BOKU ATW-matshic:01-May-2024(122)
1.2
1.1
1
0.9
0.8
300
320
340
360
380
400
420
440
460
480
500
wl [nm]
GSA
QASUME
6
5
4
3
2
1
0
5
10
15
20
UVIndex

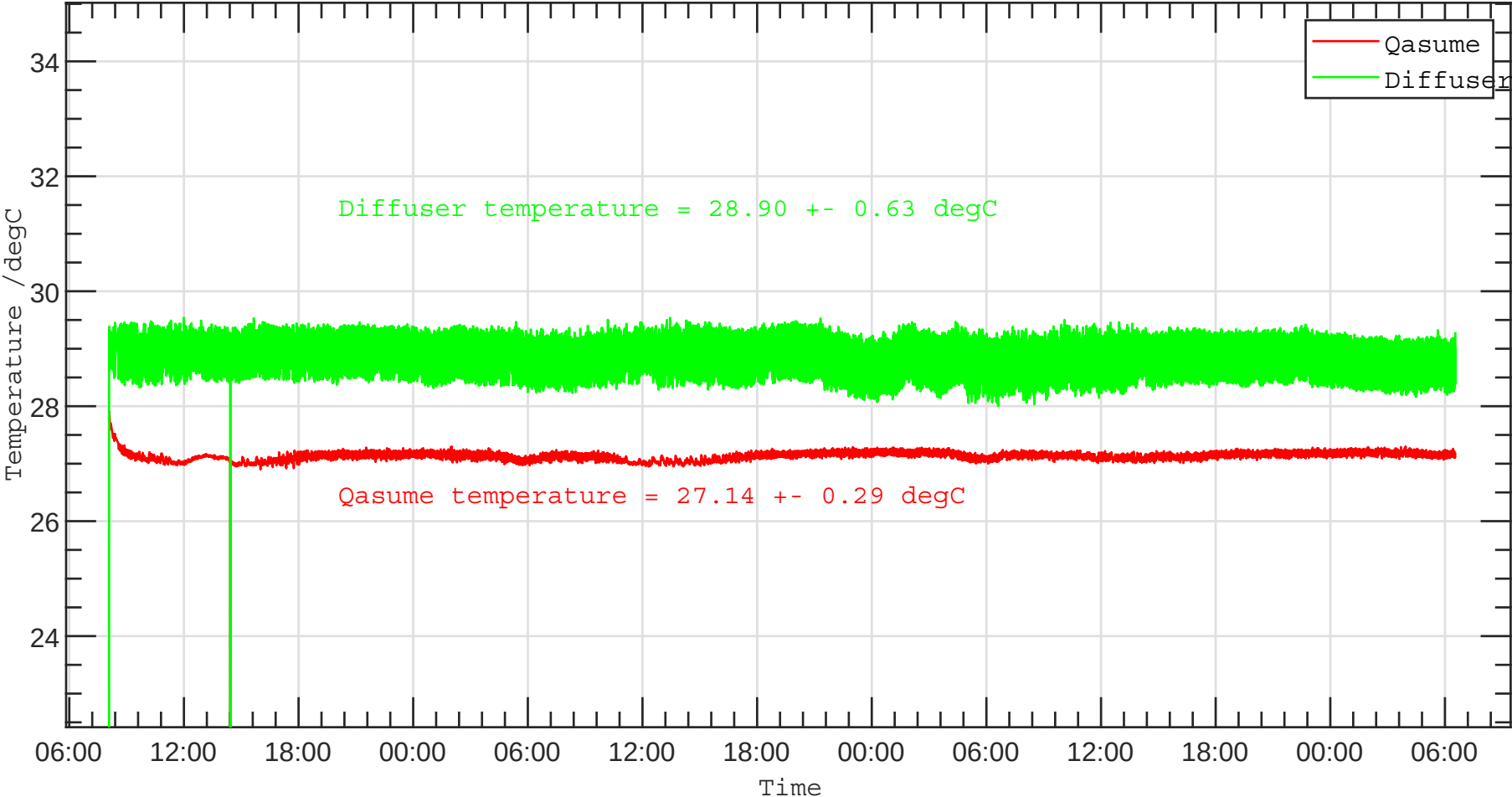

Daily variation. Wavelength bands are ± 2.5 nm
82°
85°
1.2
1.1
1
0.9
0.8
4(96)
6(77)
8(57)
10(40)
12(33)
14(42)
16(60)
18(80)
20(98)
TIME [UT+1](SZA)
305 nm
310 nm
320 nm
350 nm
400 nm
450 nm
495 nm


Global irradiance ratios GSA/QASUME at Grossenzersdorf-BOKU ATW-matshic:02-May-2024(123)
wl [nm]
UVIndex
GSA
QASUME
Daily variation. Wavelength bands are ± 2.5 nm
82°
72°
TIME [UT+1](SZA)
305 nm
310 nm
320 nm
350 nm
400 nm
450 nm
495 nm


Mean ratio GSA/QASUME at Grossenzersdorf-BOKU ATW-matshic:29-Apr-2024(120) to 02-May-2024(123)
Mean ratio SZA<85
Mean ratio SZA<50
5/95th percentile
RATIO GSA/QASUME
Wavelength [nm]
N GSA Spectra=79
N Sync-Spectra=64
1.2
1.15
1.1
1.05
1
0.95
0.9
0.85
0.8
300
320
340
360
380
400
420
440
460
480
500


Wavelength shift
Mean
MinMax
STD
Wavelength shift /nm
0.05
0
-0.05
300
320
340
360
380
400
420
440
460
480
500
Wavelength /nm
WL=350.00 nm
Wavelength shift /nm
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
04/29
04/30
05/01
05/02
05/03
Date & time


UVRES/SSDS for b5503
Ratio to mean
1.02
1
0.98
300
320
340
360
380
400
420
440
460
480
500
Wavelength /nm
r1202024 (258.0)
r1212024 (260.0)
r1222024 (258.2)
300
350
400
495
120
120.2
120.4
120.6
120.8
121
121.2
121.4
121.6
121.8
122


Qasume
Diffuser
Diffuser temperature = 28.90 +- 0.63 degC
Qasume temperature = 27.14 +- 0.29 degC
Temperature /degC
34
32
30
28
26
24
06:00
12:00
18:00
00:00
06:00
12:00
18:00
00:00
06:00
12:00
18:00
00:00
06:00
Time


pmod wrc
pmod wrc