Protocol of the intercomparison at AEMET, Madrid, Spain on August 31 to September 3, 2021 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 spectroradiometer AEM operated by AEMET Madrid and the travel reference spectroradiometer QASUME. The measurement site is located at Madrid; Latitude 40.45 N, Longitude 3.72 W and altitude 680 m.a.s.l.
The horizon of the measurement site is free down to at least 85° solar zenith angle (SZA). Measurements between 5:00 UT and 20:00 UT have been analysed.

QASUME was installed on the measurement platform of AEMET-Madrid in the morning of 31 August 2021. The spectroradiometer was installed next to the AEM spectroradiometer with the entrance optic of QASUME within 2 m to the other instrument. The spectroradiometer in use at AEMET is a Bentham DM300 double monochromator system (AEM). The input optics is from CMS Schreder. The intercomparison between QASUME and AEM lasted four days, from morning of August 31 to the afternoon of September 3, 2021.

QASUME was calibrated several times during the intercomparison period using a portable calibration system. Three lamps (T68522, T68523 and T16573) 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 4 days of the intercomparison period (Day of year 243-246). To account for the responsivity change, the responsivity was calculated for each day separately and used for that specific day. The internal temperature of QASUME was 30.4±0.3 °C.
The wavelength shifts relative to the QASUMEFTS (Gröbner et al., 2017) spectrum as retrieved from the MatSHIC analysis were between ±50 pm in the spectral range 290 to 400 nm.

Protocol:

The measurement protocol was to measure one solar irradiance spectrum every 30 minutes from 290 to 400 nm, every 0.25 nm, and 1.5 seconds between each wavelength increment.

DOY	Date	DAY	Weather	Comment (times are in UT)
243	31-Aug	Tuesday	Clear sky in the morning, then Cirrus and some Cu	Installed at 7:00 8:30 T68522 9:35 T68523 16:35 T68523
244	01-Sep	Wednesday	Rain over night, overcast in the morning, then mix of sun and clouds during day Rain starting at 14:00	09:05 calibration (T68523)
245	02-Sep	Thursday	Rain until 6:30, then clearing up, Cirrus and again overcast from 13:30 to the evening	10:05 calibration (T68523)
246	03-Sep	Friday	Clear sky, some cirrus in the afternoon	11:00 calibration (T68523) 11:35 Calibration (T16573) 15:30 last scan & End of Campaign

Results:

In total 68 quality controlled synchronised simultaneous spectra from QASUME and AEM, are available from the measurement period. Measurements between 6:00 and 18:30 UT have been analysed (SZA smaller than 90°).

Remarks:

The comparison between AEM and QASUME was very successful, and consistent with the results obtained in previous visits (see Figure 1).

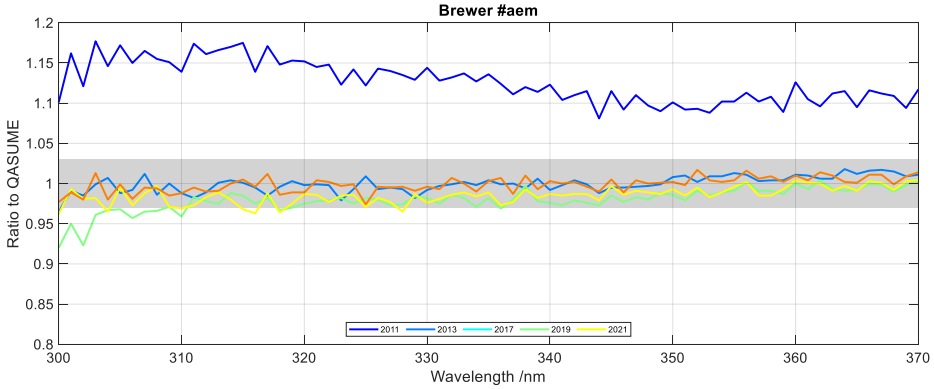


Figure 1 Spectral average ratio AEM/QASUME from QASUME site visits since 2011. The gray shaded area represents an uncertainty of 3%.

1. The spectral ratios between AEM and QASUME are very stable during the intercomparison period and do not deviate more than 5% from QASUME.
2. The wavelength shifts of AEM with respect to a high resolution reference spectrum are constant during the intercomaprison. However there is a large offset of 0.25 nm between 300 nm and 350 nm, with a decrease to 0.15 nm up to 400 nm.

Recommendation:

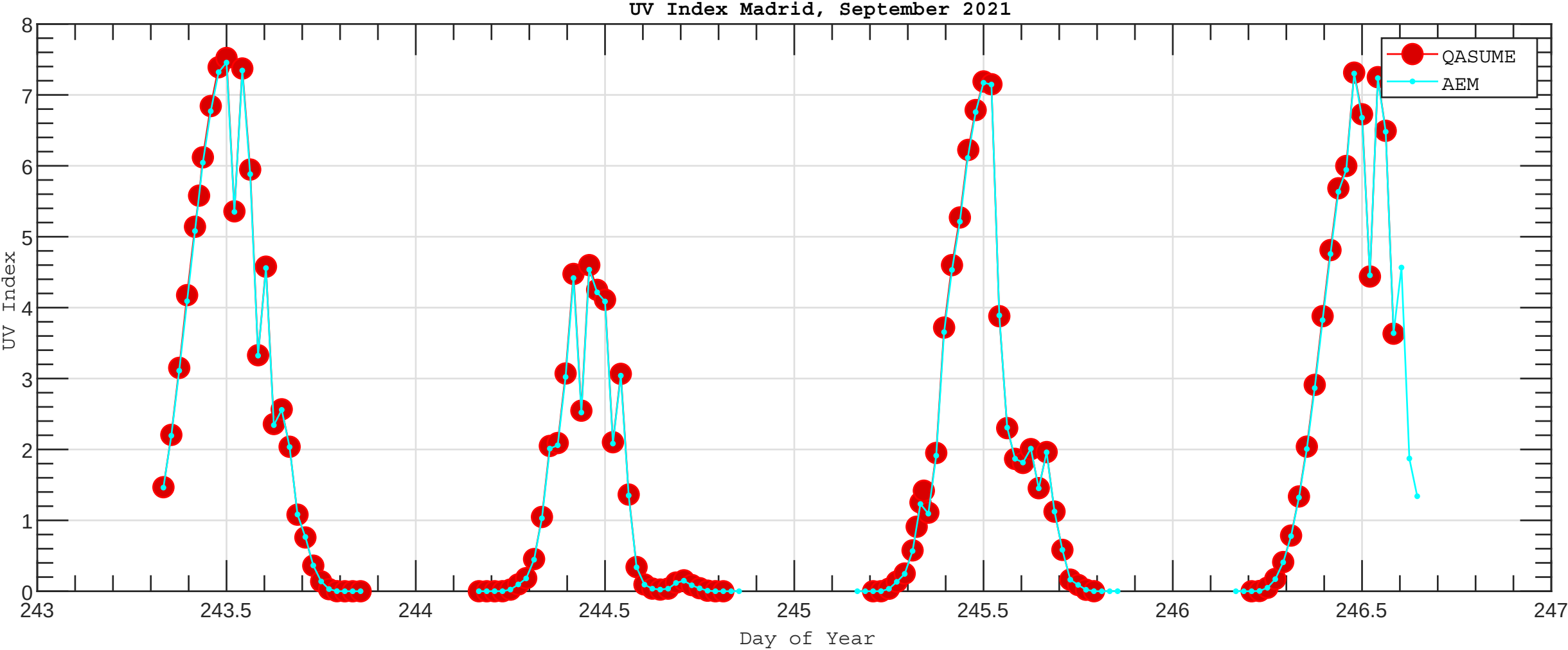
The wavelength settings of AEM need to be updated to account for the spectral offsets observed during the intercomparison. Apart from this fact, the instrument performed very well, and has shown consistent results with QASUME, as has been the case during all site 4 since 2013.

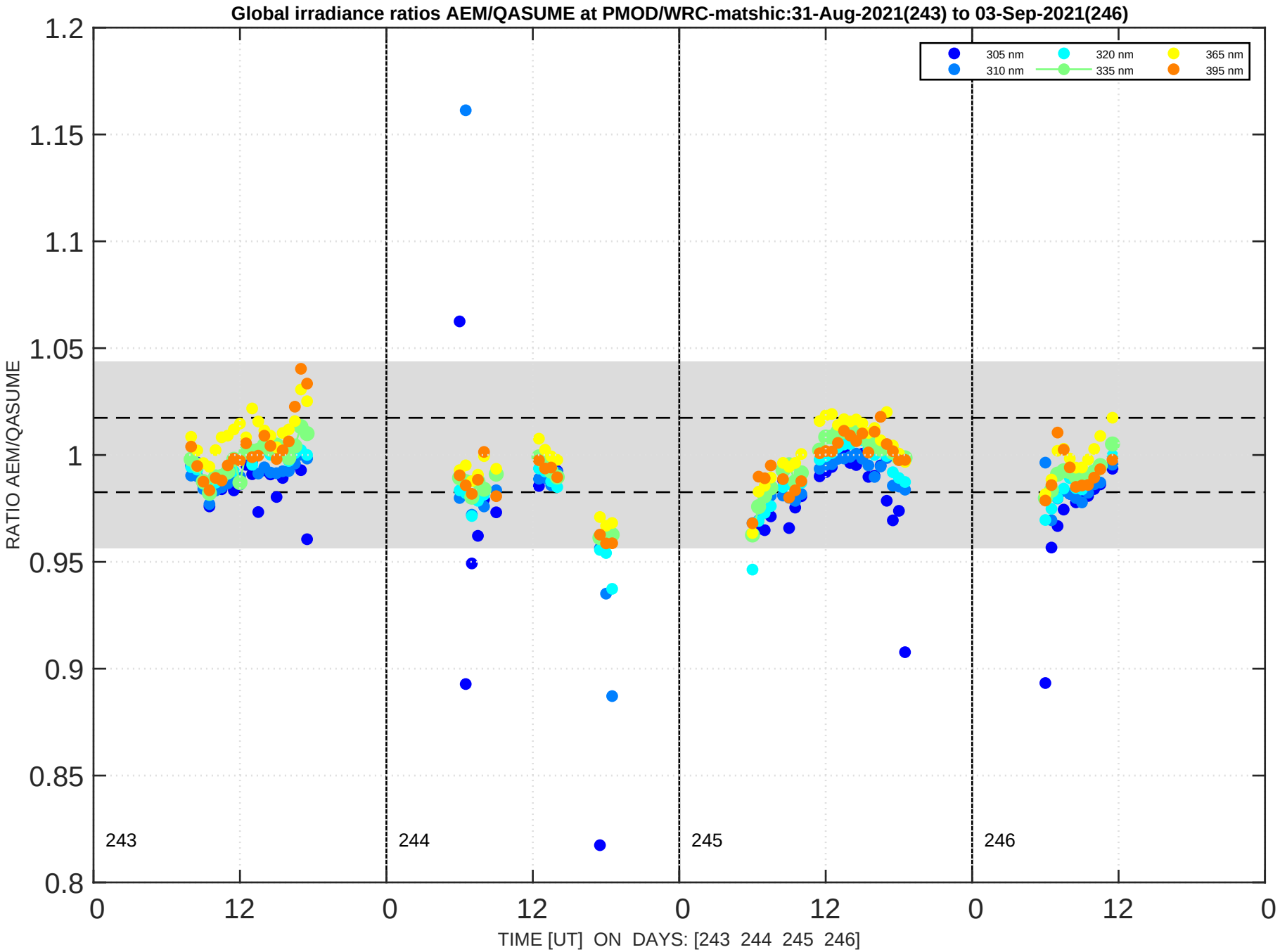
Comments of the Operator:

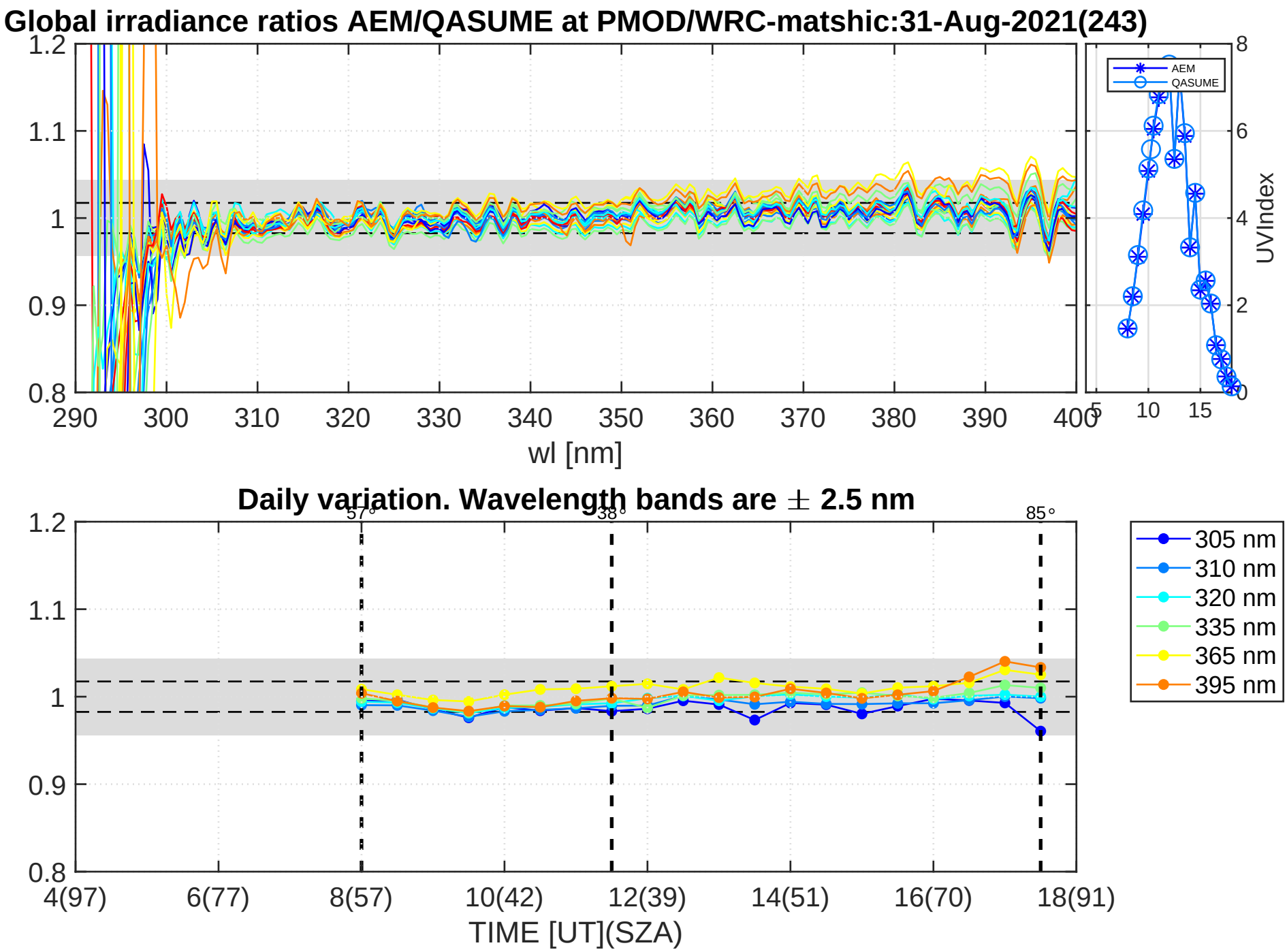
Currently the software ShicRIVM is applied to all the AEM spectra in order to correct the effect of the wavelength shift.

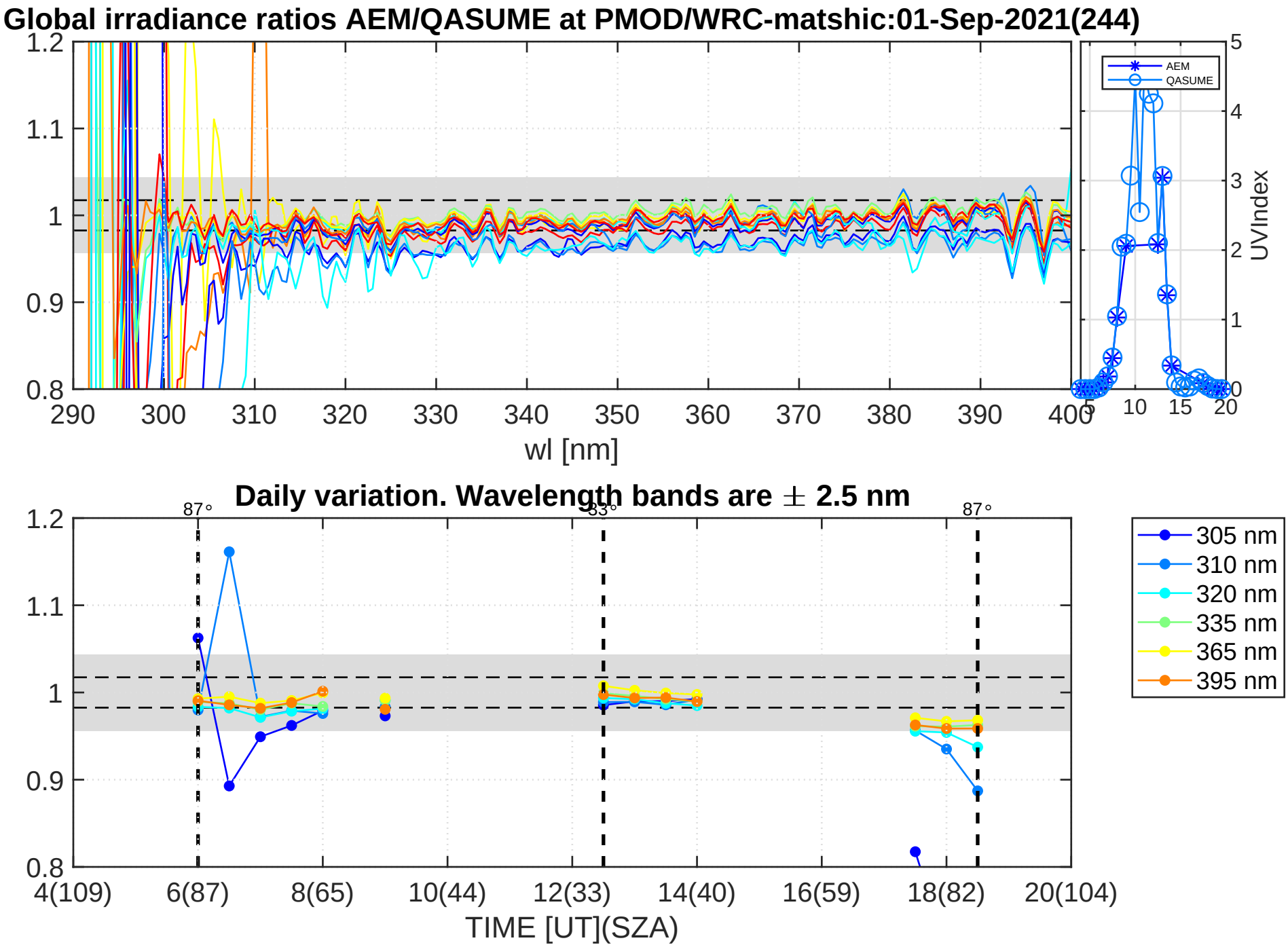
References:

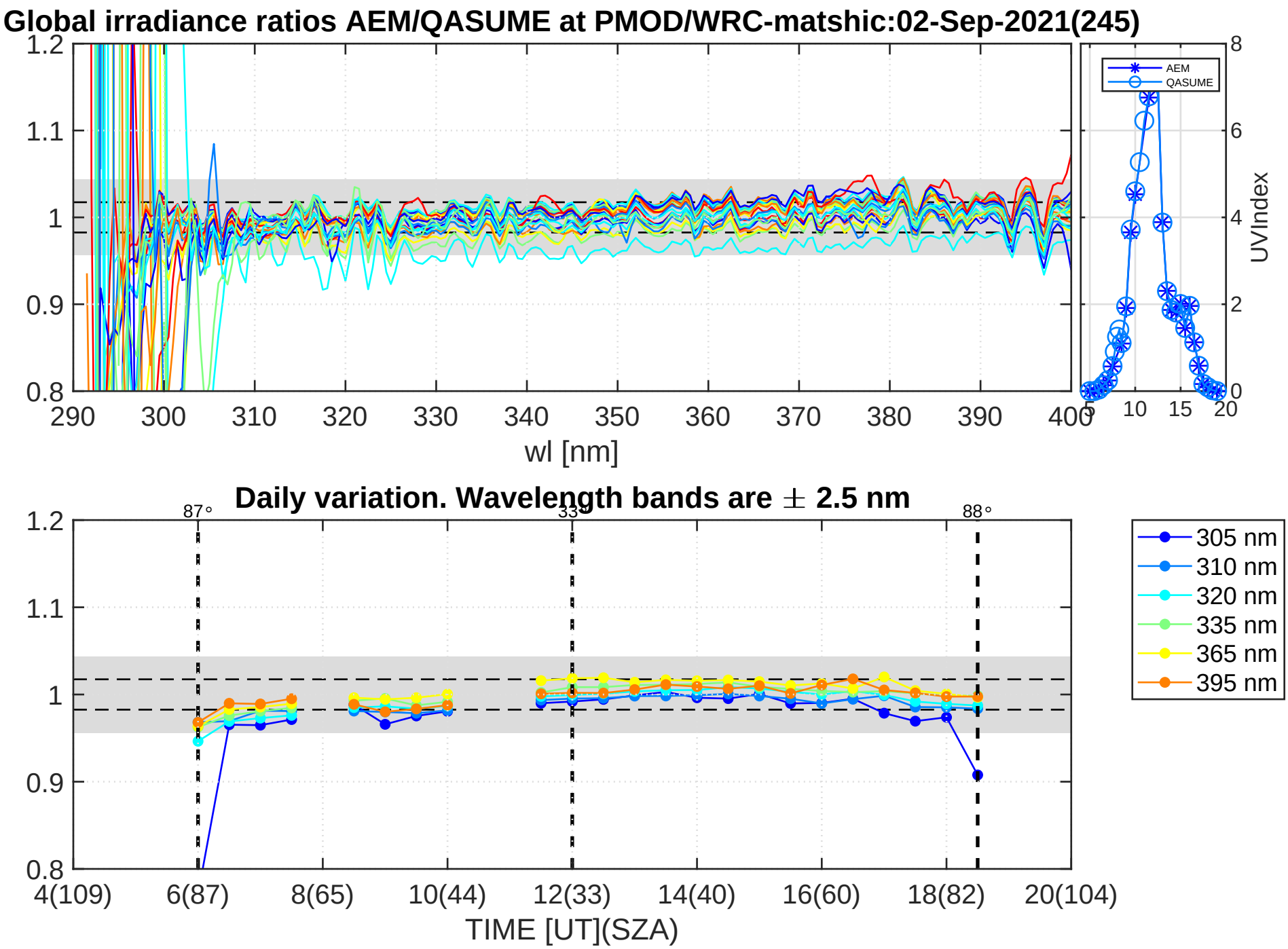
Gröbner, J., Kröger, I., Egli, L., Hülsen, G., Riechelmann, S., and Sperfeld, P.: The high-resolution extraterrestrial solar spectrum (QASUMEFTS) determined from ground-based solar irradiance measurements, Atmos. Meas. Tech., 10, 3375-3383, https://doi.org/10.5194/amt-10-3375-2017, 2017.

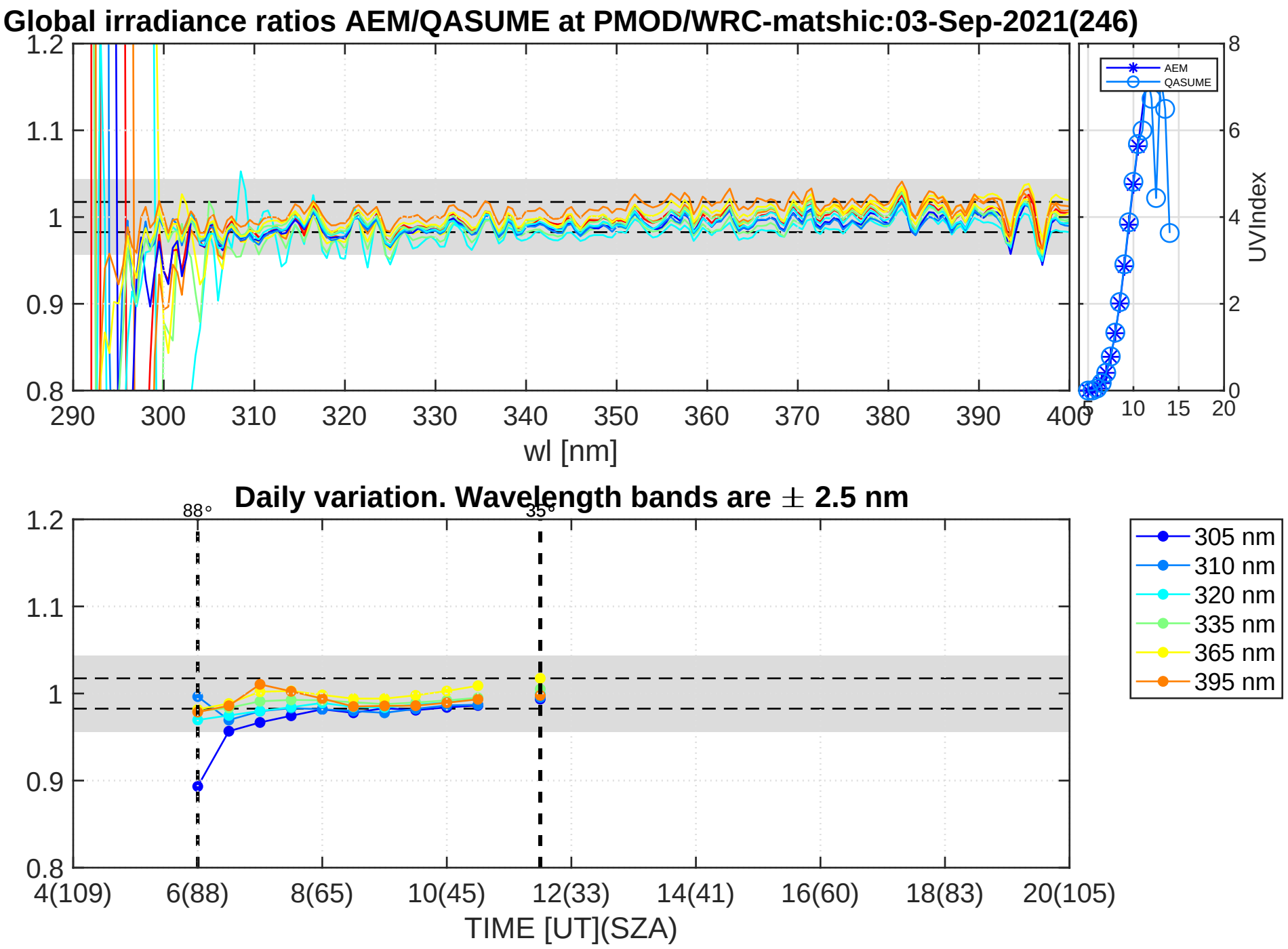

UV Index Madrid, September 2021
QASUME
AEM
UV Index
Day of Year
0
1
2
3
4
5
6
7
8
243
243.5
244
244.5
245
245.5
246
246.5
247

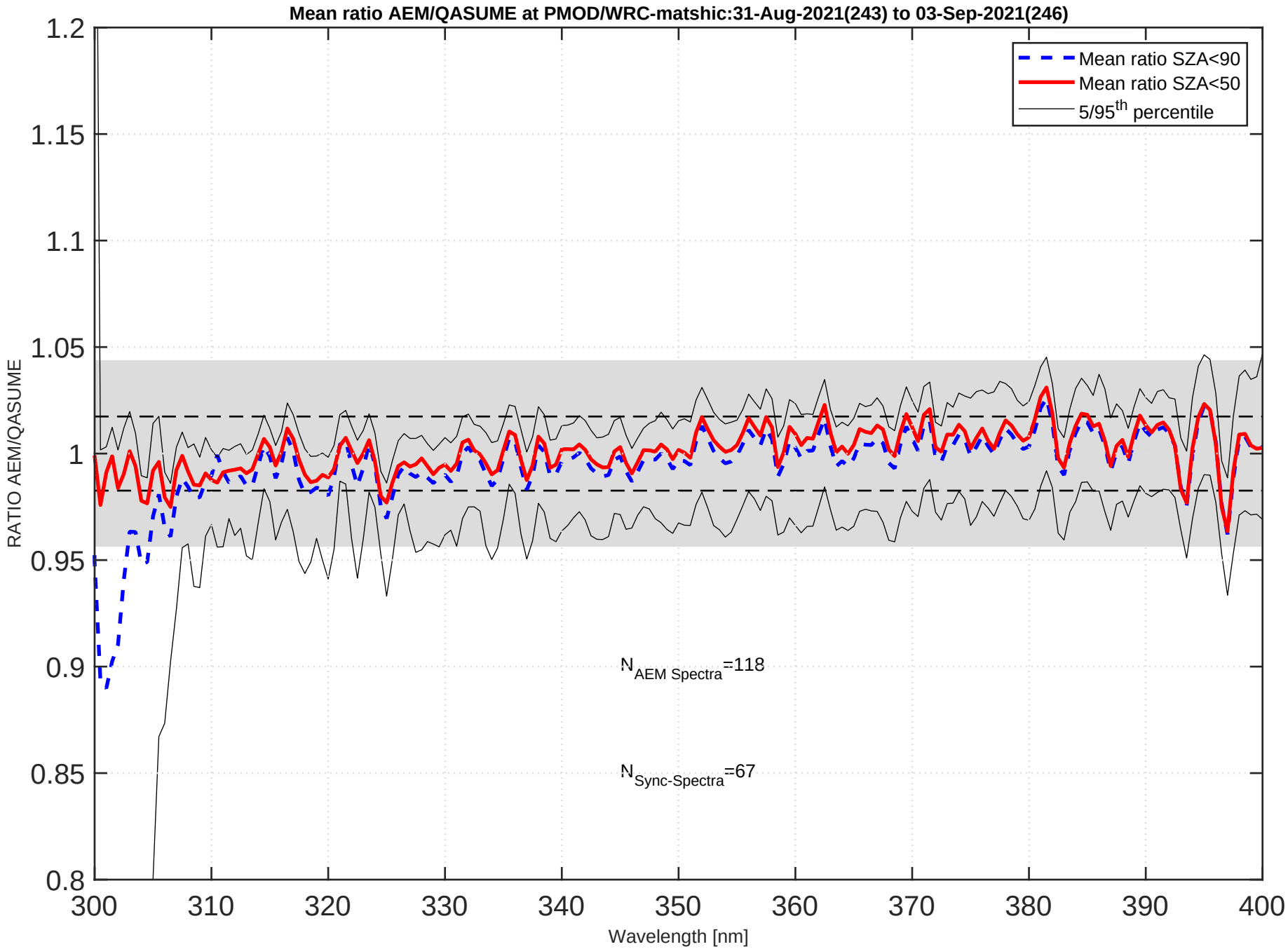

Global irradiance ratios AEM/QASUME at PMOD/WRC-matshic:31-Aug-2021(243) to 03-Sep-2021(246)
305 nm
310 nm
320 nm
335 nm
365 nm
395 nm
RATIO AEM/QASUME
1.2
1.15
1.1
1.05
1
0.95
0.9
0.85
0.8
243
244
245
246
0
12
0
12
0
12
0
12
0
TIME [UT] ON DAYS: [243 244 245 246]

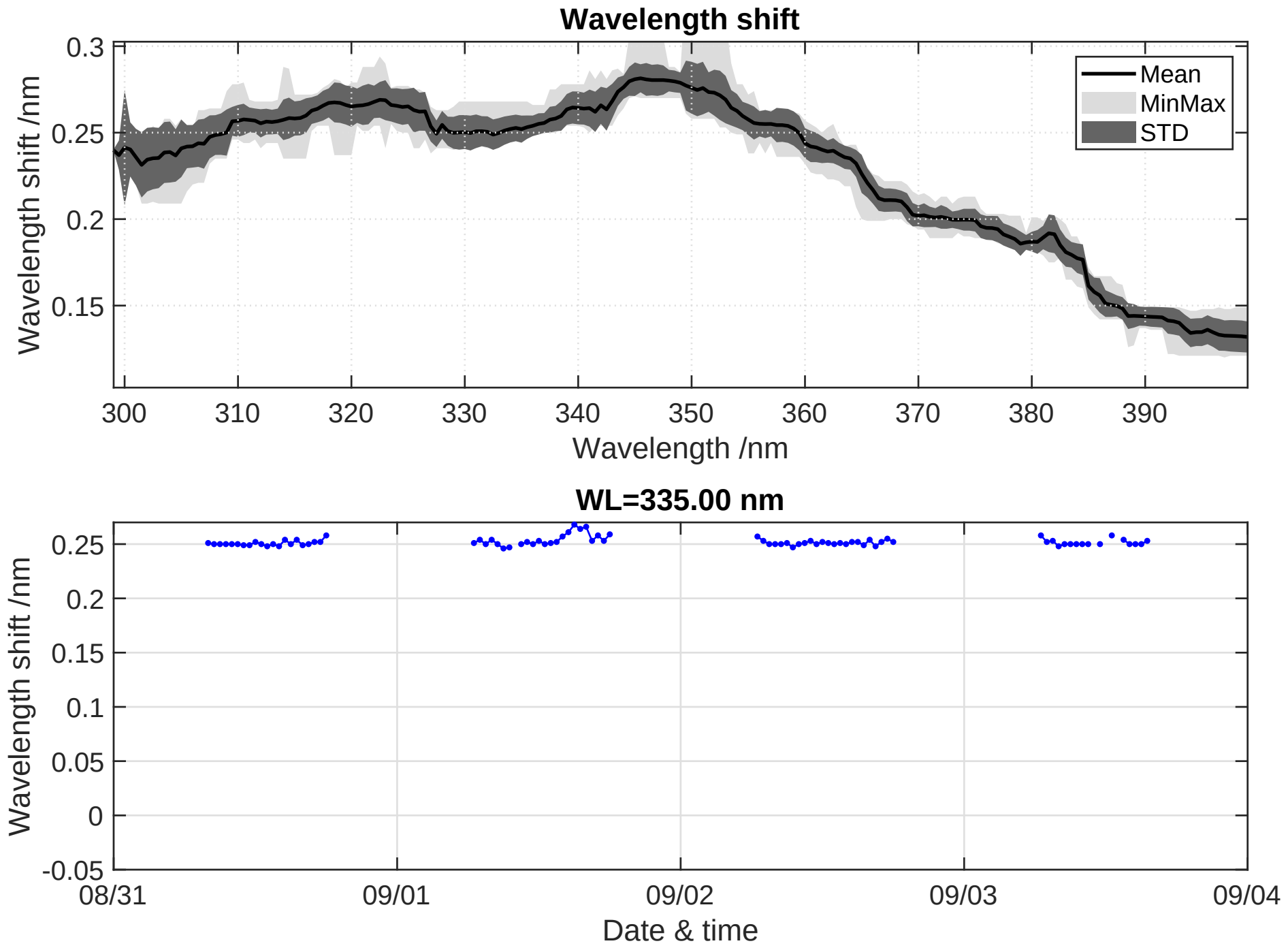

Global irradiance ratios AEM/QASUME at PMOD/WRC-matshic:31-Aug-2021(243)
1.2
1.1
1
0.9
0.8
290
300
310
320
330
340
350
360
370
380
390
400
wl [nm]
AEM
QASUME
8
6
4
2
0
5
10
15
UVIndex
Daily variation. Wavelength bands are ± 2.5 nm
57°
38°
85°
4(97)
6(77)
8(57)
10(42)
12(39)
14(51)
16(70)
18(91)
TIME [UT](SZA)
305 nm
310 nm
320 nm
335 nm
365 nm
395 nm

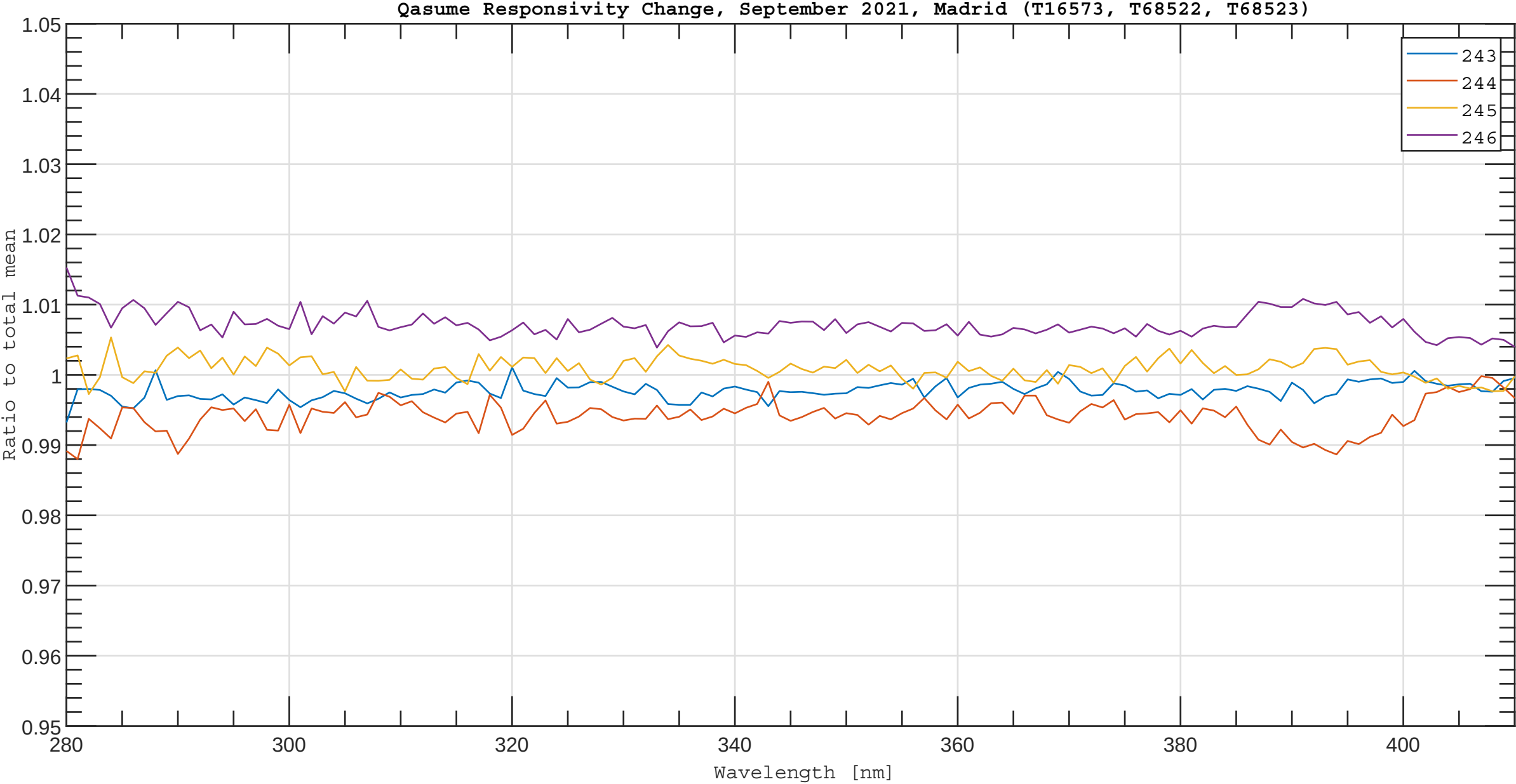

Global irradiance ratios AEM/QASUME at PMOD/WRC-matshic:01-Sep-2021(244)
1.2
1.1
1
0.9
0.8
290
300
310
320
330
340
350
360
370
380
390
400
wl [nm]
AEM
QASUME
5
4
3
2
1
0
UVIndex
5
10
15
20
Daily variation. Wavelength bands are ± 2.5 nm
87°
33°
87°
1.2
1.1
1
0.9
0.8
4(109)
6(87)
8(65)
10(44)
12(33)
14(40)
16(59)
18(82)
20(104)
TIME [UT](SZA)
305 nm
310 nm
320 nm
335 nm
365 nm
395 nm


Global irradiance ratios AEM/QASUME at PMOD/WRC-matshic:02-Sep-2021(245)
1.2
1.1
1
0.9
0.8
290
300
310
320
330
340
350
360
370
380
390
400
wl [nm]
AEM
QASUME
8
6
4
2
0
5
10
15
20
UVIndex
Daily variation. Wavelength bands are ± 2.5 nm
87°
33°
88°
4(109)
6(87)
8(65)
10(44)
12(33)
14(40)
16(60)
18(82)
20(104)
TIME [UT](SZA)
305 nm
310 nm
320 nm
335 nm
365 nm
395 nm


Global irradiance ratios AEM/QASUME at PMOD/WRC-matshic:03-Sep-2021(246)
1.2
1.1
1
0.9
0.8
290
300
310
320
330
340
350
360
370
380
390
400
wl [nm]
AEM
QASUME
8
6
4
2
0
5
10
15
20
UVIndex
Daily variation. Wavelength bands are ± 2.5 nm
88°
35°
4(109)
6(88)
8(65)
10(45)
12(33)
14(41)
16(60)
18(83)
20(105)
TIME [UT](SZA)
305 nm
310 nm
320 nm
335 nm
365 nm
395 nm


Mean ratio AEM/QASUME at PMOD/WRC-matshic:31-Aug-2021(243) to 03-Sep-2021(246)
Mean ratio SZA<90
Mean ratio SZA<50
5/95th percentile
RATIO AEM/QASUME
Wavelength [nm]
N AEM Spectra=118
N Sync-Spectra=67
1.2
1.15
1.1
1.05
1
0.95
0.9
0.85
0.8
300
310
320
330
340
350
360
370
380
390
400


Wavelength shift
Mean
MinMax
STD
Wavelength shift /nm
0.3
0.25
0.2
0.15
300
310
320
330
340
350
360
370
380
390
Wavelength /nm
WL=335.00 nm
Wavelength shift /nm
0.25
0.2
0.15
0.1
0.05
0
-0.05
08/31
09/01
09/02
09/03
09/04
Date & time


Qasume Responsivity Change, September 2021, Madrid (T16573, T68522, T68523)
Ratio to total mean
Wavelength [nm]
243
244
245
246
1.05
1.04
1.03
1.02
1.01
1
0.99
0.98
0.97
0.96
0.95
280
300
320
340
360
380
400


BREWER