Protocol of the intercomparison at Reading, U.K. from June 15 to 19, 2026 with the travelling reference spectroradiometer QASUME from PMOD/WRC

Report prepared by Julian Gröbner

Operator: Julian Gröbner

The purpose of the visit was the comparison of global solar irradiance measurements between the Bentham DM150 spectroradiometer operated at the University of Reading by the Univ. of Manchester and the travel reference spectroradiometer QASUME. The measurement site is located at the University of Reading; Latitude 51.441 N, Longitude 0.937 W and altitude 50 m.a.s.l.
The horizon of the measurement site is free down to at least 85° solar zenith angle (SZA). Measurements between 6:00 UT and 18:00 UT have been analysed.

QASUME was installed in the morning of June 15, 2026. The spectroradiometer was installed within 1 m of the entrance optic of the local spectroradiometer. The intercomparison between QASUME and the local spectroradiometer lasted five days, from the morning of June 15 to noon of June 19.

QASUME was calibrated several times during the intercomparison period using a portable calibration system. Three lamps (T157824, T157825, T68523) 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 27.37±0.07 °C and the diffuser head was heated to a temperature of 29.11±0.45 °C.
The wavelength shifts relative to an extraterrestrial spectrum as retrieved from the matSHIC analysis were between ±50 pm in the spectral range 290 to 500 nm.

Protocol:

The measurement protocol was to measure one solar irradiance spectrum every 30 minutes from 290 to 500 nm, every 0.5 nm, and 3.0 seconds between each wavelength increment. QASUME recorded the spectra in 30 min intervals with 0.25 nm increments.

DOY	Date	Day	Weather	Comments (times in UT)
166	15 June	Monday	Mix of sun and clouds.	7:50 QASUME installed. 12:50 T157825. 13:10 T157824.
167	16 June	Tuesday	Mix of sun and clouds	9:50 T157825
168	17 June	Wednesday	Mix of sun and clouds	11:15 T157825
169	18 June	Thursday	Mostly overcast. Clears up in the afternoon.	
170	19 June	Friday	Clear sky in the morning	9:50 T157825 10:10 T68523 11:00 QASUME OFF

Results:

In total 112 synchronised simultaneous spectra from QASUME and the local spectroradiometer D26 are available from the measurement period. Measurements between 4:30 UT and 19:30 UT have been analysed (SZA smaller than 85°). Many ratios between D26 and QASUME are noisy due to fast moving clouds. The submitted spectra from D26 were not corrected for wavelengths shifts by the operator. A revised dataset was submitted by the local operator after the campaign.

Remarks:

1. The Spectroradiometer D26 was very stable during the whole measurement period with a ratio to QASUME very close to 1 at wavelengths longer than 360 nm. At shorter wavelengths, D26 underestimates solar irradiance by about 2% to 3%.
2. A constant wavelengths shift of D26 of about 0.4 nm was observed. It is nearly uniform across the whole spectrum. While the solar irradiance spectra are corrected for this wavelength shift, it will affect the calibration of D26.
3. Some angular response related effect of about 5% was observed in the afternoon of June 18 when the sky was clear. This could be due to an angular response error, or a levelling error of the entrance optic.
4. The long-term stability of D26 (Figure 1), based on the 5 site visits performed so far (2003, 2012, 2018, 2022, and 2026), is approximately 10%, with ratios to QASUME varying from 0.92 in 2012 and 2026 to 1.02 in 2018. If the average measurement from the visit of 2012 is excluded, all measurements are within ±4%of QASUME.

Summary:

Assuming an expanded relative uncertainty of D26 of 5%, the measurements of D26 are within the combined uncertainties for wavelengths longer than 360 nm, but outside at shorter wavelengths.

Recommendations:

1. The traceability chain from primary standard (1 kW FEL lamp) to secondary standards used for on-site calibrations should be verified.
2. The wavelength shift of 0.4 nm has an impact on the calibration of D26 and should be corrected.
3. The levelling of the entrance optic should be verified.

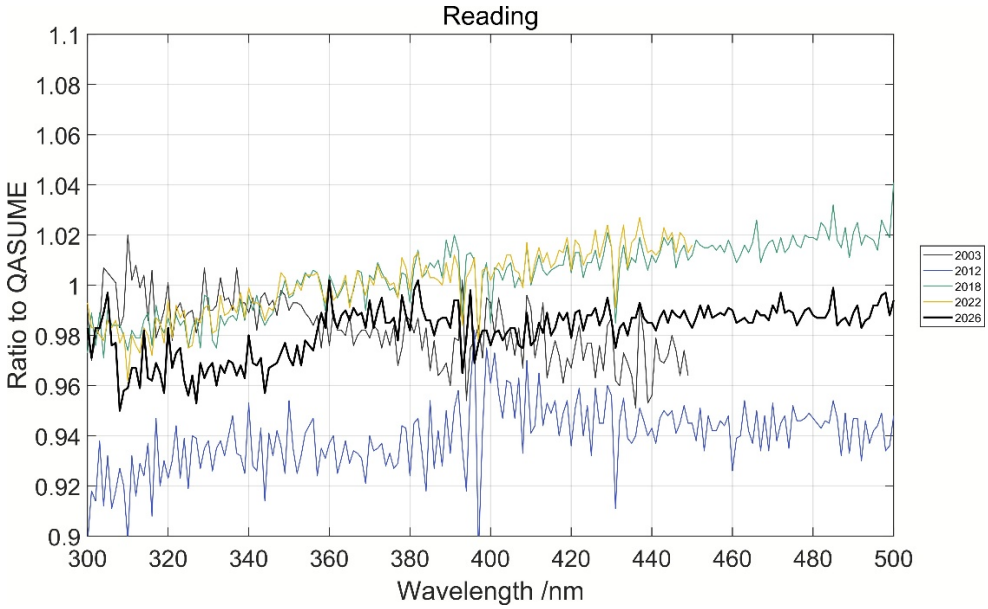


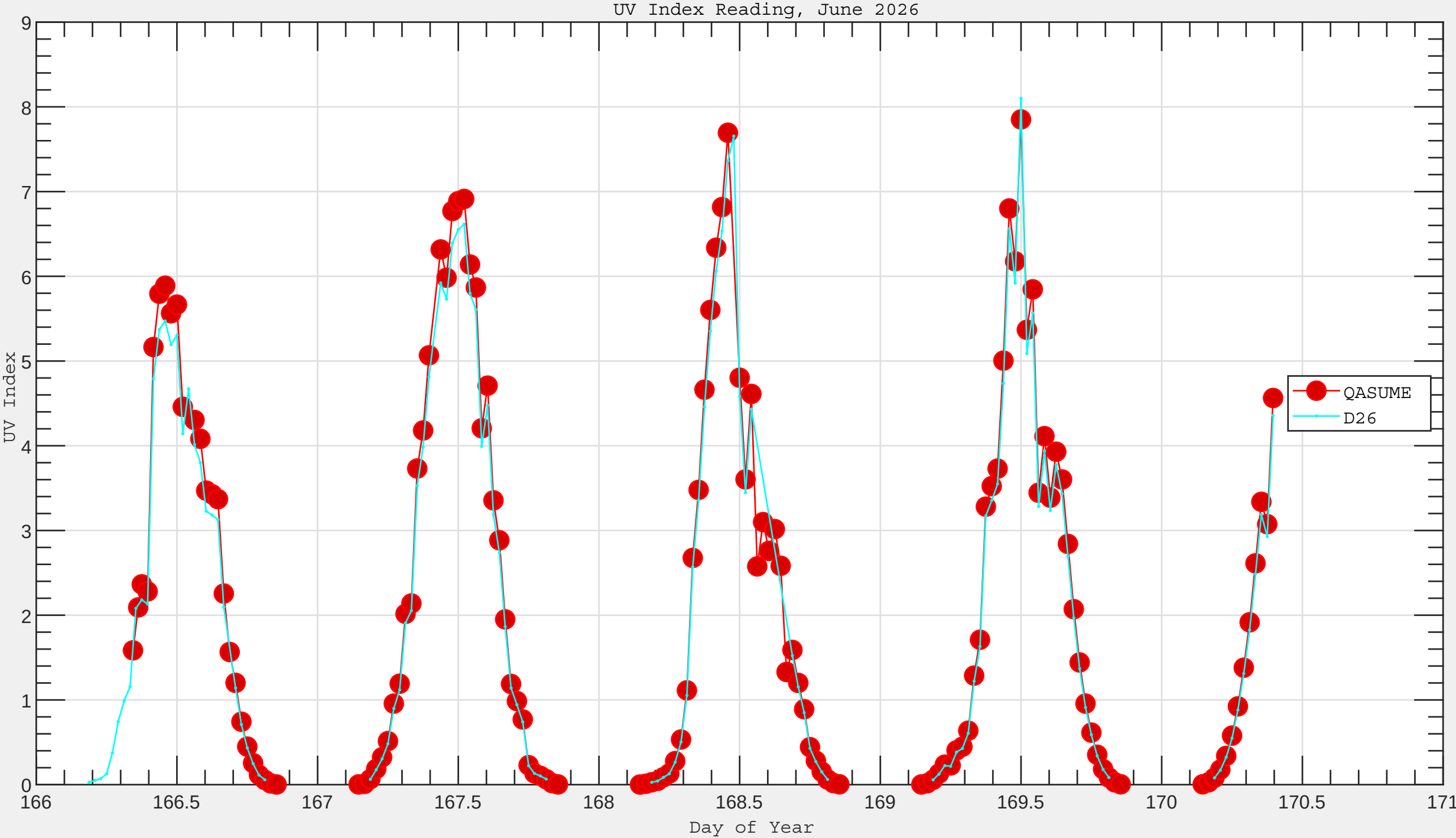
Figure 1 Average ratios between D26 and QASUME from this and previous site visits.

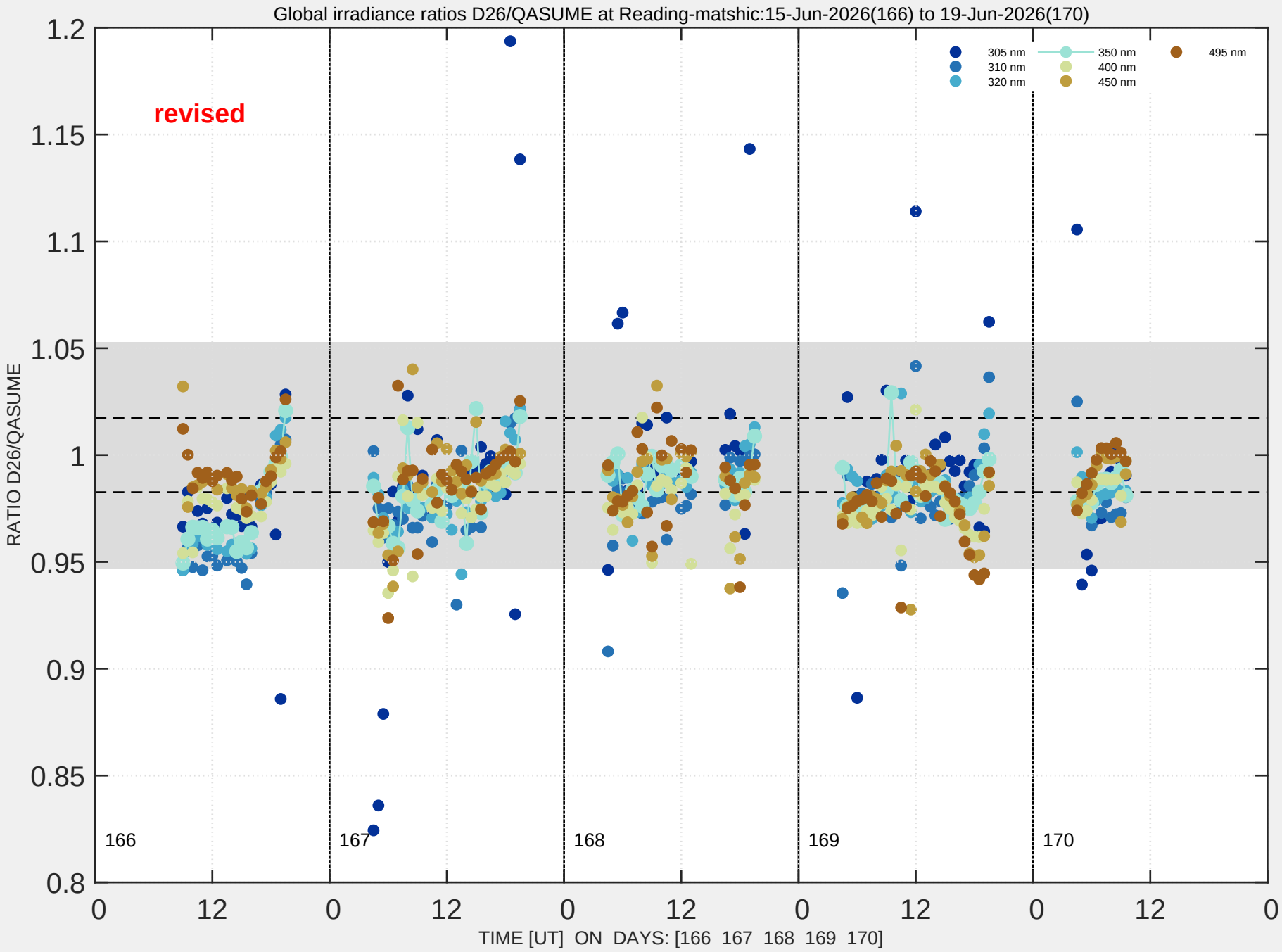
Local Operator: Richard Kift, Omer Celebi

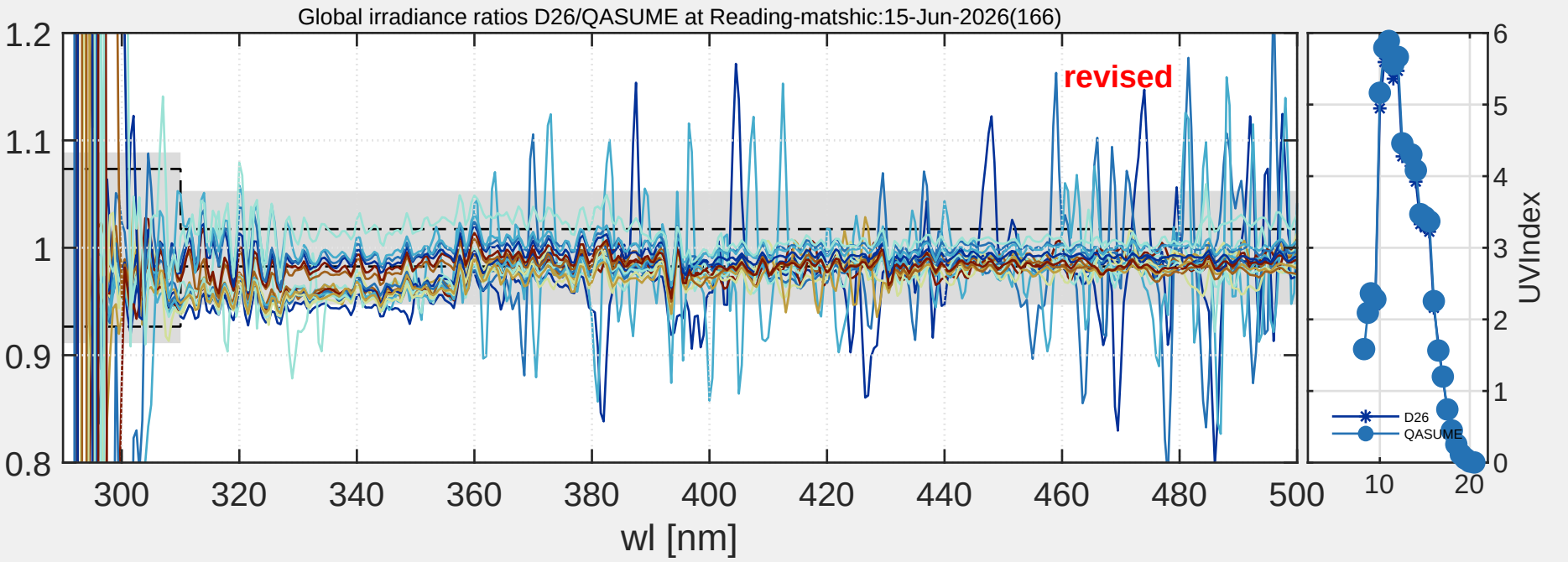
Comments from the operator:

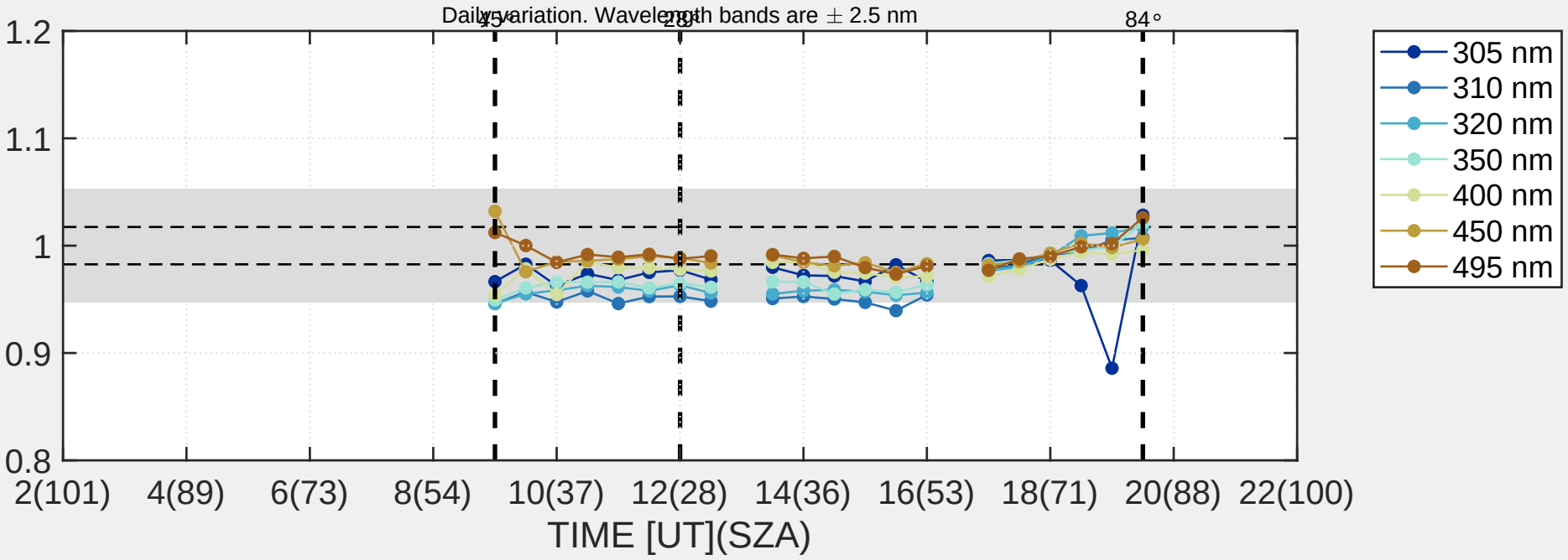
The initial dataset on the first day was based on a correction using the 200 W lamp ratio as we usually only alter the calibration file if there is a change > 2% to the ratio so I made a small change to the calibration file to correct the ratio to ~ 1.

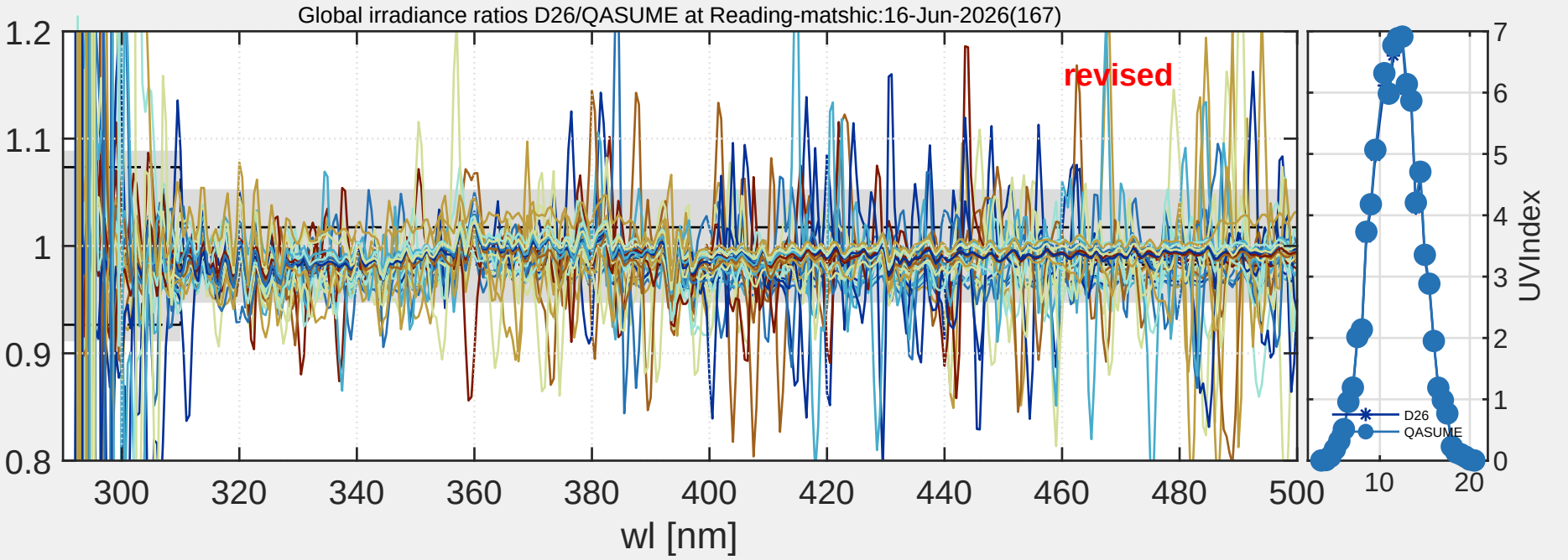
As regards the revised data, I found that the larger than expected wavelength shift caused an error in our 200 W check as we use unshicced files. Correcting for this improved the dataset.

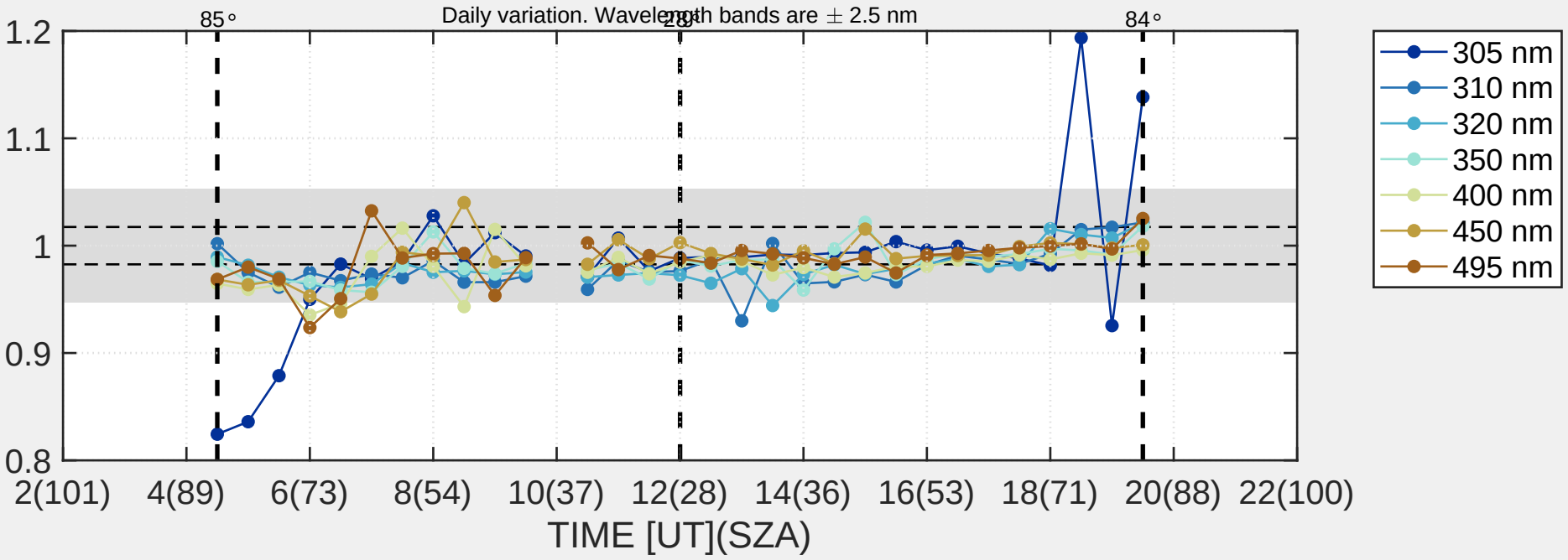

UV Index Reading, June 2026
UV Index
Day of Year
QASUME
D26
0
1
2
3
4
5
6
7
8
9
166
166.5
167
167.5
168
168.5
169
169.5
170
170.5
171

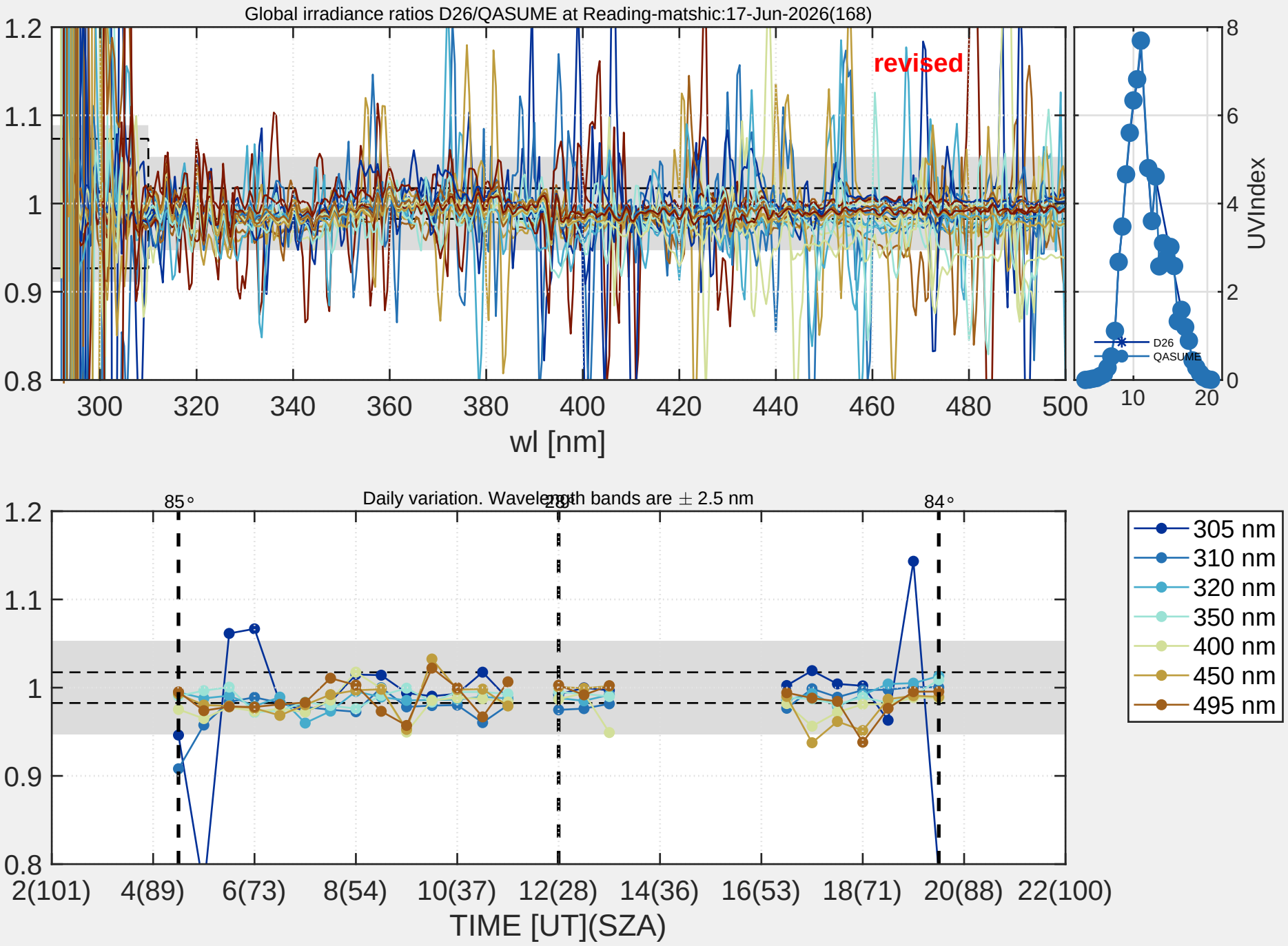

Global irradiance ratios D26/QASUME at Reading-matshic:15-Jun-2026(166) to 19-Jun-2026(170)
revised
305 nm
310 nm
320 nm
350 nm
400 nm
450 nm
495 nm
RATIO D26/QASUME
1.2
1.15
1.1
1.05
1
0.95
0.9
0.85
0.8
166
167
168
169
170
0
12
TIME [UT] ON DAYS: [166 167 168 169 170]

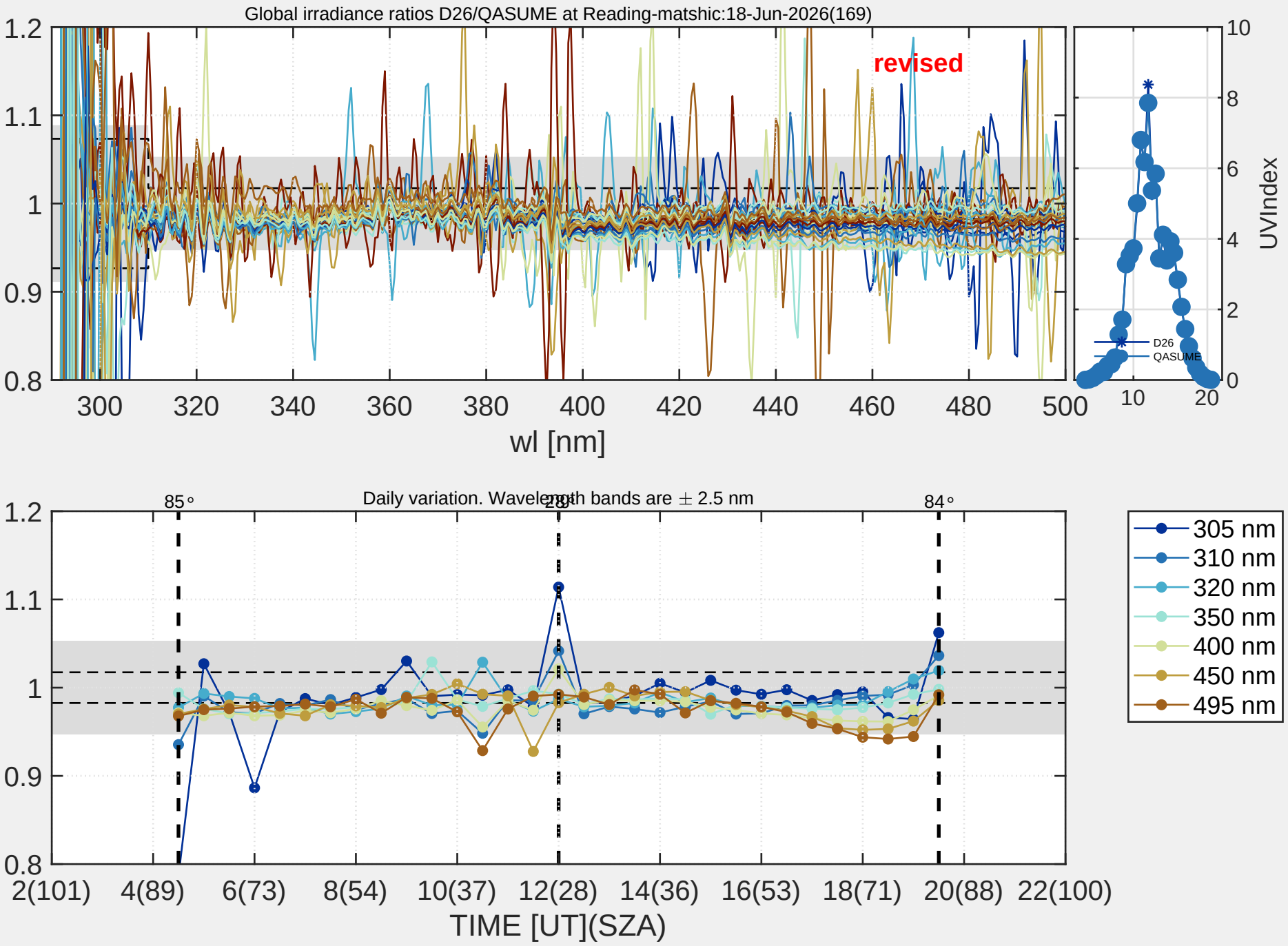

Global irradiance ratios D26/QASUME at Reading-matshic:15-Jun-2026(166)
revised
wl [nm]
UVIndex
D26
QASUME

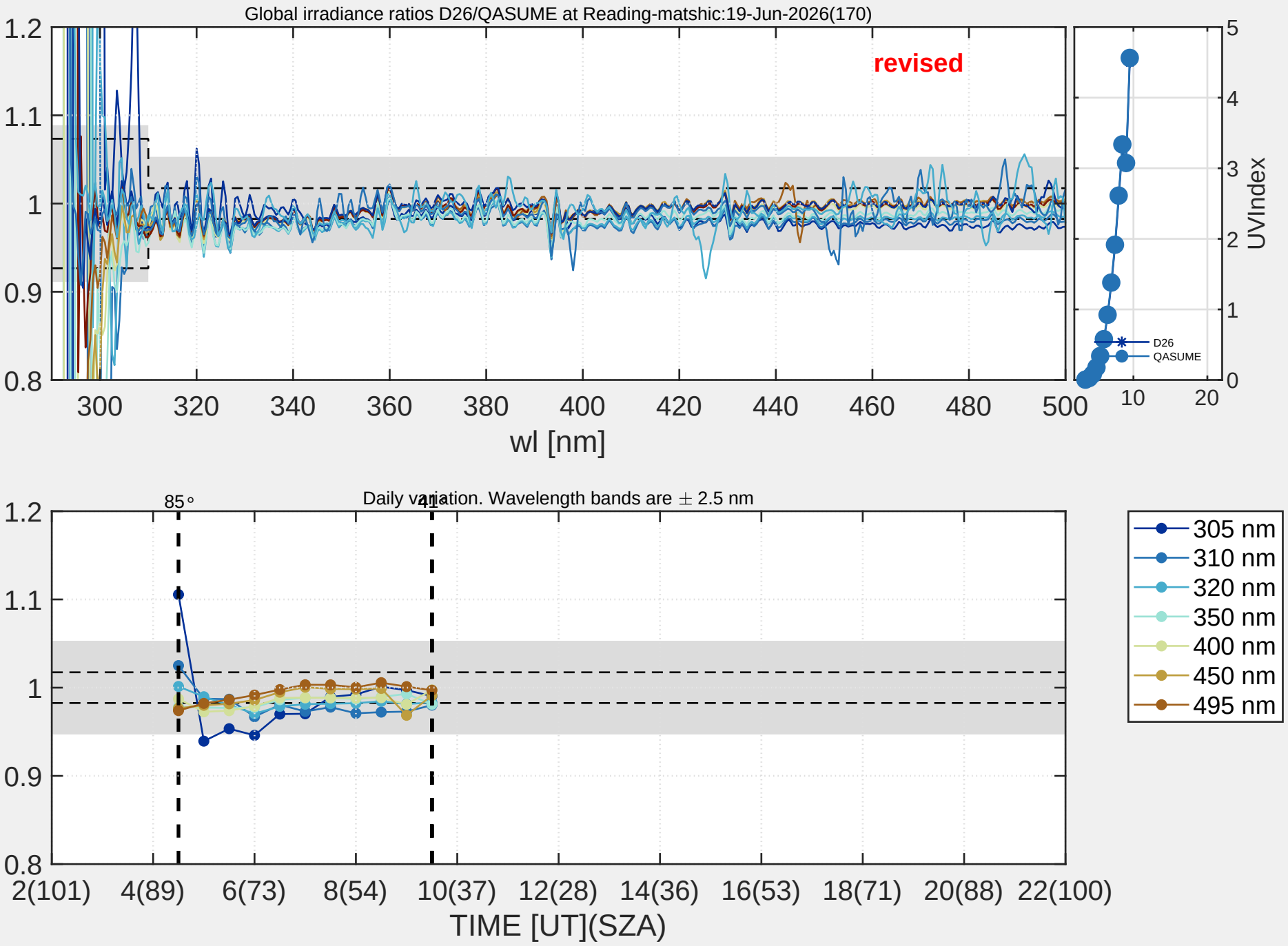

Daily variation. Wavelength bands are ± 2.5 nm
45°
28°
84°
TIME [UT](SZA)
305 nm
310 nm
320 nm
350 nm
400 nm
450 nm
495 nm

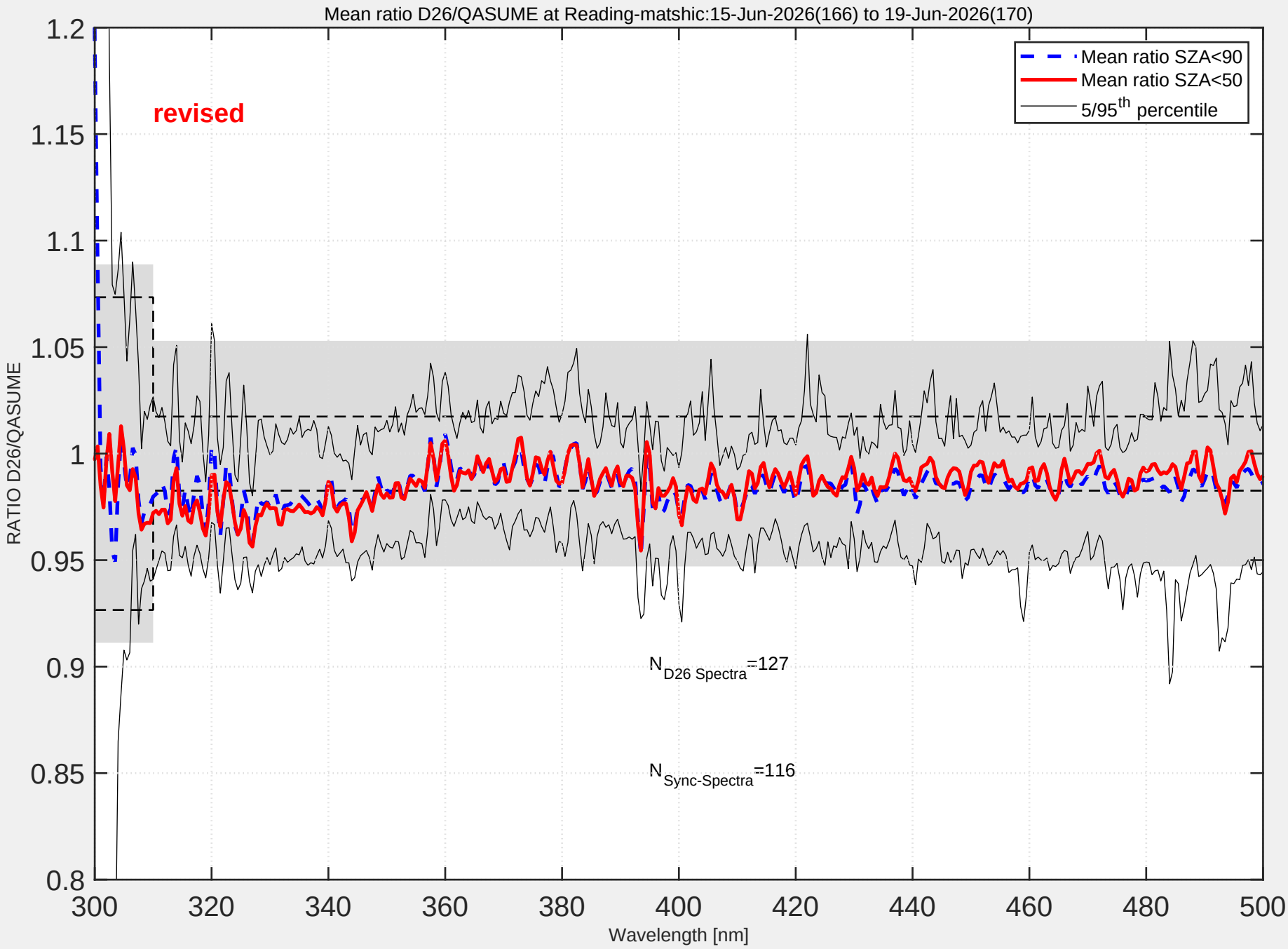

Global irradiance ratios D26/QASUME at Reading-matshic:16-Jun-2026(167)
revised
1.2
1.1
1
0.9
0.8
300
320
340
360
380
400
420
440
460
480
500
wl [nm]
7
6
5
4
3
2
1
0
UVIndex
10
20
D26
QASUME

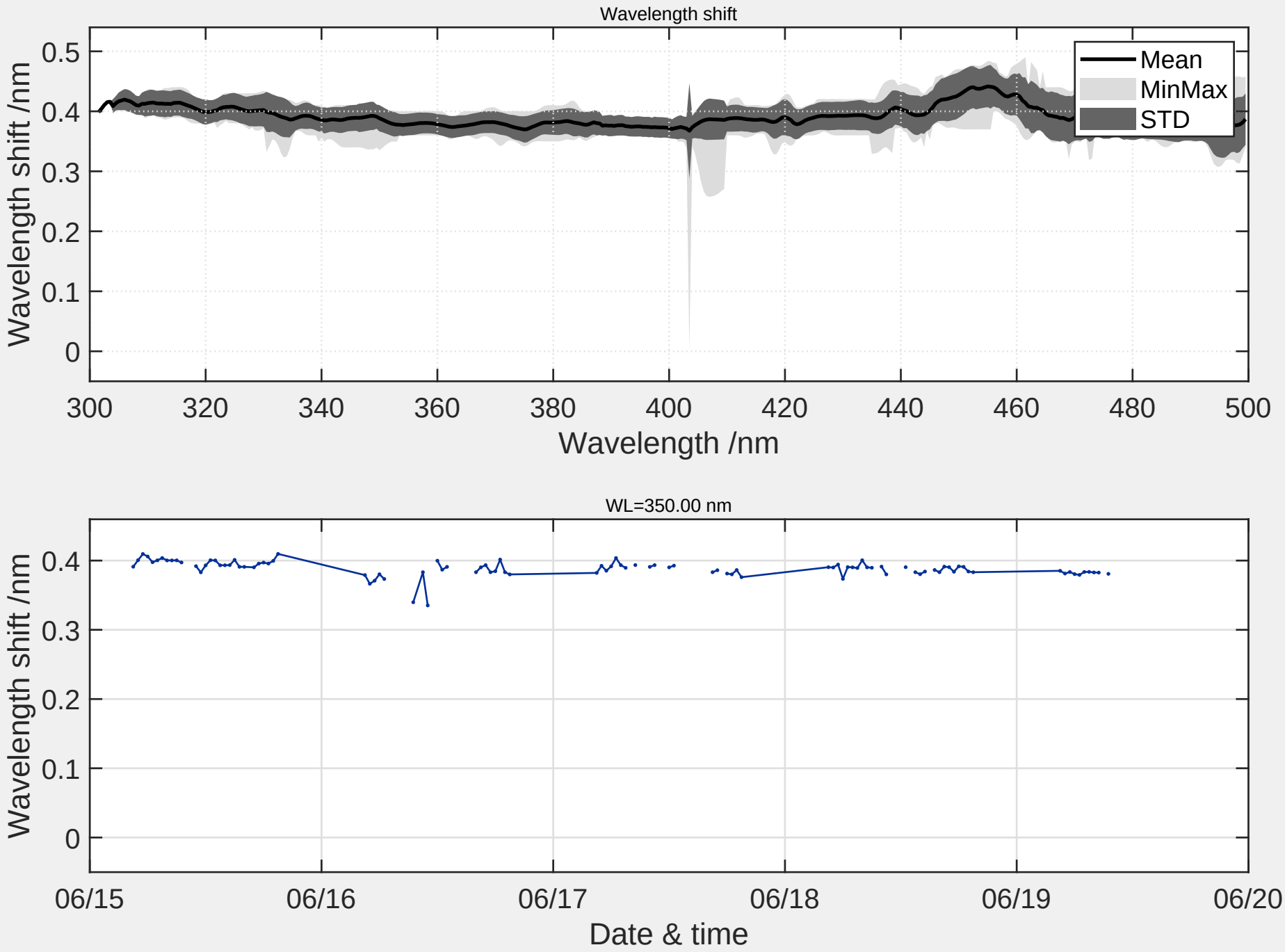

Daily variation. Wavelength bands are ± 2.5 nm
85°
28°
84°
1.2
1.1
1
0.9
0.8
2(101)
4(89)
6(73)
8(54)
10(37)
12(28)
14(36)
16(53)
18(71)
20(88)
22(100)
TIME [UT](SZA)
305 nm
310 nm
320 nm
350 nm
400 nm
450 nm
495 nm

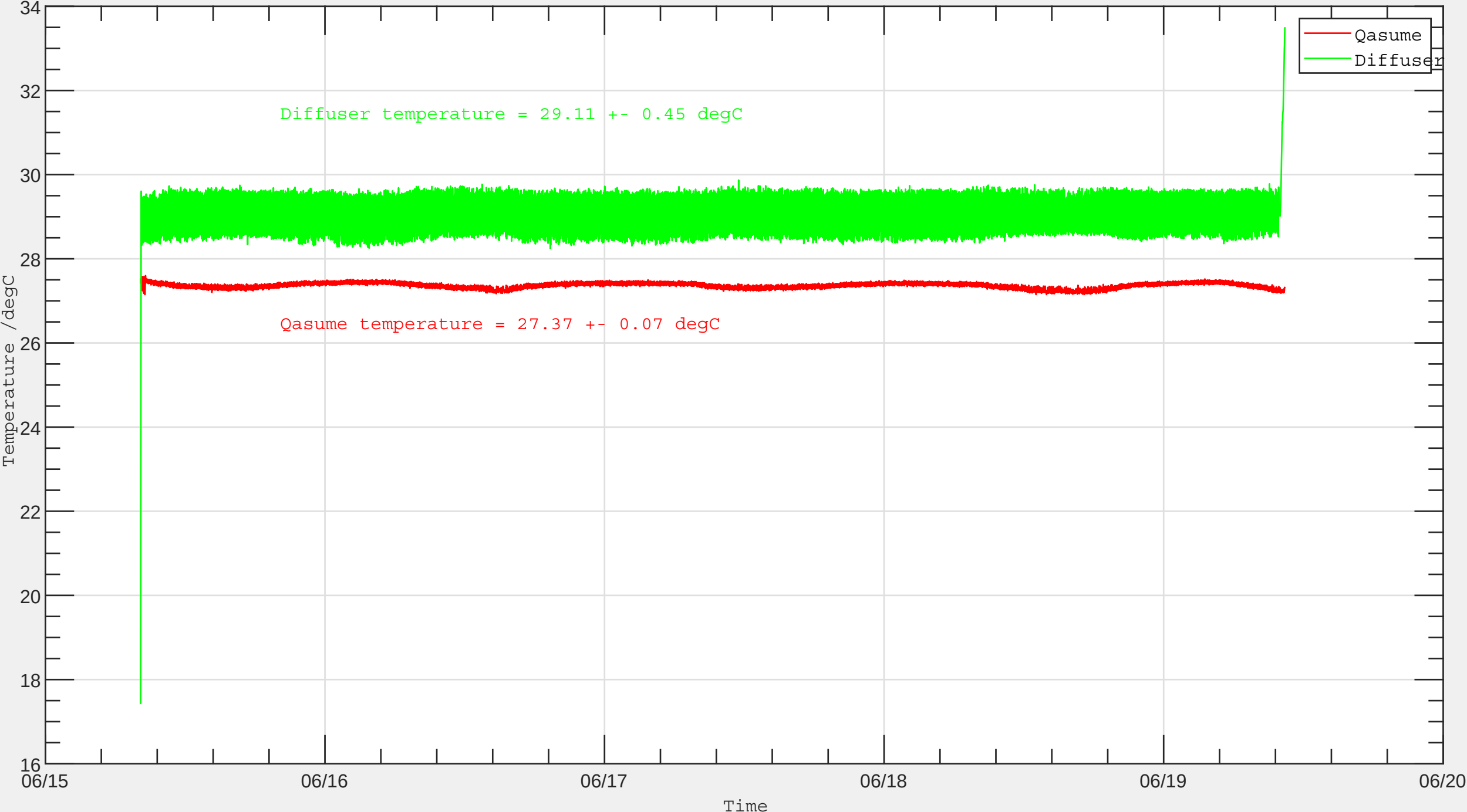

Global irradiance ratios D26/QASUME at Reading-matshic:17-Jun-2026(168)
revised
wl [nm]
UVIndex
D26
QASUME
Daily variation. Wavelength bands are ± 2.5 nm
85°
84°
TIME [UT](SZA)
305 nm
310 nm
320 nm
350 nm
400 nm
450 nm
495 nm

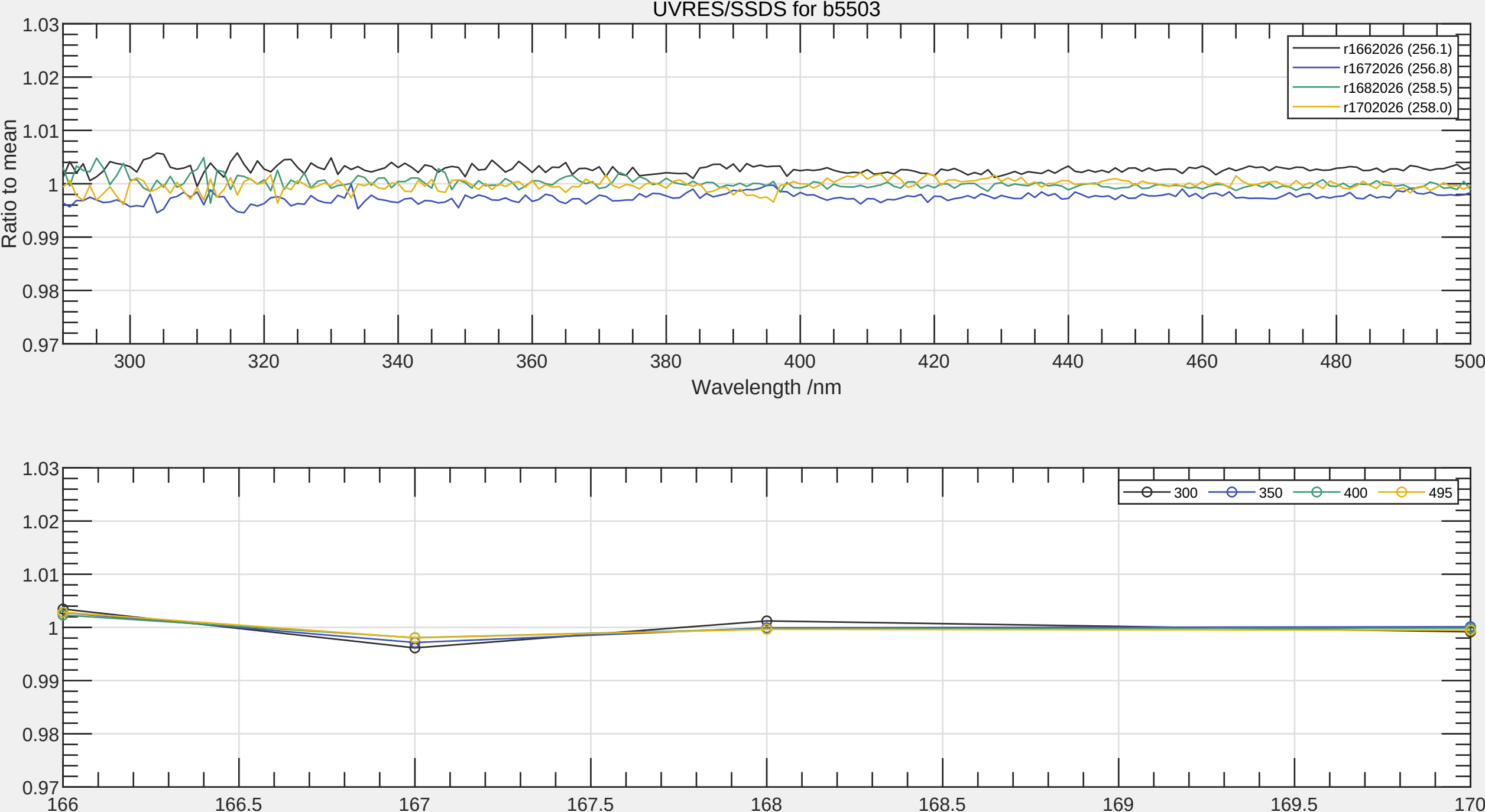

Global irradiance ratios D26/QASUME at Reading-matshic:18-Jun-2026(169)
revised
wl [nm]
UVIndex
D26
QASUME
Daily variation. Wavelength bands are ± 2.5 nm
85°
84°
TIME [UT](SZA)
2(101)
4(89)
6(73)
8(54)
10(37)
12(28)
14(36)
16(53)
18(71)
20(88)
22(100)
305 nm
310 nm
320 nm
350 nm
400 nm
450 nm
495 nm


Global irradiance ratios D26/QASUME at Reading-matshic:19-Jun-2026(170)
revised
wl [nm]
UVIndex
D26
QASUME
Daily variation. Wavelength bands are ± 2.5 nm
85°
TIME [UT](SZA)
305 nm
310 nm
320 nm
350 nm
400 nm
450 nm
495 nm


Mean ratio D26/QASUME at Reading-matshic:15-Jun-2026(166) to 19-Jun-2026(170)
revised
Mean ratio SZA<90
Mean ratio SZA<50
5/95th percentile
N D26 Spectra =127
N Sync-Spectra =116
RATIO D26/QASUME
Wavelength [nm]
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
0.1
0.2
0.3
0.4
0.5
300
320
340
360
380
400
420
440
460
480
500
Wavelength /nm
WL=350.00 nm
Wavelength shift /nm
0
0.1
0.2
0.3
0.4
06/15
06/16
06/17
06/18
06/19
06/20
Date & time


Qasume
Diffuser
Diffuser temperature = 29.11 +- 0.45 degC
Qasume temperature = 27.37 +- 0.07 degC
Temperature /degC
Time
34
32
30
28
26
24
22
20
18
16
06/15
06/16
06/17
06/18
06/19
06/20


UVRES/SSDS for b5503
Ratio to mean
Wavelength /nm
r1662026 (256.1)
r1672026 (256.8)
r1682026 (258.5)
r1702026 (258.0)
300
350
400
495

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