Protocol of the intercomparison at LKO, Arosa, Switzerland on July 16 to 25, 2012 with the travelling reference spectroradiometer QASUME from PMOD/WRC

Report prepared by Gregor Hülsen

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The purpose of the visit was the comparison of spectral global solar irradiance measurements between the 9 spectrophotometers participating in the 7th Regional Brewer Calibration Center – Europe (RBCC-E) Campaign (see Table 1) and the travel reference spectroradiometer QASUME at the Lichtklimatische Observatorium (LKO) in Arosa; Latitude 46.78 N, Longitude 9.68 E and altitude 1846 m.a.s.l.. The horizon of the measurement site is free down to ~80° solar zenith angle (SZA).
Measurements between 4:00 UT and 19:00 UT have been analysed.

QASUME arrived at LKO in the morning of July 16, 2012. The spectroradiometer was installed in line to the Brewer spectrophotometers with the entrance optic of QASUME between 2 and 10 m away from the other instruments. The measurement campaign lasted seven days, from July 16 to the morning of July 25; the core UV comparison days were July 22 till 24.

QASUME was calibrated several times during the intercomparison period using a portable calibration system. Two lamps (T68522 and 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 23.9±0.3 °C. The diffuser head was heated to a temperature of 28.5±1.6 °C.
The wavelength shifts relative to an extraterrestrial spectrum as retrieved from the SHICRivm analysis were between ±50 pm in the spectral range 290 to 400 nm.

Table 1: Participating Brewer spectrophotometers; 5 single and 4 double monochromators.

Instrument ID	Institution	Operator	Country
#017-MKII (No Data)	IOS	Ken Lamb	Canada
#040-MKII	MeteoSwiss	Herbert Schill	Switzerland
#072-MKII	MeteoSwiss	Herbert Schill	Switzerland
#156-MKIII	MeteoSwiss	Herbert Schill	Switzerland
#066-MKIV (AAB)	Arpa Aosta	Henri Diemoz	Italy
#067-MKIV	Uni. Rome	Giuseppe Casale	Italy
#158-MKIII	K&Z	Clive Lee	Netherlend
#163-MKIII (ISQ)	PMOD/WRC	Julian Gröbner	Switzerland
#185-MKIII (IZ3)	INM IZANA	Alberto Redondas	Spain

Protocol:

The measurement protocol was to measure one solar irradiance spectrum every 30 minutes from 290 to 400 nm, every 0.5 nm, and 3 seconds between each wavelength increment.

DOY	Date	DAY	Weather	Comment
198	16-Jul	Monday	Mostly clear sky with few cirrus clouds	Installed at 11:00 UT
199	17-Jul	Tuesday	Mix of sun & clouds	Calibrated: 10:28 (T68523) Calibrated: 10:48 (T68522)
200	18-Jul	Wednesday	Mostly clear sky with few cirrus clouds	12-16 UT: Cooling Problem
201	19-Jul	Thursday	Mix of sun & clouds Rain shower (afternoon)	
202	20-Jul	Friday	Mix of sun & clouds Foog in the morning	Calibrated: 9:32 (T68523)
203	21-Jul	Saturday	Mix of sun & clouds Rain during the day	(No Qasume Operator) Qasume Com.Error
204	22-Jul	Sunday	Mix of sun & clouds Rain during the day	UV Days Cooling Problem
205	23-Jul	Monday	Mostly clear sky	UV Days Calibrated: 6:11 (T68523)
206	24-Jul	Tuesday	Clear sky (Morning) Mix of sun & clouds	Calibrated: 9:12 (T68523)
207	25-Jul	Wednesday	Clear sky (Morning) Mix of sun & clouds Rain started 9:30	Calibrated: 5:45 (T68523) Calibrated: 6:13 (T68522) End of Campaign: 10:00 UT

Results:

In total 35 to 82 synchronised simultaneous spectra from QASUME and the Brewer spectrophotometers are available from the measurement period. Measurements between 4:00 and 19:00 UT have been analysed (SZA smaller than 90°).

Table 2: Mean values of the ratio Brewer/QASUME (305 – 320 nm), the diurnal variability and the wavelength shifts.

Instrument ID	Brewer to QASUME [%]	Diurnal variability [%]	Wavelength shift [pm]
#017	NaN	NaN	NaN
#040	-5	±3	-20 .. +40
#072	-6	±4	-20 .. +40
#156	-4	±5	-50 .. +50
#066_AAB	-3	±2	-20 .. +50
#067	5	±2	-50 .. +50
#158	-5	±4	-70 .. +50
#163_ISQ	NaN	NaN	NaN
#185_IZ3	-4	±3	-30 .. +30

Remarks:

1. The first day of the intercomparison was dedicated to the setup and training phase. The official “UV-days” where 22 and 24 July (204-206). However, synchronized UV scans are also available from the start of the campaign.
2. Although different calibrations and measurements were performed during the campaign, traffic on the roof could be limited. Therefore only few scans are disturbed.

Specific Remarks for the individual Brewer spectrophotometer:

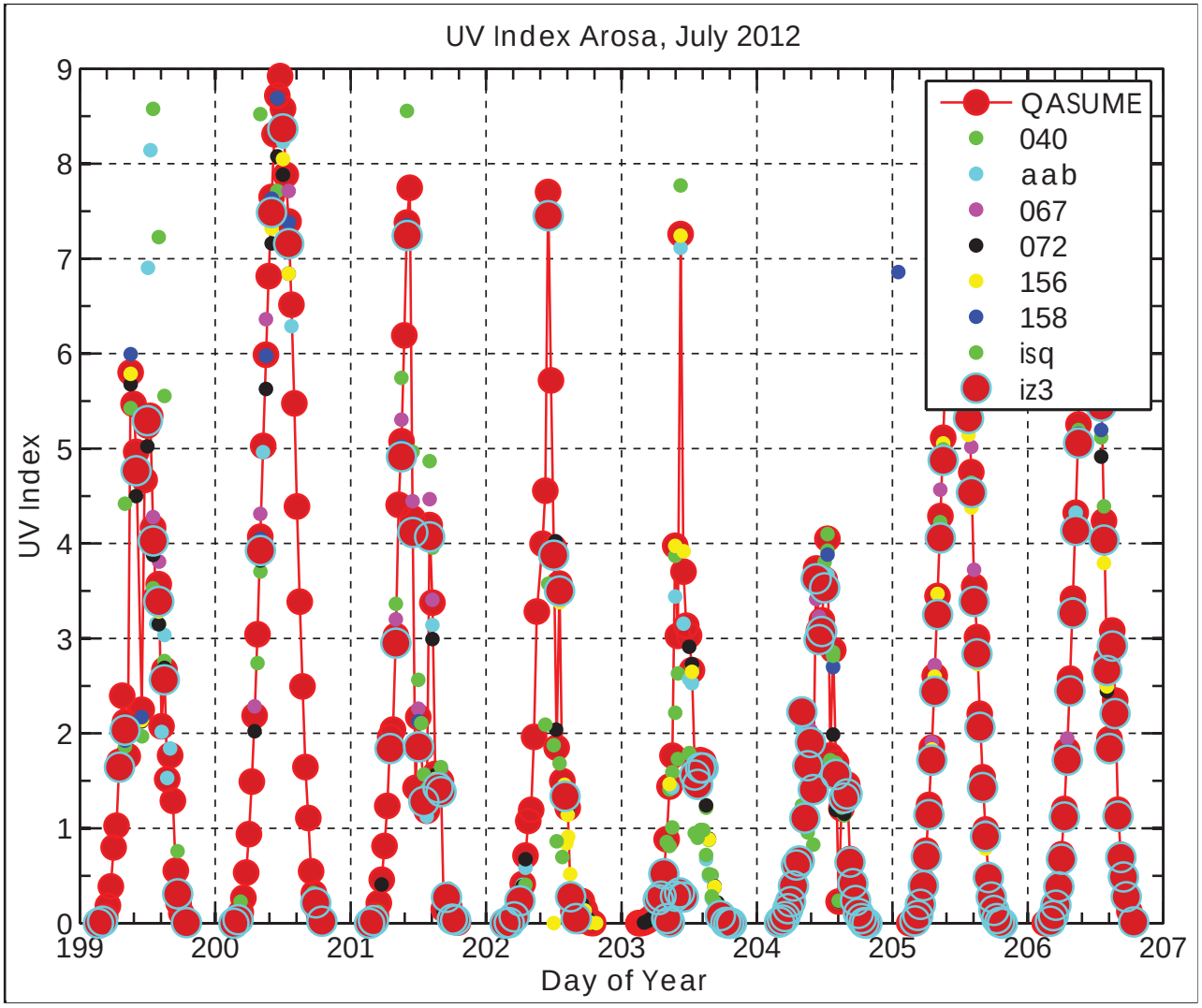
1. Brewer #017 arrived at Arosa without electronic boards and case. The optical parts (front optics and spectrometer) of this reference instrument were used for ozone calibration but not for UV measurements.
2. Brewer #066 (AAB) and #158 show various spikes in the data during the campaign.
3. Brewer #156: The largest contribution to its measurement uncertainty arises from its exceptional large temperature dependence (see discussion on the next page). A temperature correction of the data is recommended.
4. Brewer #163 (ISQ) malfunctioned during the campaign. No reliable UV data could be recorded.
5. Brewer #185 (IZ3): On clear sky days (see for example DOY 205 and 206) the cosine error of the input optic of this instrument dominates its measurement uncertainty.

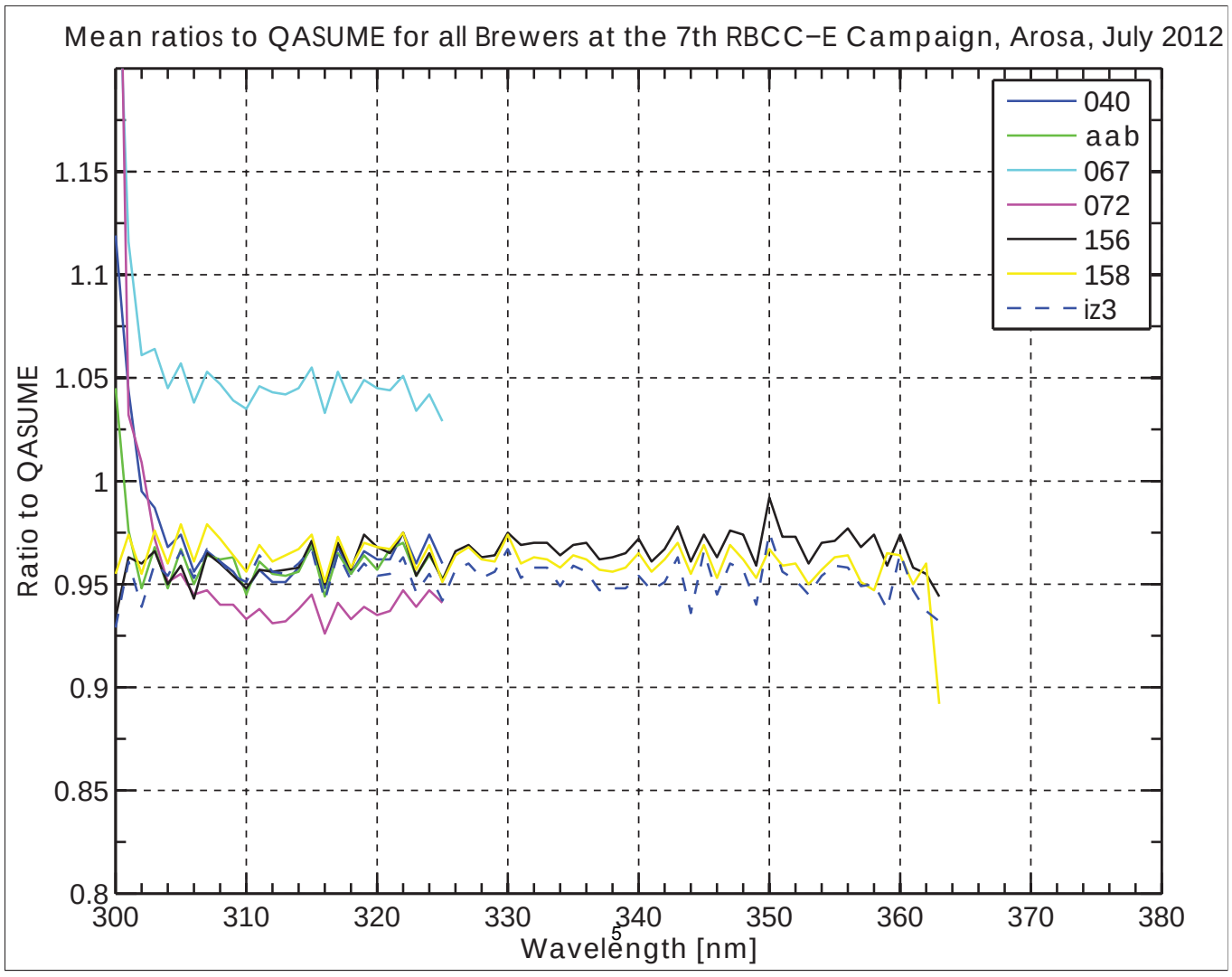
Brewer Temperature dependence:

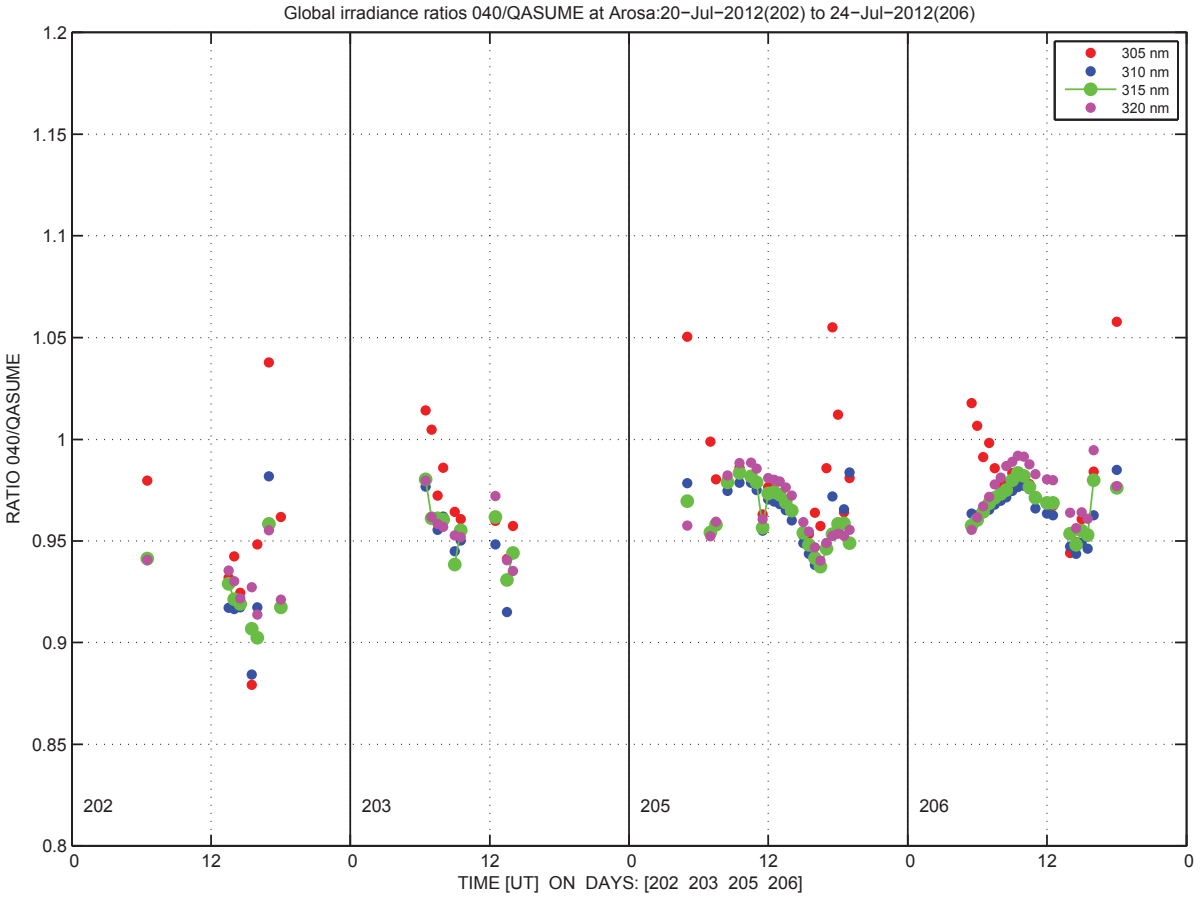
The standard Brewer global UV measurement procedure does not take into account the dependence of the Brewer spectral responsibility to ambient temperature. However several studies have shown, that Brewer spectrophotometers have a temperature dependence which can be as large as 0.9%/K and which depends on wavelength (Cappellani, F., and C. Kochler (2000), Temperature effects correction in a Brewer MKIV spectrophotometer for solar UV measurements, J. Geophys. Res., 105(D4), 4829–4831; Weatherhead, E., et al. (2001), Temperature dependence of the Brewer ultraviolet data, J. Geophys. Res., 106(D24), 34,121–34,129).
At Arosa, due to the high diurnal temperature variations, the temperature dependence of the Brewer spectrophotometers has therefore a significant influence on the global UV measurements as can be seen in the respective ratios relative to the QASUME spectroradiometer which is temperature stabilised. An example can be seen with Brewer #156 on the clear sky day 205 and 206 (see also protocol of the 3rd RBBC-E, Arosa 2008).

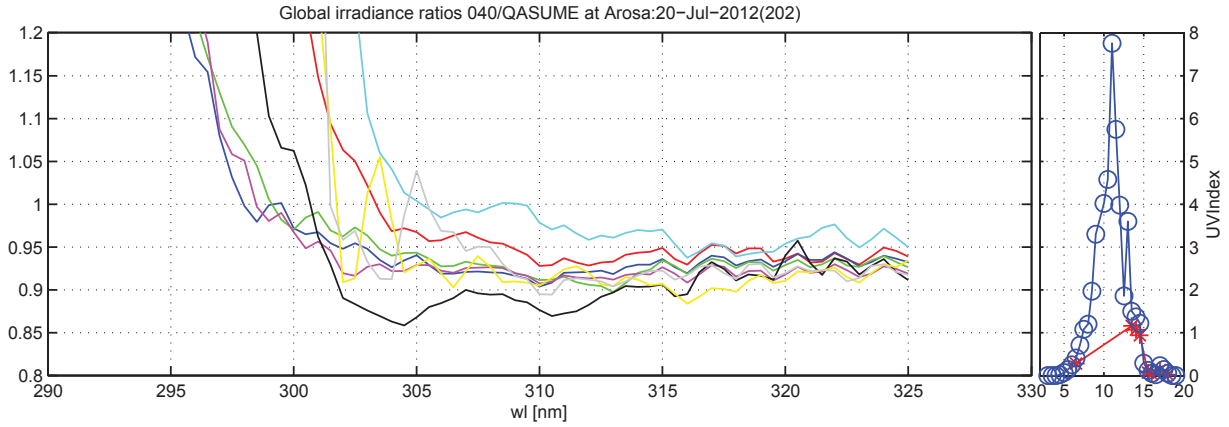
Recommendations:

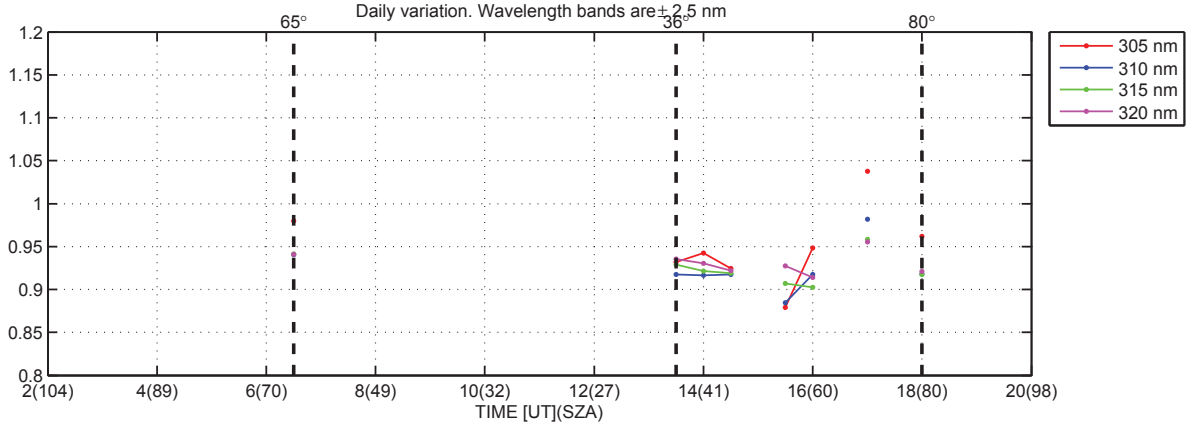
The variabilities observed between individual Brewer spectrophotometers relative to the QASUME spectroradiometer are due to ambient temperature variations on the one hand (see above paragraph), and to angular response errors which were not accounted for (See for example Gröbner, J., Improved entrance optic for global irradiance measurements with a Brewer spectrophotometer, Applied Optics, 42, 3516-3521, 2003). While a reliable correction of angular response errors requires the modification of the Brewer entrance optic, the temperature dependence can be corrected by applying a suitable spectral temperature correction to global UV measurements. This function should be determined individually for every Brewer using a measurement procedure as described in the refereed literature (see references).

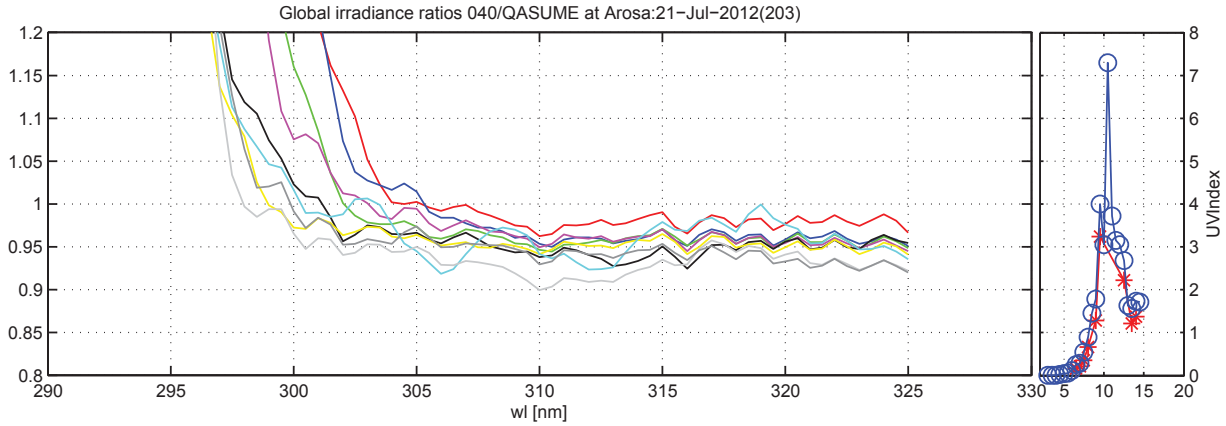

UV Index Arosa, July 2012
UV Index
Day of Year
QASUME
040
aab
067
072
156
158
isq
iz3

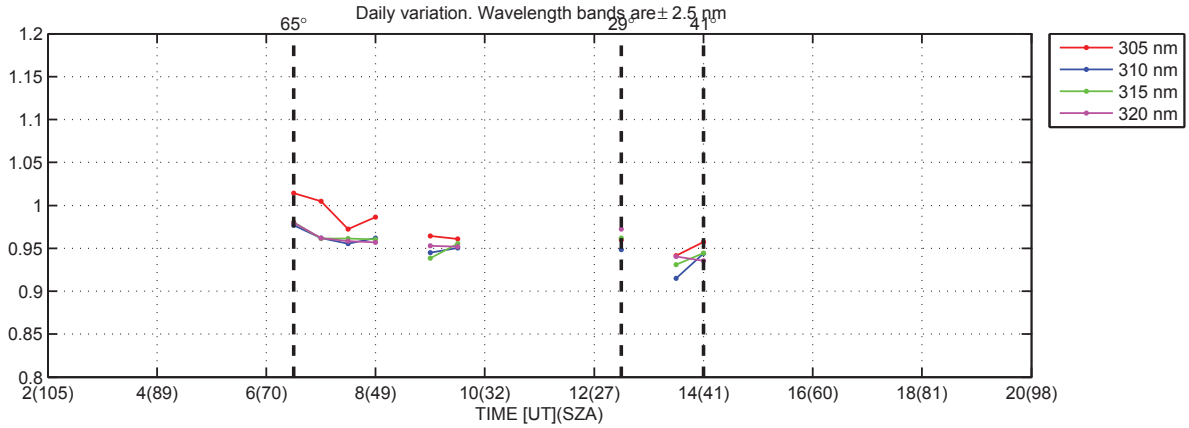

Mean ratios to QASUME for all Brewers at the 7th RBCC−E Campaign, Arosa, July 2012
Ratio to QASUME
Wavelength [nm]
040
aab
067
072
156
158
iz3

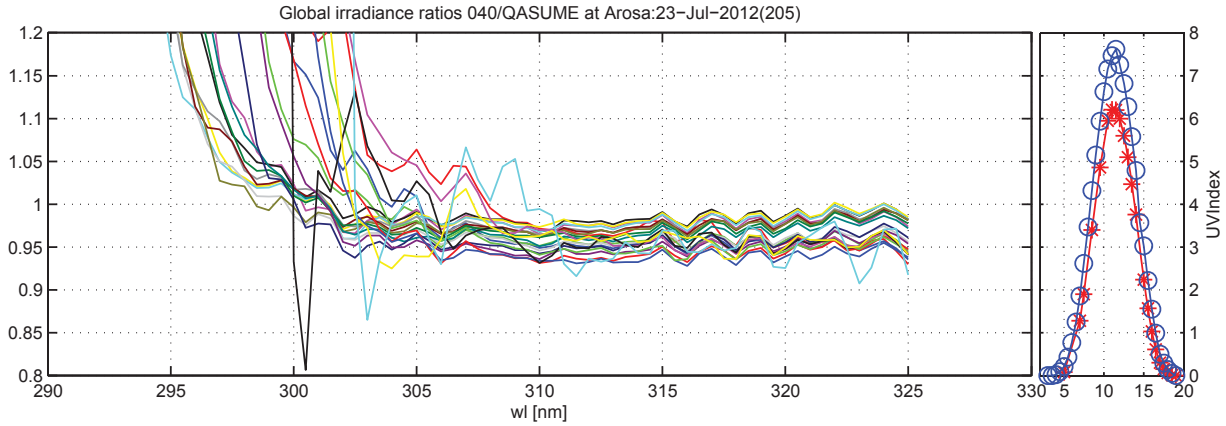

Global irradiance ratios 040/QASUME at Arosa:20−Jul−2012(202) to 24−Jul−2012(206)
RATIO 040/QASUME
TIME [UT] ON DAYS: [202 203 205 206]
305 nm
310 nm
315 nm
320 nm
202
203
205
206

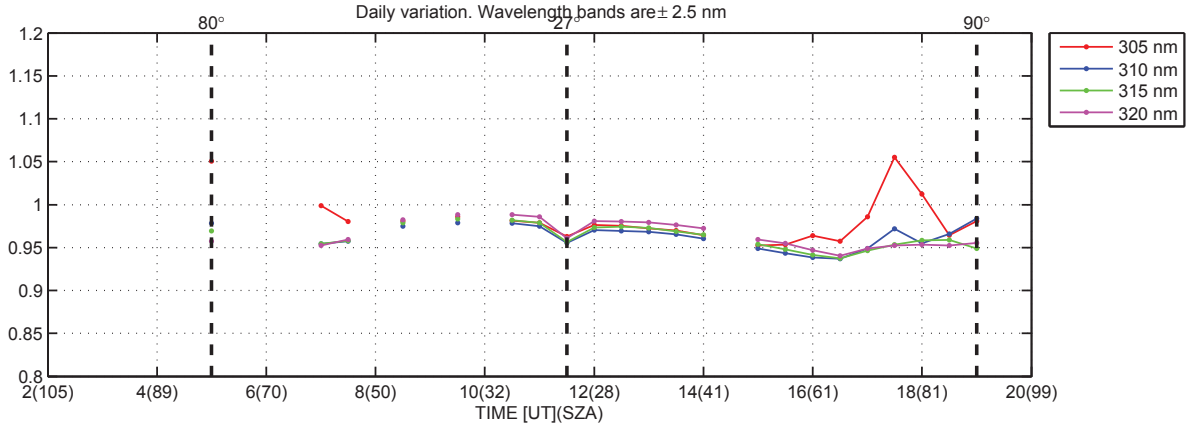

Global irradiance ratios 040/QASUME at Arosa:20−Jul−2012(202)
wl [nm]
UVIndex

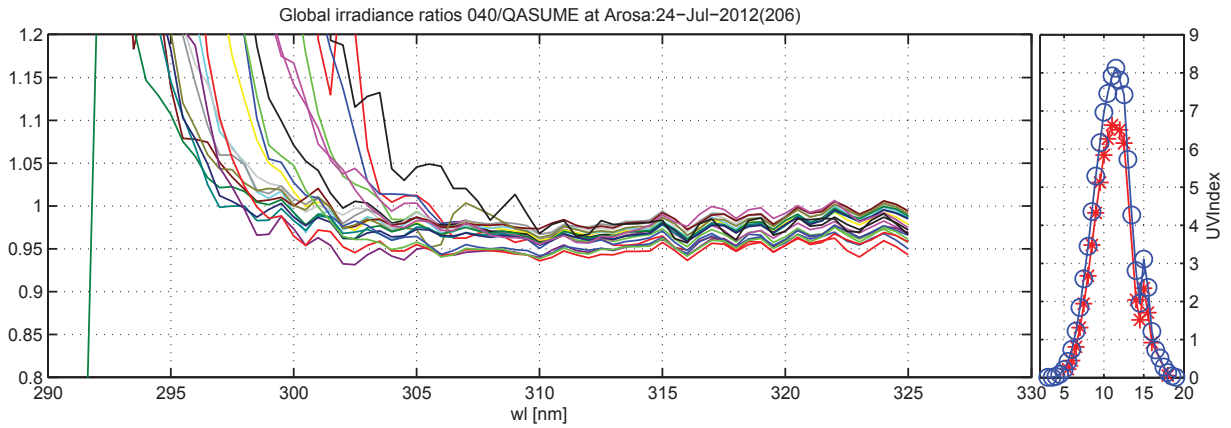

Daily variation. Wavelength bands are ± 2.5 nm
65°
36°
80°
TIME [UT](SZA)
2(104)
4(89)
6(70)
8(49)
10(32)
12(27)
14(41)
16(60)
18(80)
20(98)
305 nm
310 nm
315 nm
320 nm

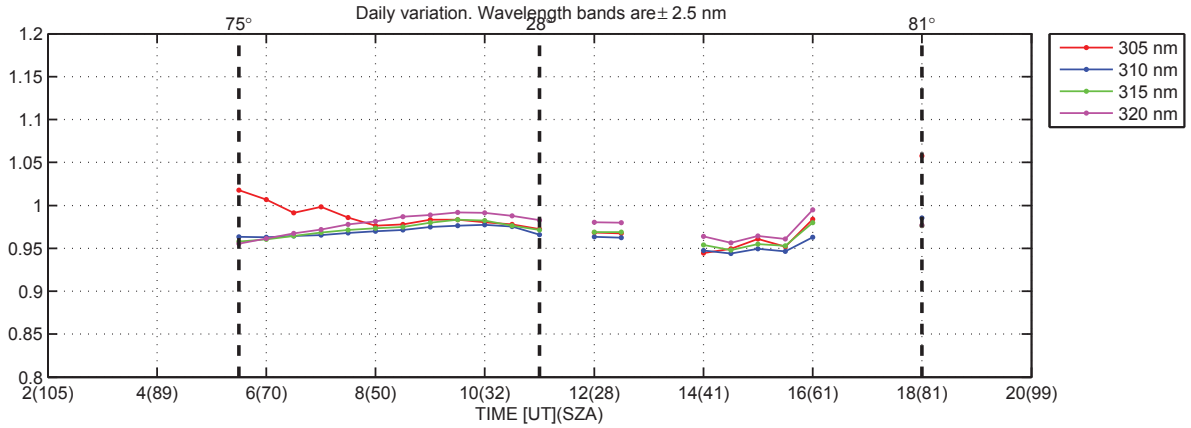

Global irradiance ratios 040/QASUME at Arosa:21−Jul−2012(203)
wl [nm]
UVIndex

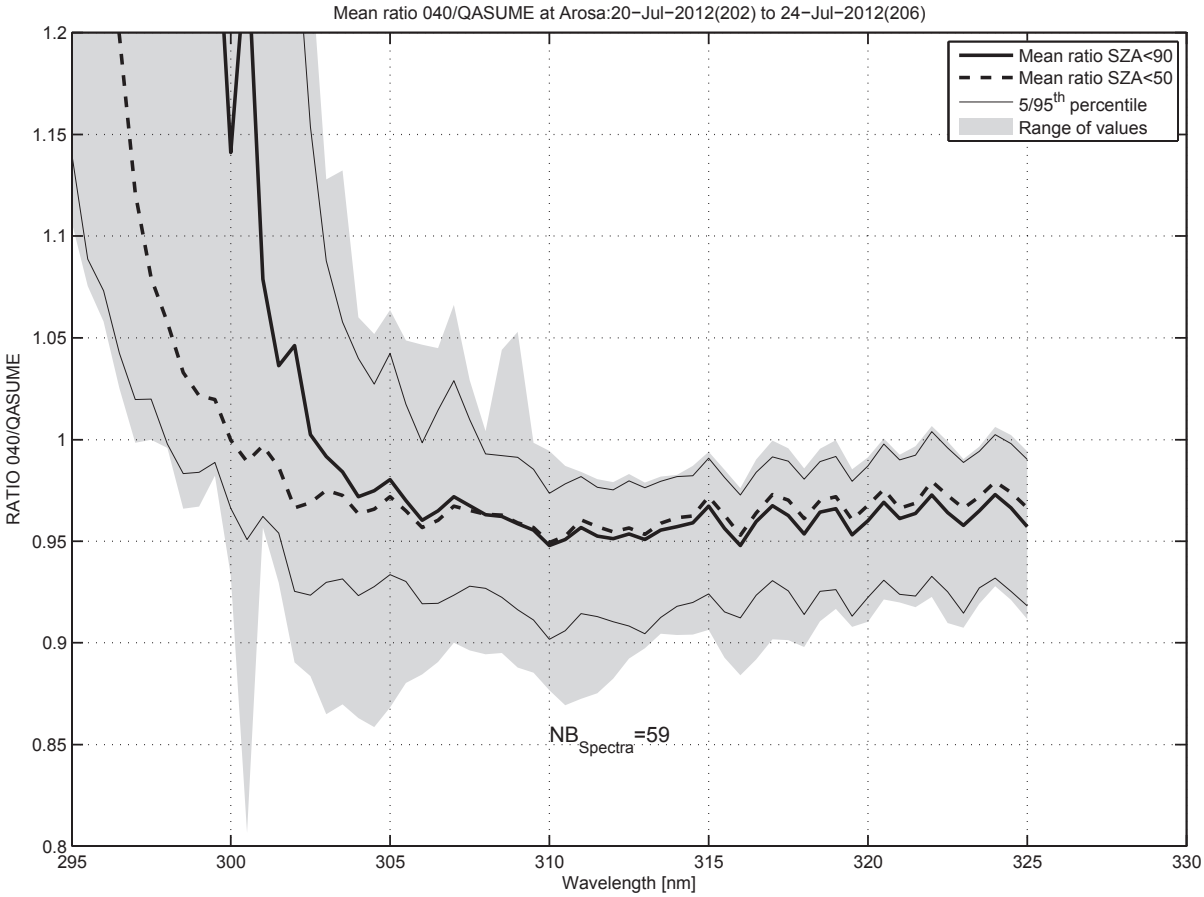

Daily variation. Wavelength bands are± 2.5 nm
65°
29°
41°
TIME [UT](SZA)
305 nm
310 nm
315 nm
320 nm

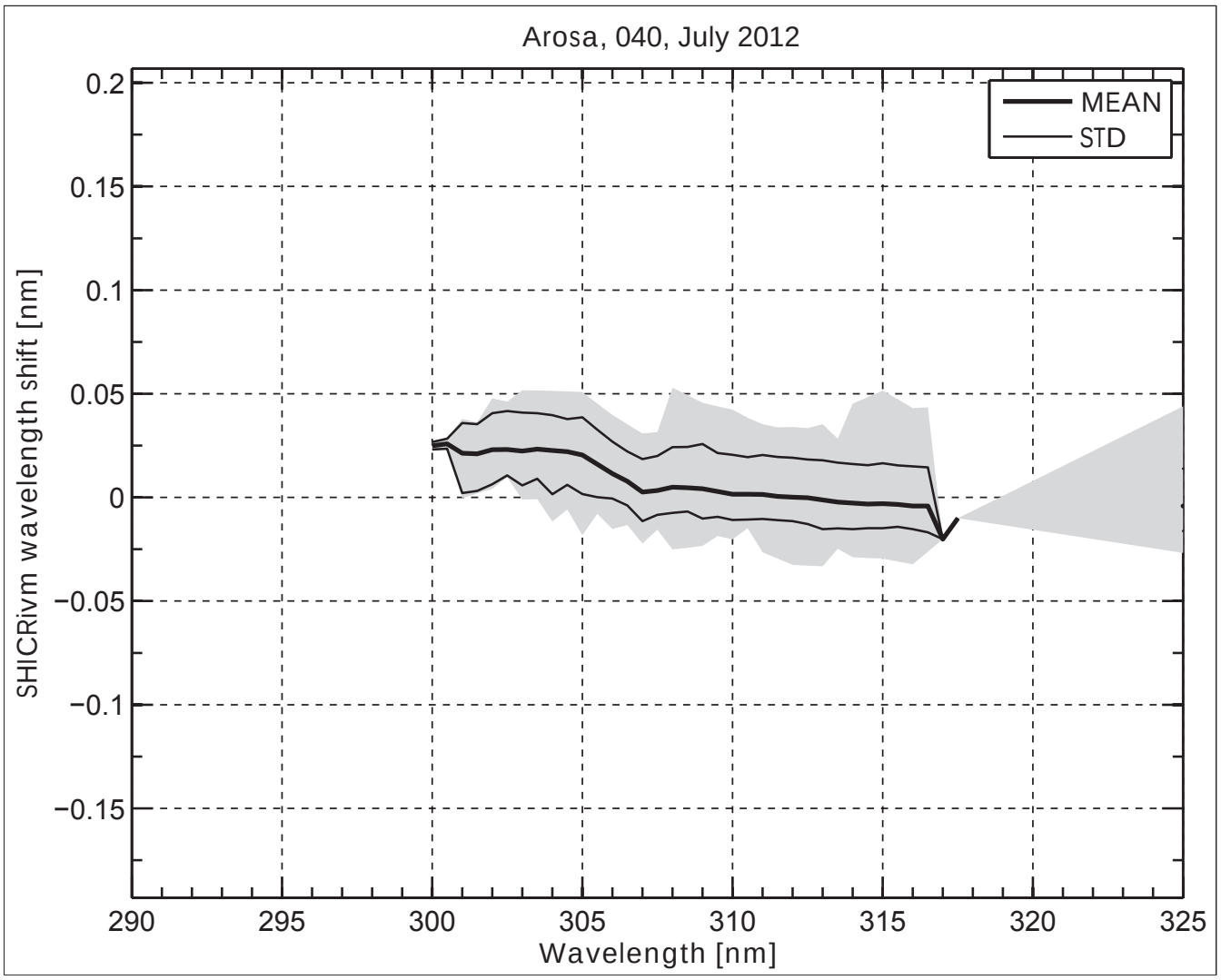

Global irradiance ratios 040/QASUME at Arosa:23−Jul−2012(205)
wl [nm]
UVIndex

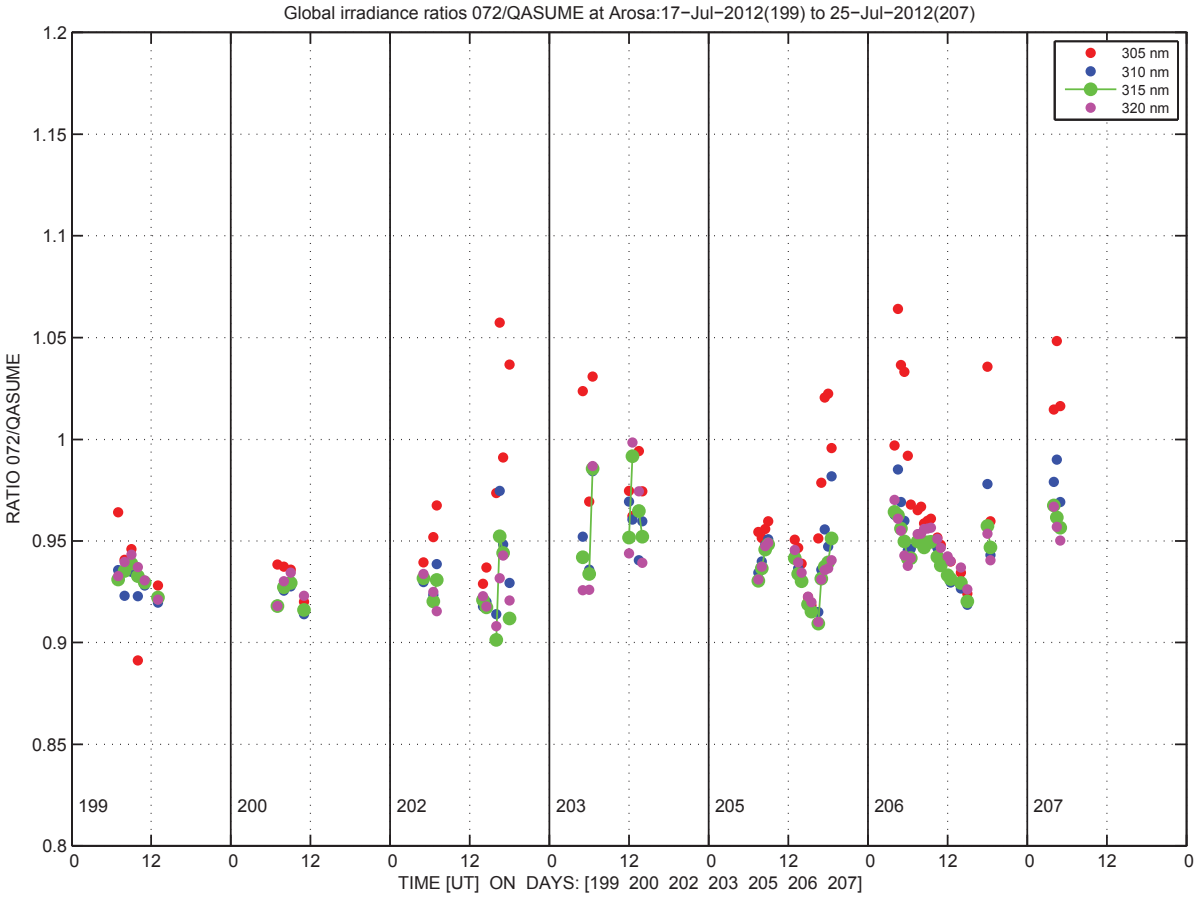

Daily variation. Wavelength bands are± 2.5 nm
80°
27°
90°
TIME [UT](SZA)
305 nm
310 nm
315 nm
320 nm

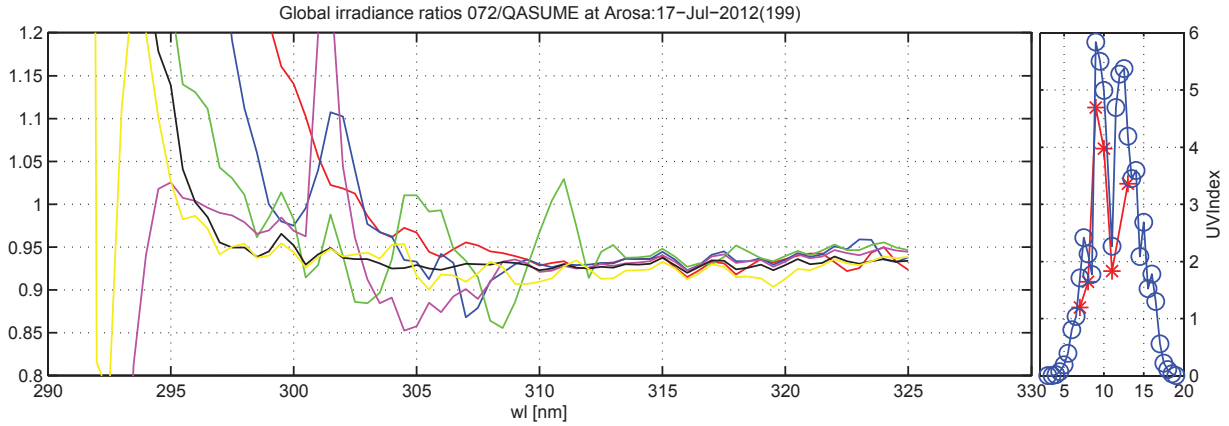

Global irradiance ratios 040/QASUME at Arosa:24−Jul−2012(206)
wl [nm]
UVIndex

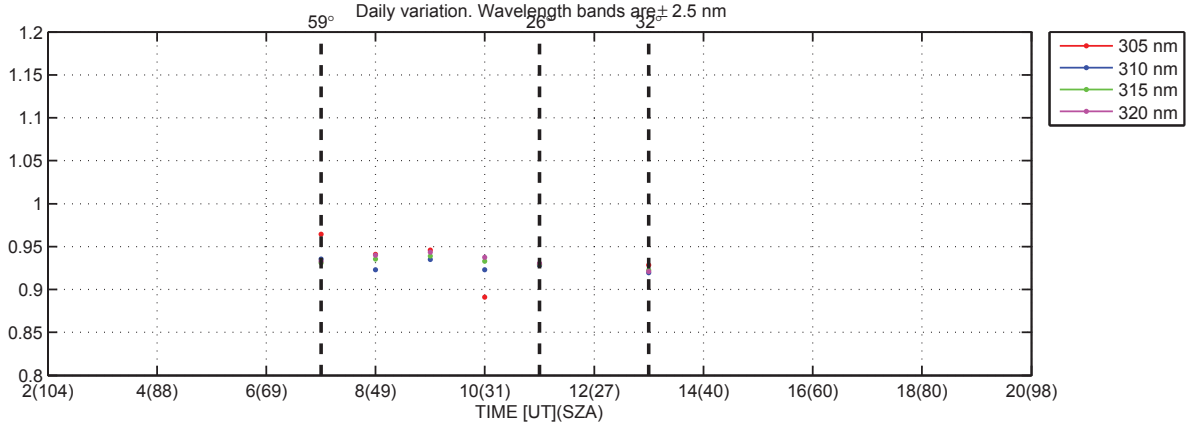

Daily variation. Wavelength bands are± 2.5 nm
75°
28°
81°
305 nm
310 nm
315 nm
320 nm
TIME [UT](SZA)

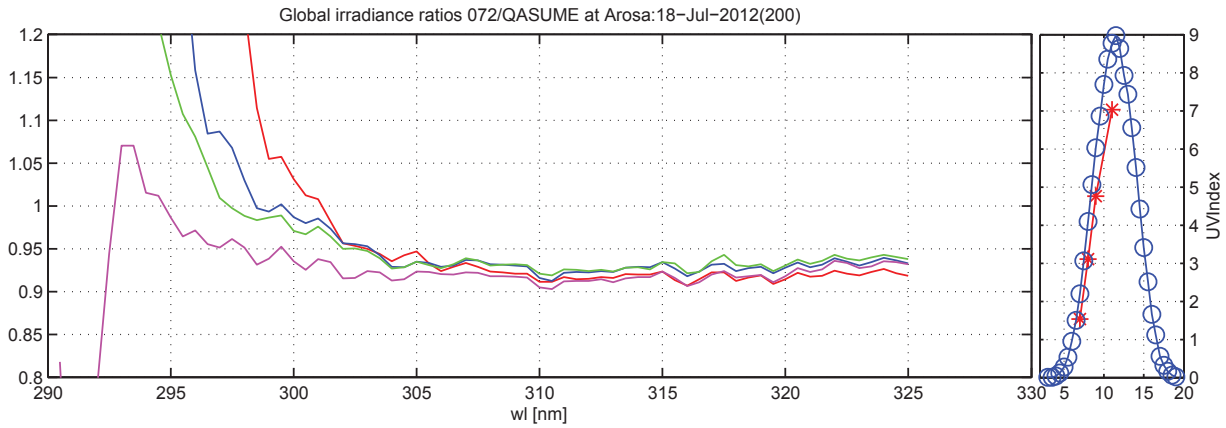

Mean ratio 040/QASUME at Arosa:20−Jul−2012(202) to 24−Jul−2012(206)
Mean ratio SZA<90
Mean ratio SZA<50
5/95th percentile
Range of values
RATIO 040/QASUME
NBSpectra=59
Wavelength [nm]

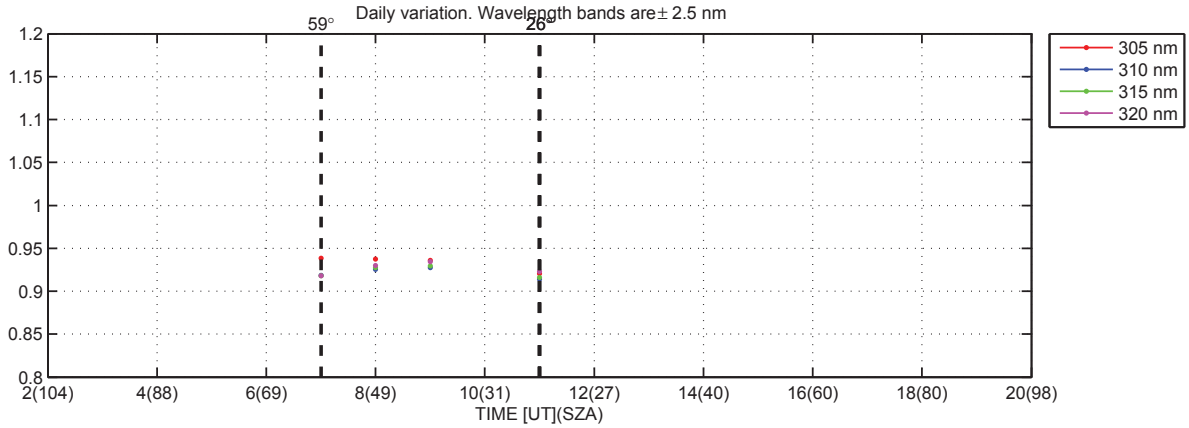

Arosa, 040, July 2012
MEAN
STD
SHICRivm wavelength shift [nm]
0.2
0.15
0.1
0.05
0
−0.05
−0.1
−0.15
290
295
300
305
310
315
320
325
Wavelength [nm]

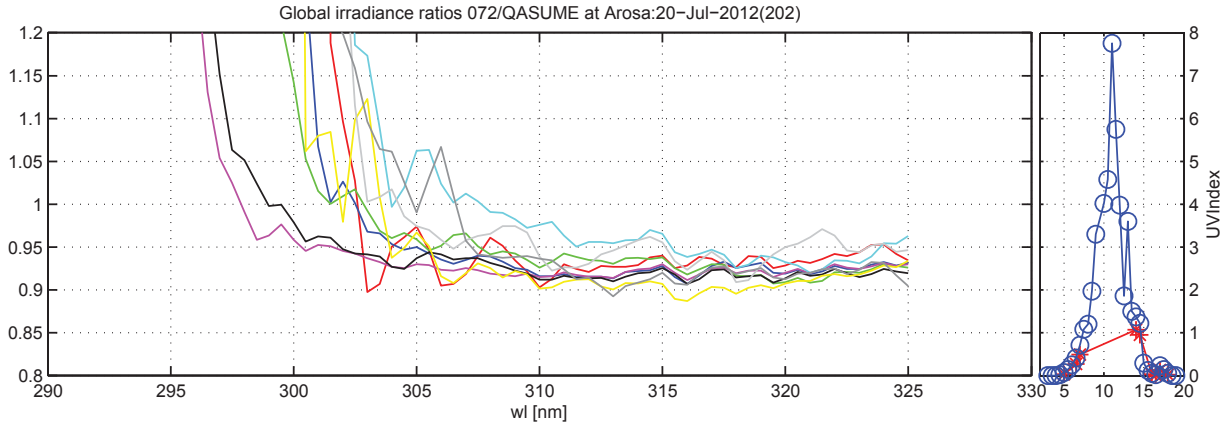

Global irradiance ratios 072/QASUME at Arosa:17−Jul−2012(199) to 25−Jul−2012(207)
RATIO 072/QASUME
TIME [UT] ON DAYS: [199 200 202 203 205 206 207]
305 nm
310 nm
315 nm
320 nm
199
200
202
203
205
206
207

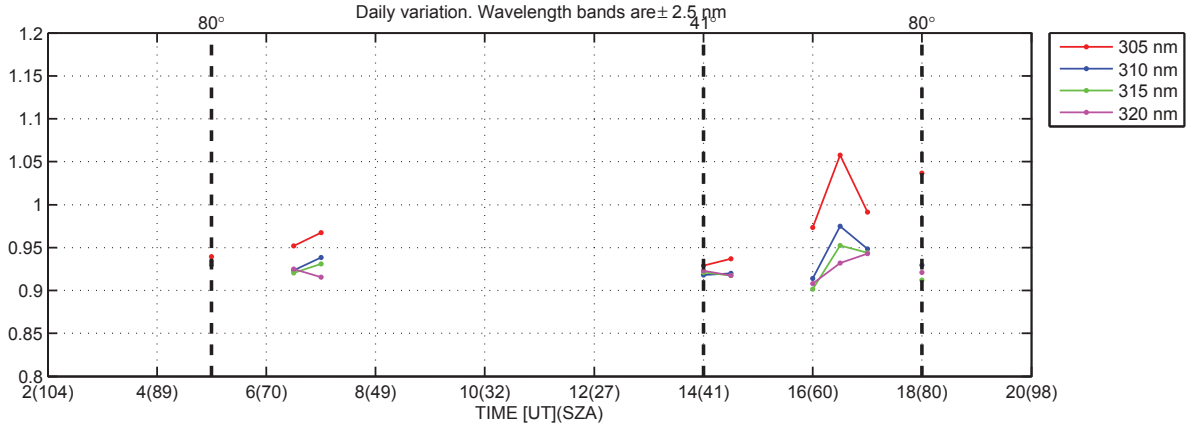

Global irradiance ratios 072/QASUME at Arosa:17−Jul−2012(199)
wl [nm]
UVIndex

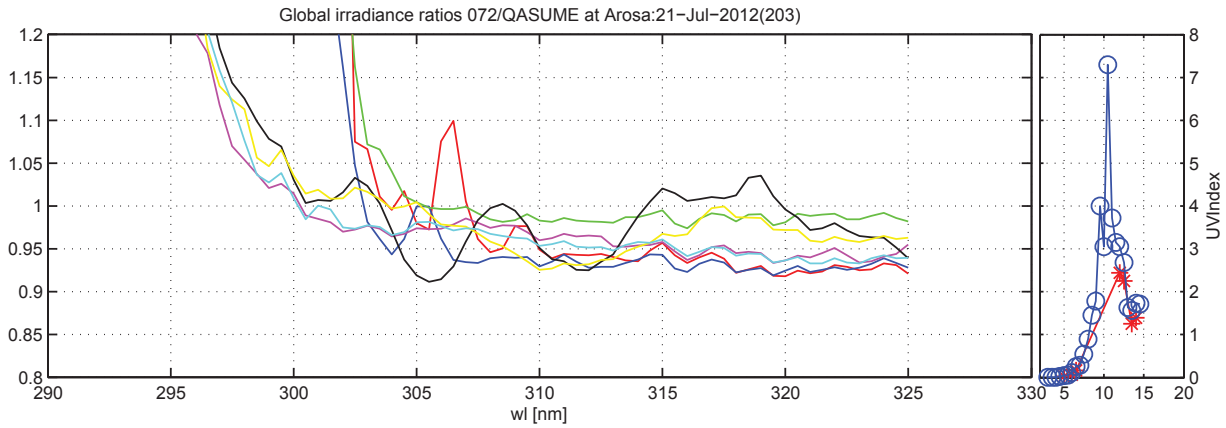

Daily variation. Wavelength bands are ± 2.5 nm
59°
26°
32°
TIME [UT](SZA)
305 nm
310 nm
315 nm
320 nm

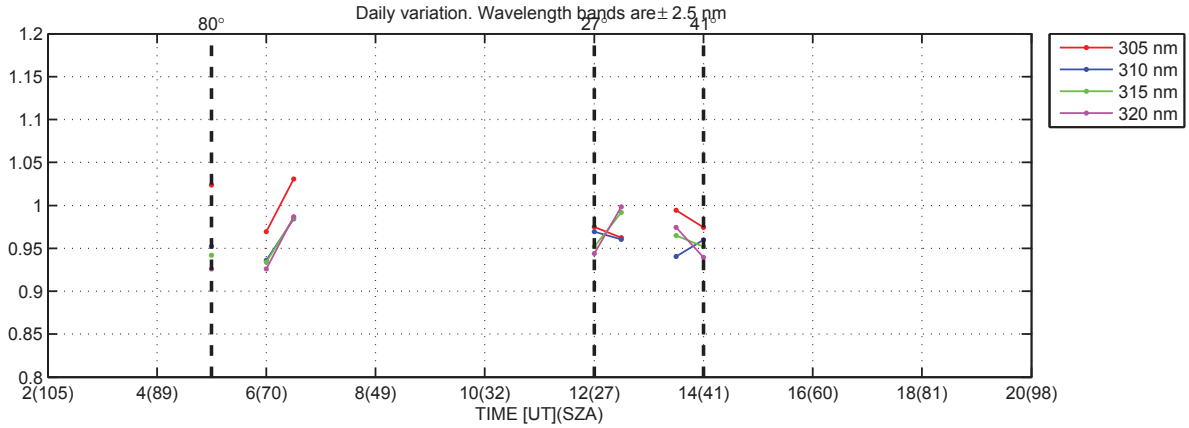

Global irradiance ratios 072/QASUME at Arosa:18−Jul−2012(200)
wl [nm]
UVIndex

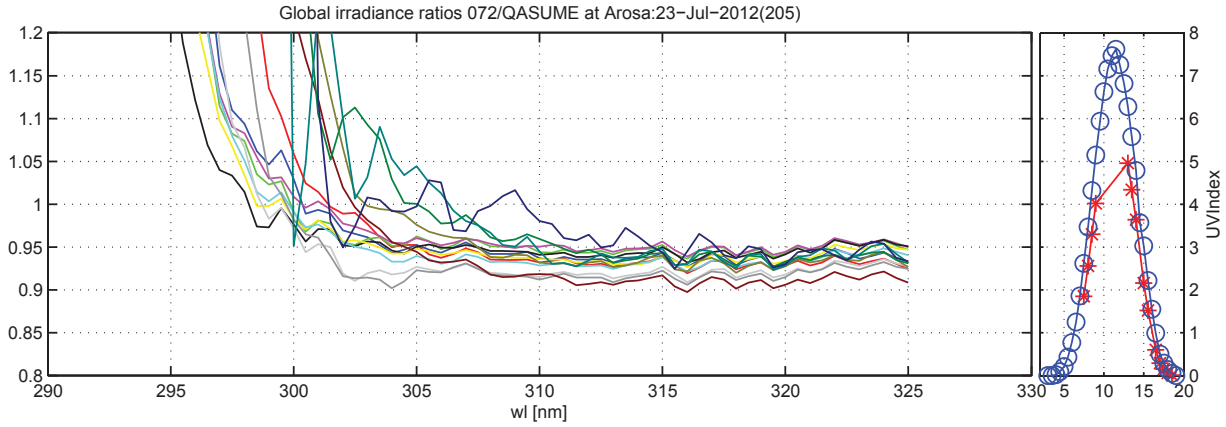

Daily variation. Wavelength bands are± 2.5 nm
59°
26°
TIME [UT](SZA)
305 nm
310 nm
315 nm
320 nm

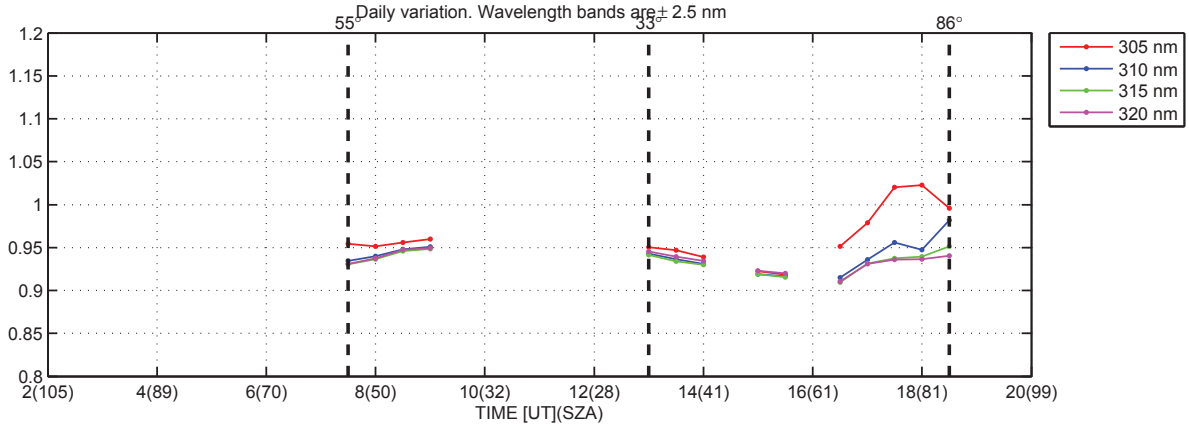

Global irradiance ratios 072/QASUME at Arosa:20−Jul−2012(202)
wl [nm]
UVIndex

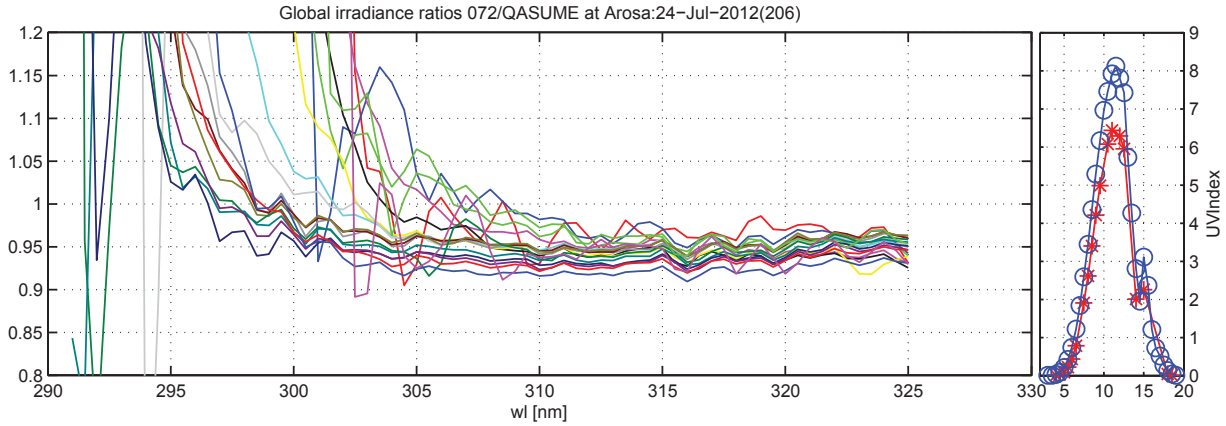

Daily variation. Wavelength bands are± 2.5 nm
80°
41°
80°
TIME [UT](SZA)
305 nm
310 nm
315 nm
320 nm

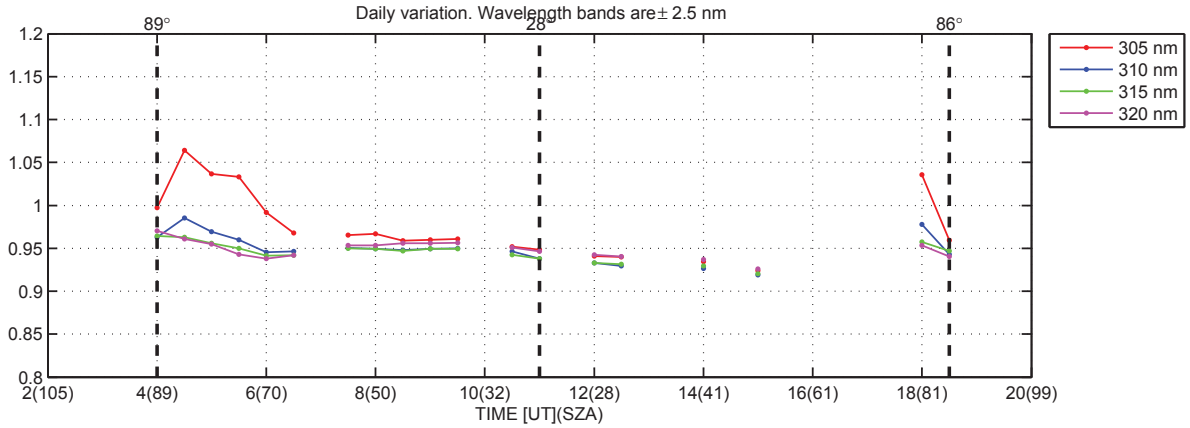

Global irradiance ratios 072/QASUME at Arosa:21−Jul−2012(203)
wl [nm]
UVIndex

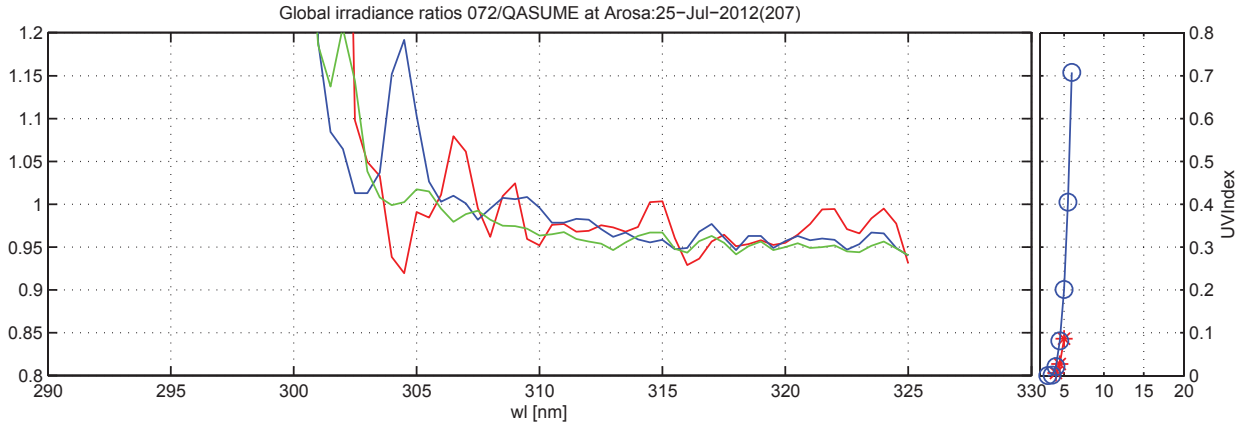

Daily variation. Wavelength bands are± 2.5 nm
80°
27°
41°
305 nm
310 nm
315 nm
320 nm
TIME [UT](SZA)

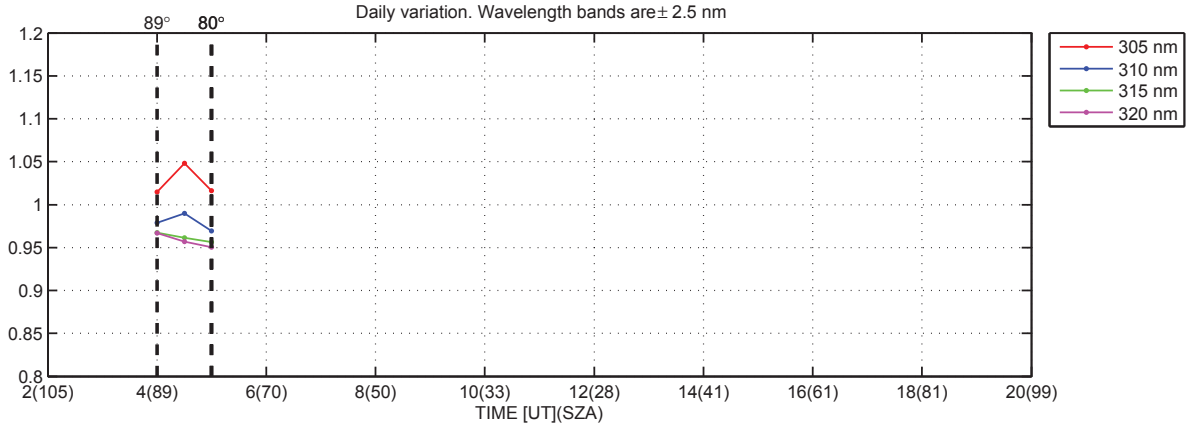

Global irradiance ratios 072/QASUME at Arosa:23−Jul−2012(205)
wl [nm]
UVIndex

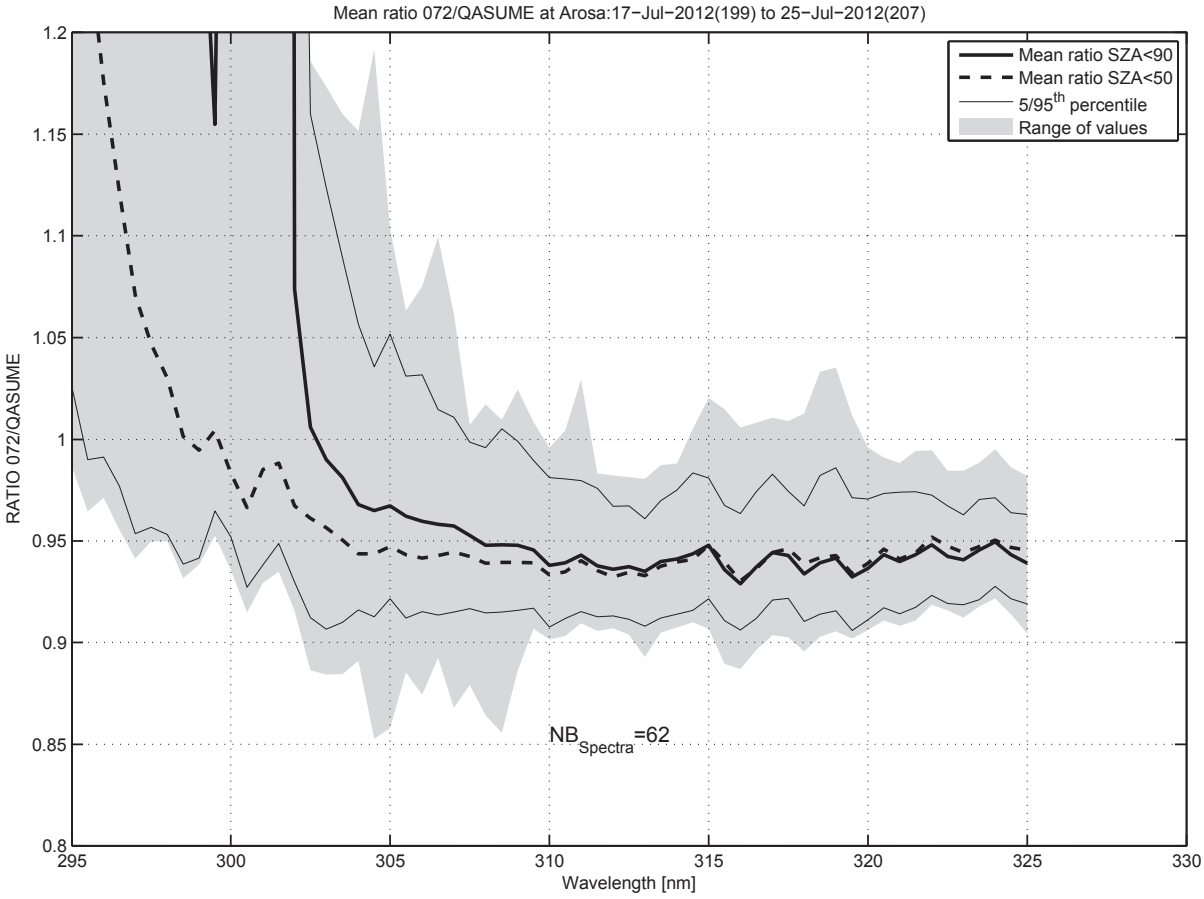

Daily variation. Wavelength bands are± 2.5 nm
55°
33°
86°
305 nm
310 nm
315 nm
320 nm
TIME [UT](SZA)

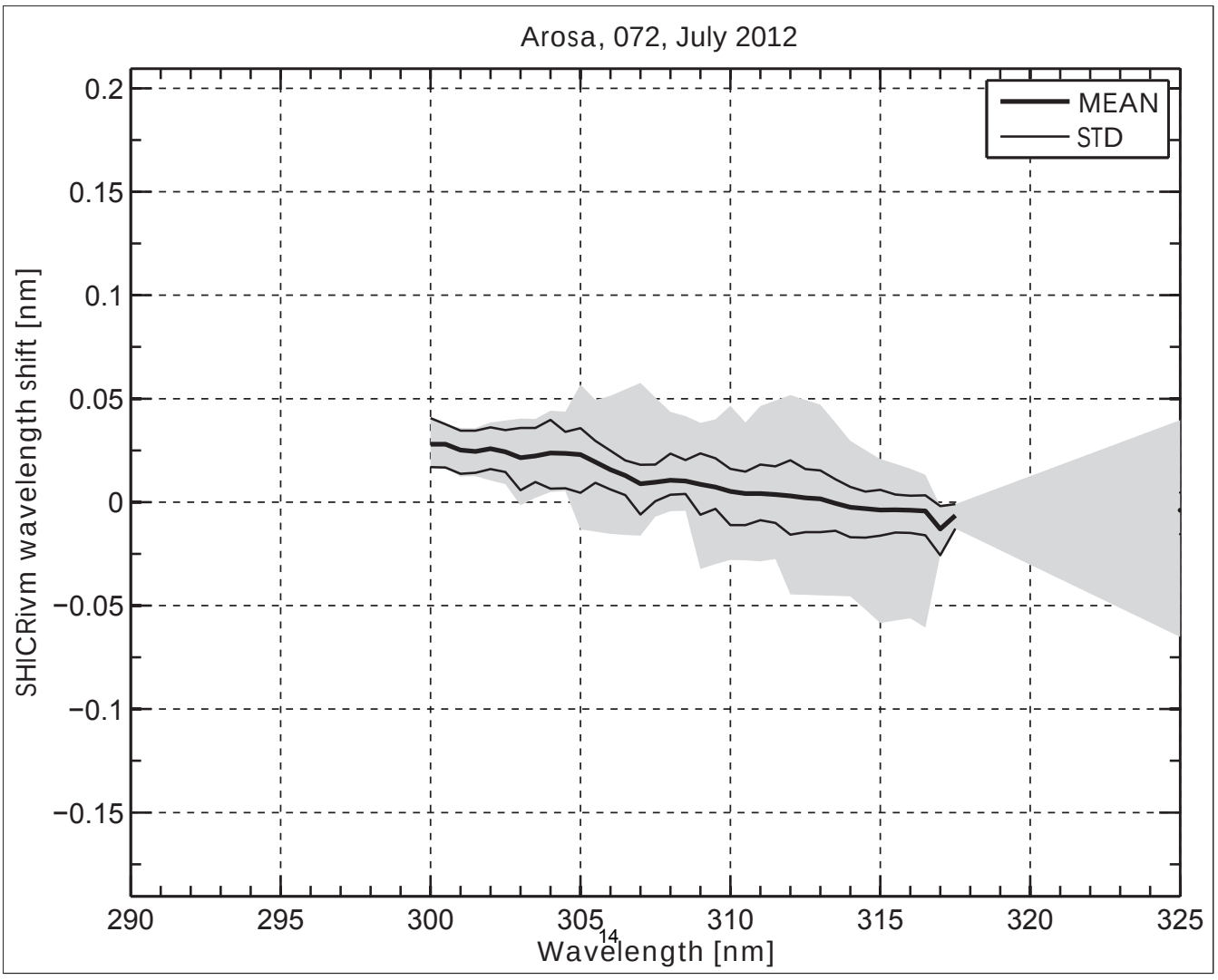

Global irradiance ratios 072/QASUME at Arosa:24−Jul−2012(206)
wl [nm]
UVIndex

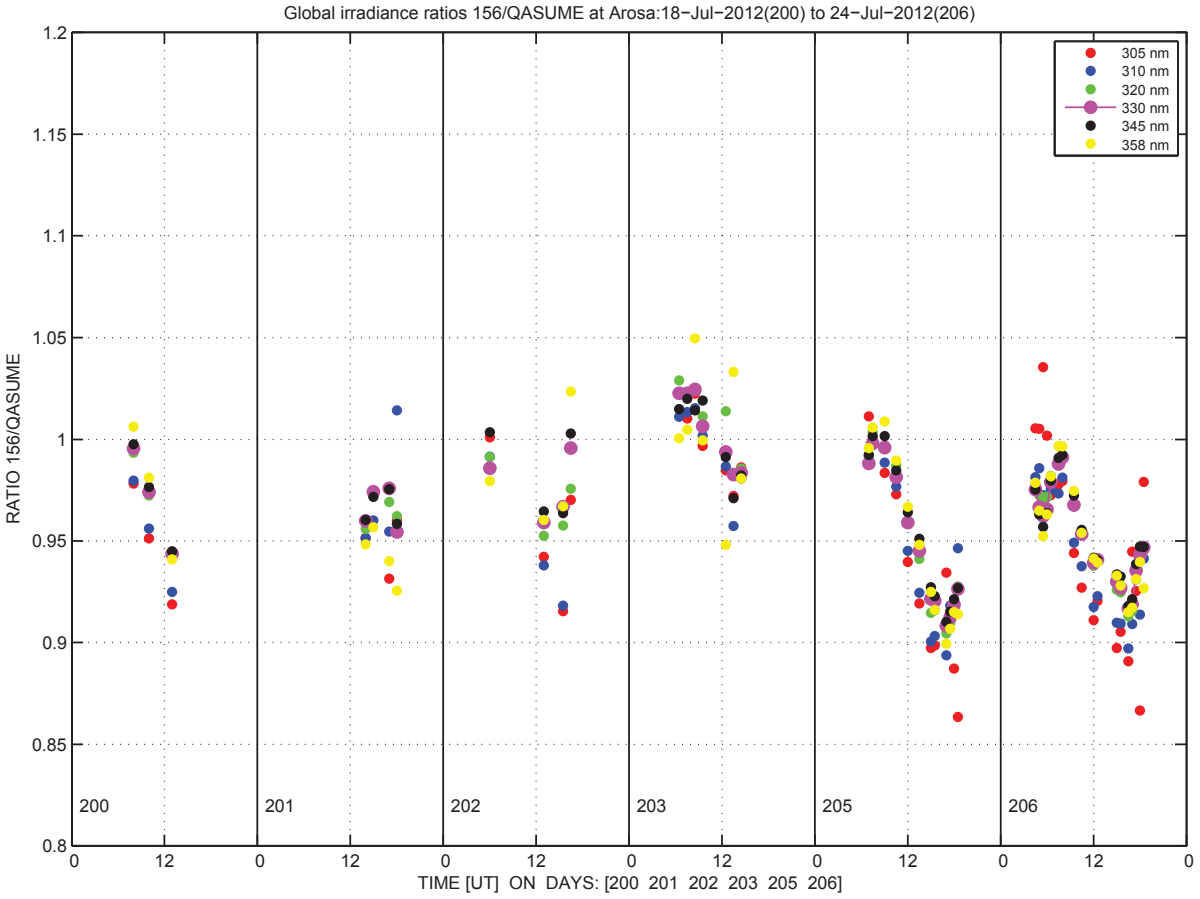

Daily variation. Wavelength bands are± 2.5 nm
89°
28°
86°
305 nm
310 nm
315 nm
320 nm
TIME [UT](SZA)

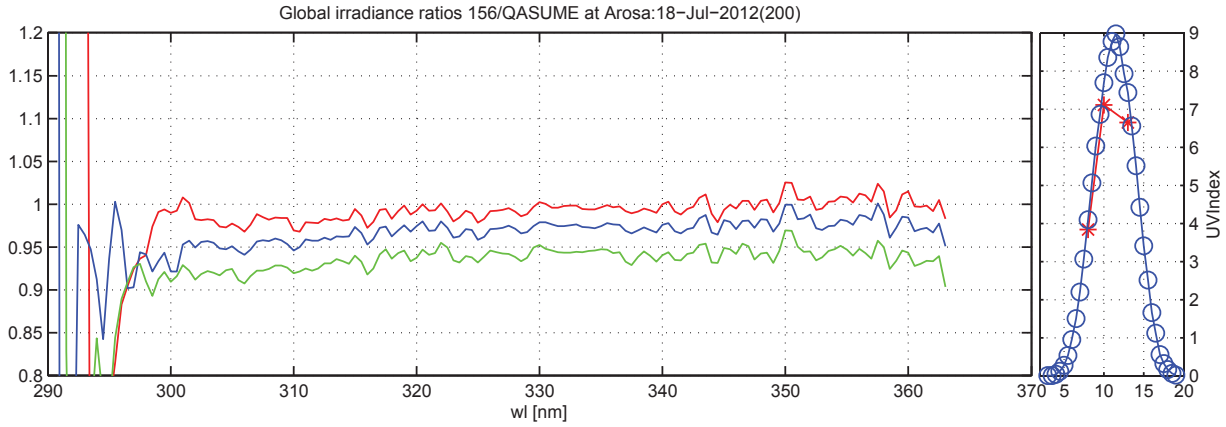

Global irradiance ratios 072/QASUME at Arosa:25−Jul−2012(207)
wl [nm]
UVIndex

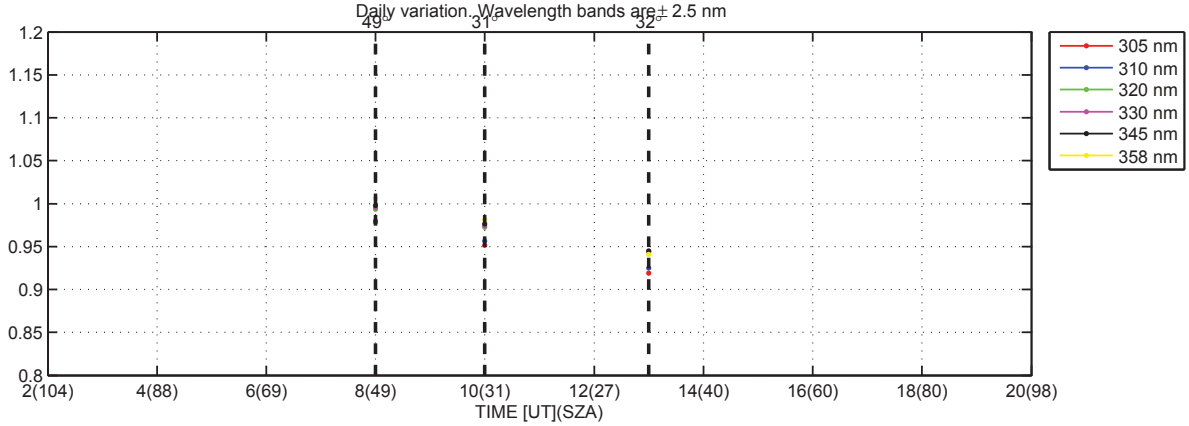

Daily variation. Wavelength bands are± 2.5 nm
89°
80°
305 nm
310 nm
315 nm
320 nm
TIME [UT](SZA)

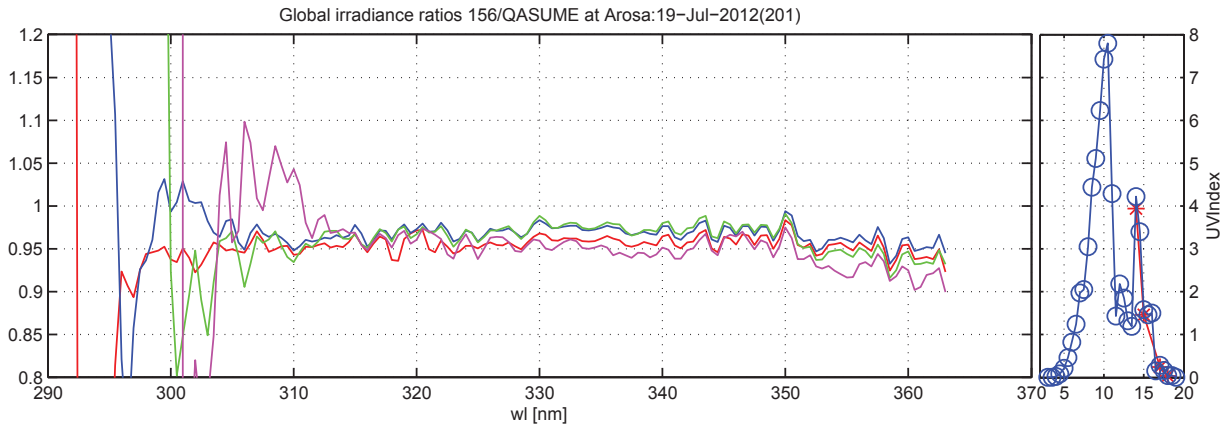

Mean ratio 072/QASUME at Arosa:17−Jul−2012(199) to 25−Jul−2012(207)
Mean ratio SZA<90
Mean ratio SZA<50
5/95th percentile
Range of values
RATIO 072/QASUME
NBSpectra=62
Wavelength [nm]

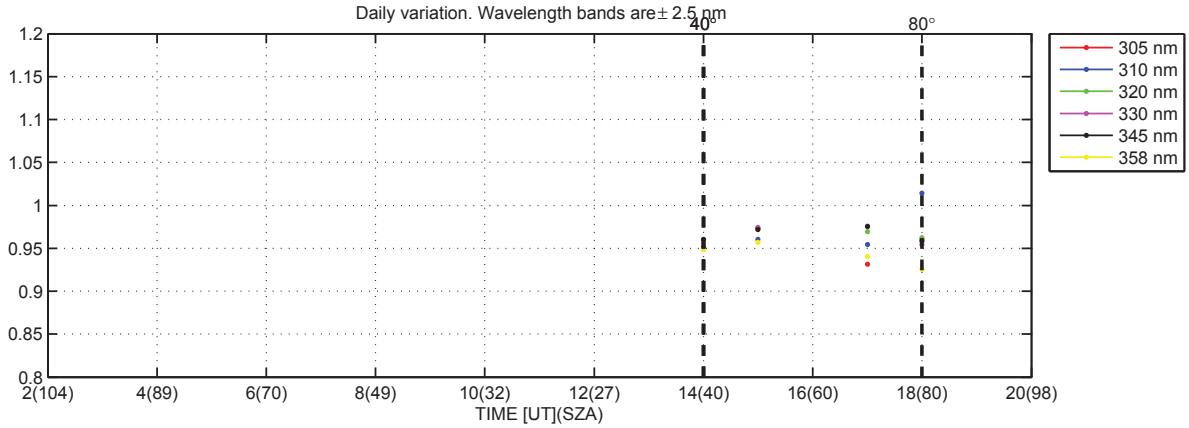

Arosa, 072, July 2012
MEAN
STD
SHICRivm wavelength shift [nm]
Wavelength [nm]

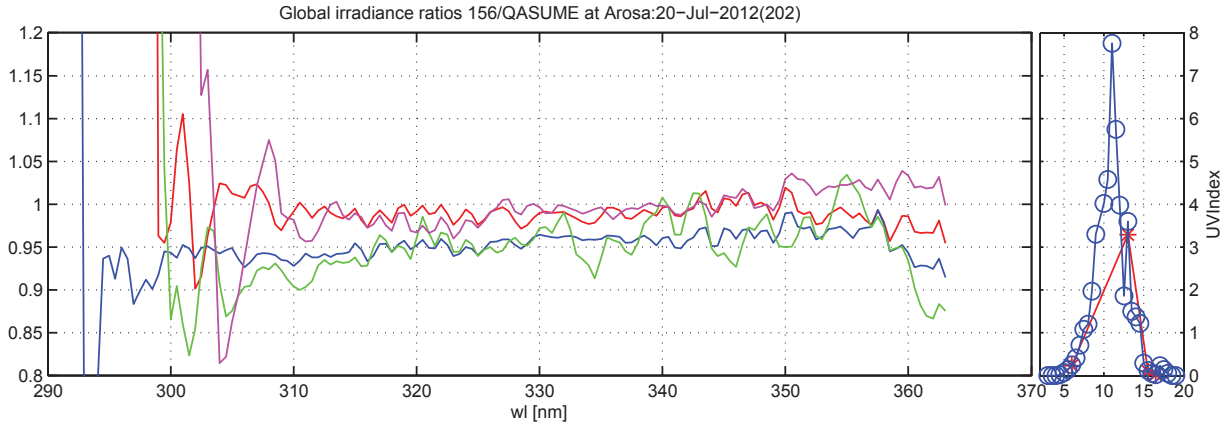

Global irradiance ratios 156/QASUME at Arosa:18−Jul−2012(200) to 24−Jul−2012(206)
RATIO 156/QASUME
TIME [UT] ON DAYS: [200 201 202 203 205 206]
305 nm
310 nm
320 nm
330 nm
345 nm
358 nm
200
201
202
203
205
206

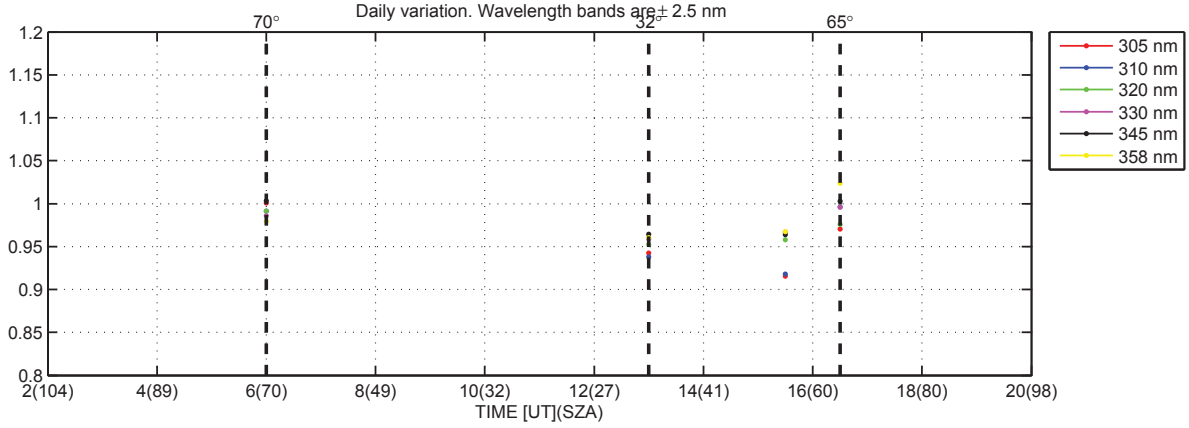

Global irradiance ratios 156/QASUME at Arosa:18−Jul−2012(200)
wl [nm]
UVIndex

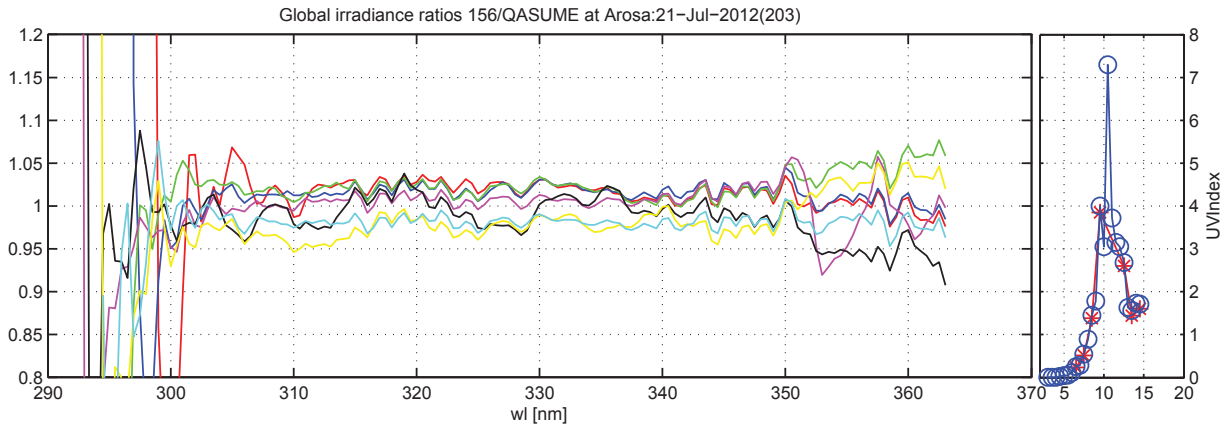

Daily variation. Wavelength bands are ± 2.5 nm
49°
31°
32°
TIME [UT](SZA)
305 nm
310 nm
320 nm
330 nm
345 nm
358 nm

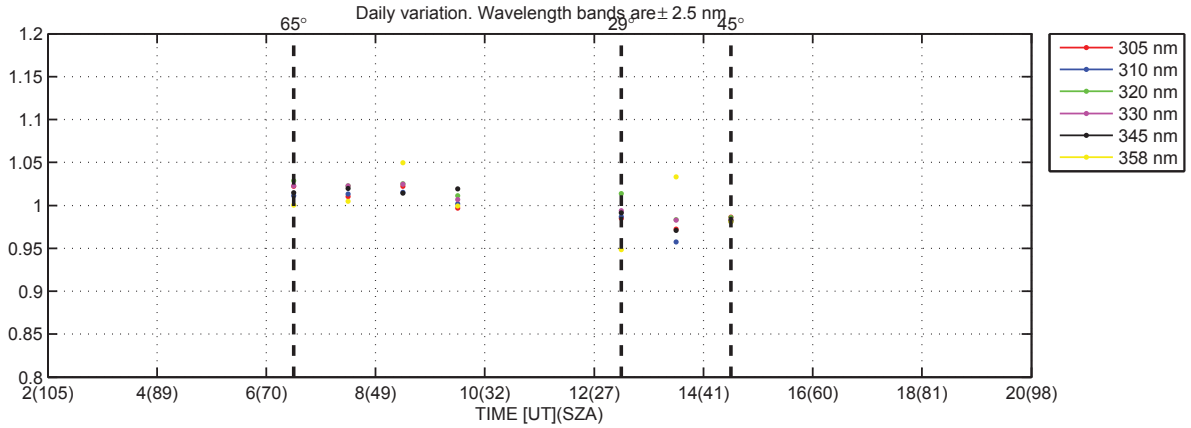

Global irradiance ratios 156/QASUME at Arosa:19−Jul−2012(201)
wl [nm]
UVIndex

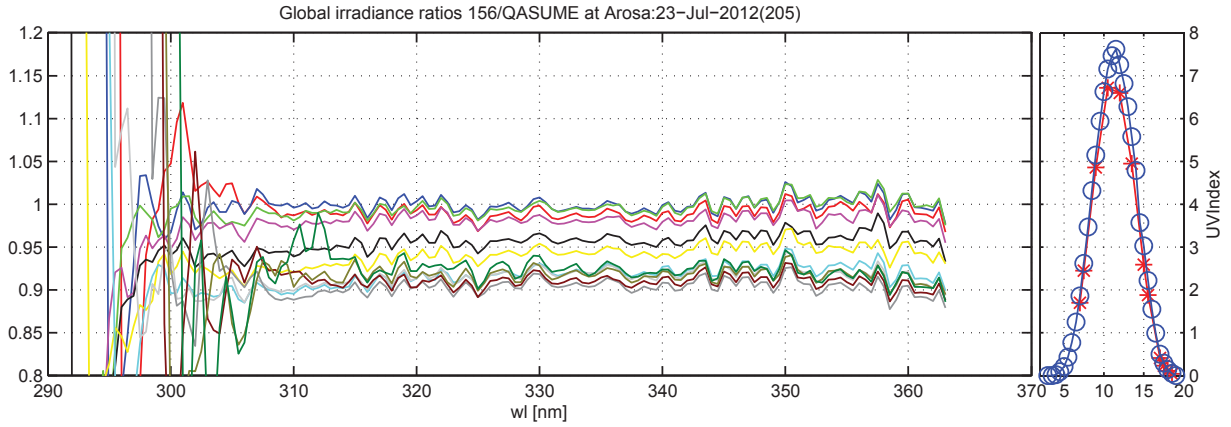

Daily variation. Wavelength bands are± 2.5 nm
40°
80°
305 nm
310 nm
320 nm
330 nm
345 nm
358 nm
TIME [UT](SZA)

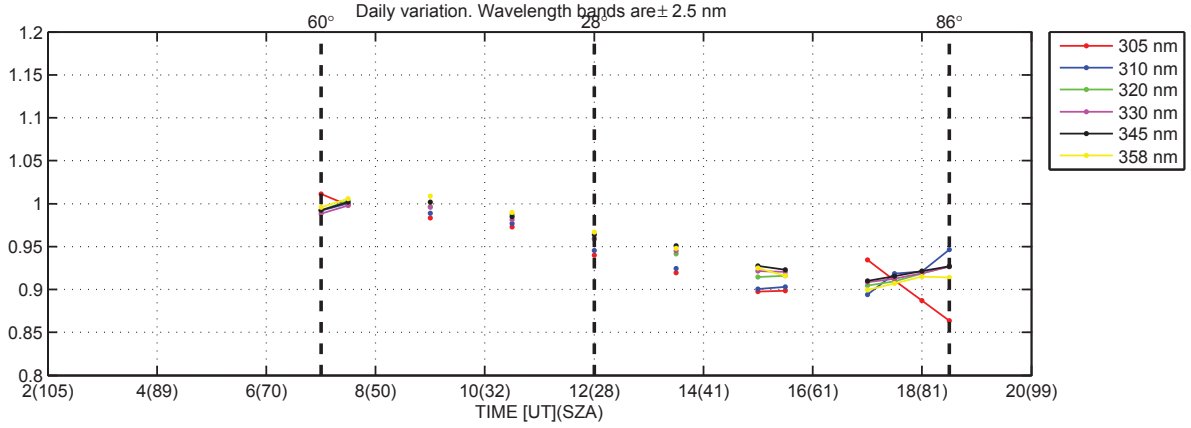

Global irradiance ratios 156/QASUME at Arosa:20−Jul−2012(202)
wl [nm]
UVIndex

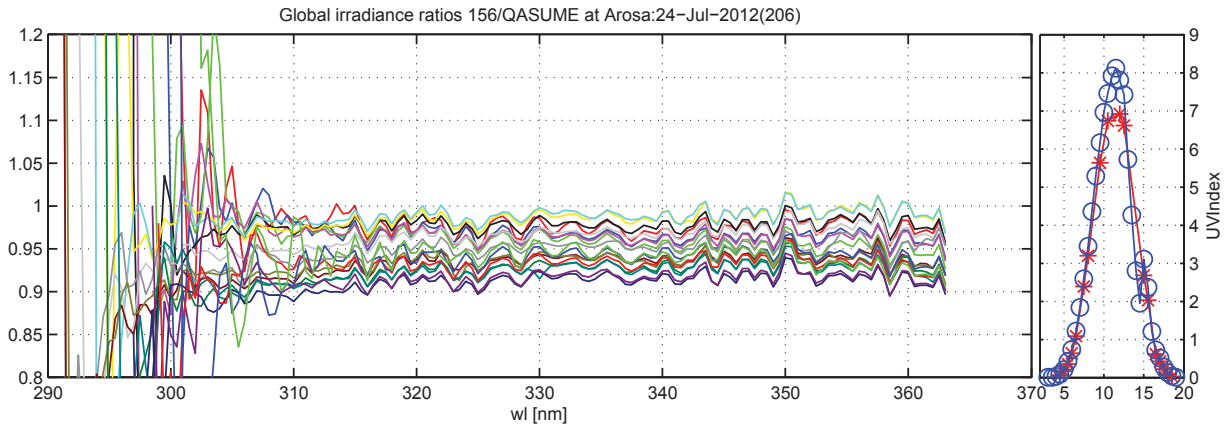

Daily variation. Wavelength bands are± 2.5 nm
70°
32°
65°
305 nm
310 nm
320 nm
330 nm
345 nm
358 nm
TIME [UT](SZA)

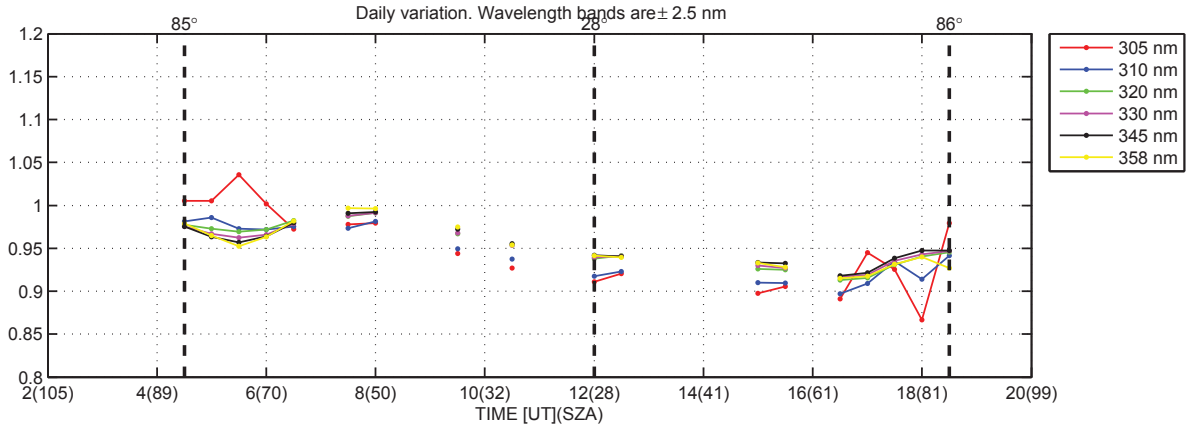

Global irradiance ratios 156/QASUME at Arosa:21−Jul−2012(203)
wl [nm]
UVIndex

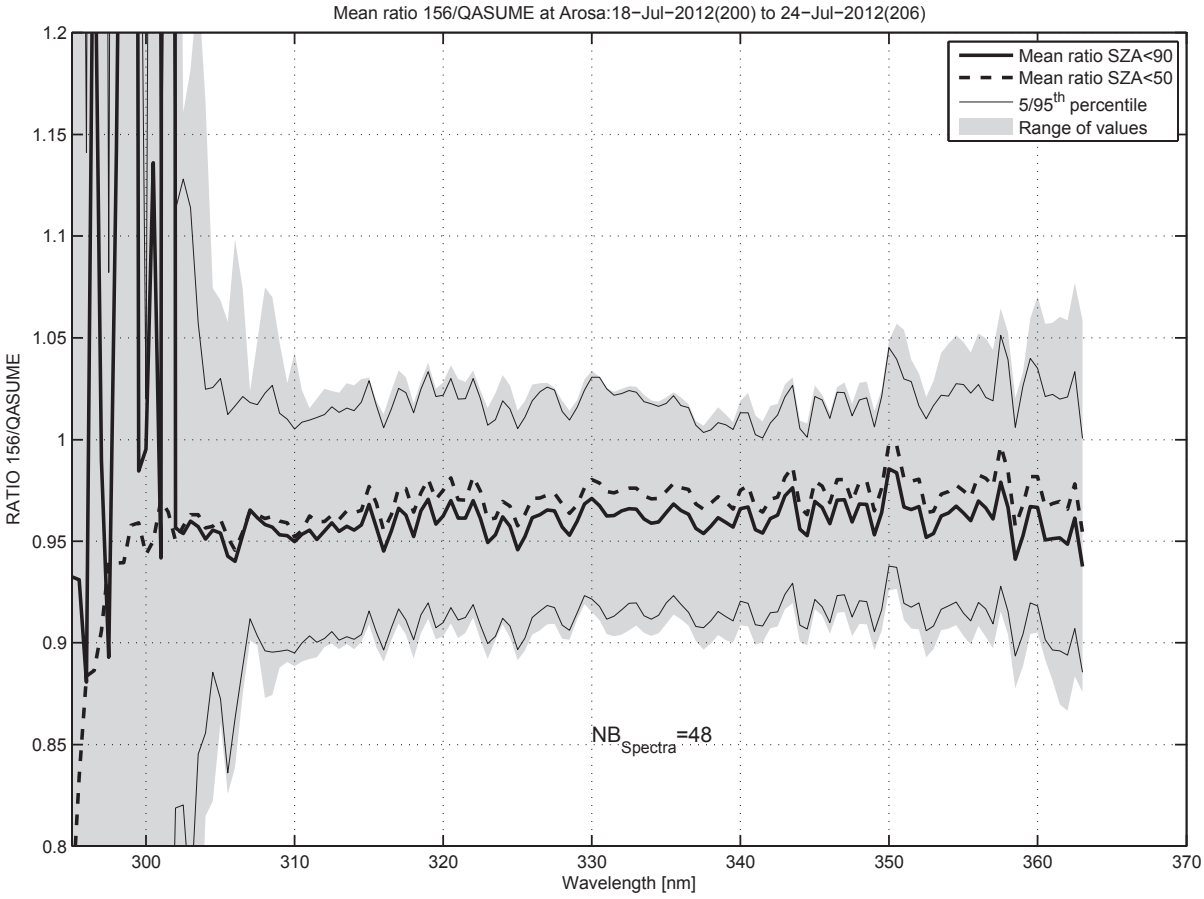

Daily variation. Wavelength bands are± 2.5 nm
65°
29°
45°
TIME [UT](SZA)
2(105)
4(89)
6(70)
8(49)
10(32)
12(27)
14(41)
16(60)
18(81)
20(98)
305 nm
310 nm
320 nm
330 nm
345 nm
358 nm

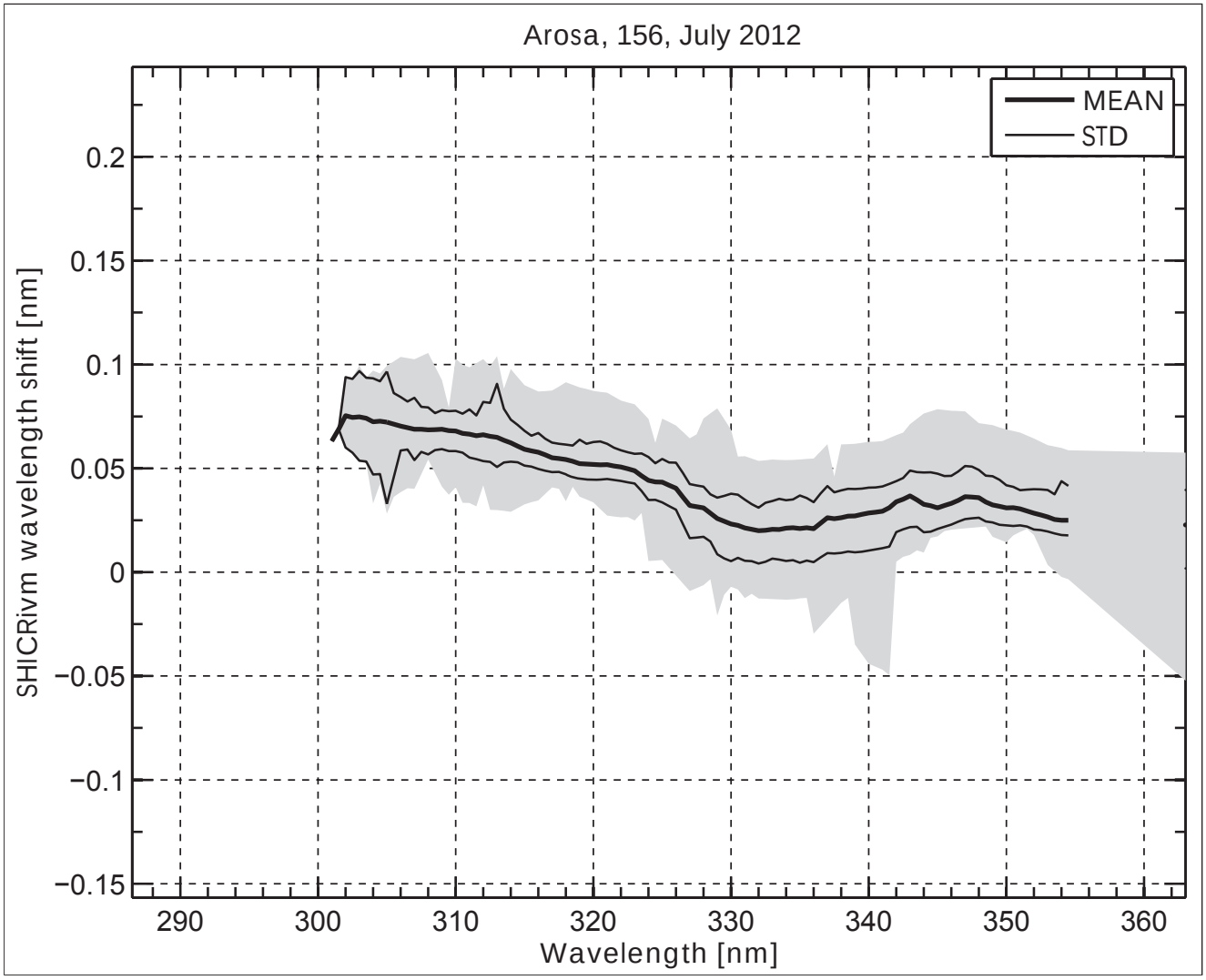

Global irradiance ratios 156/QASUME at Arosa:23−Jul−2012(205)
wl [nm]
UVIndex

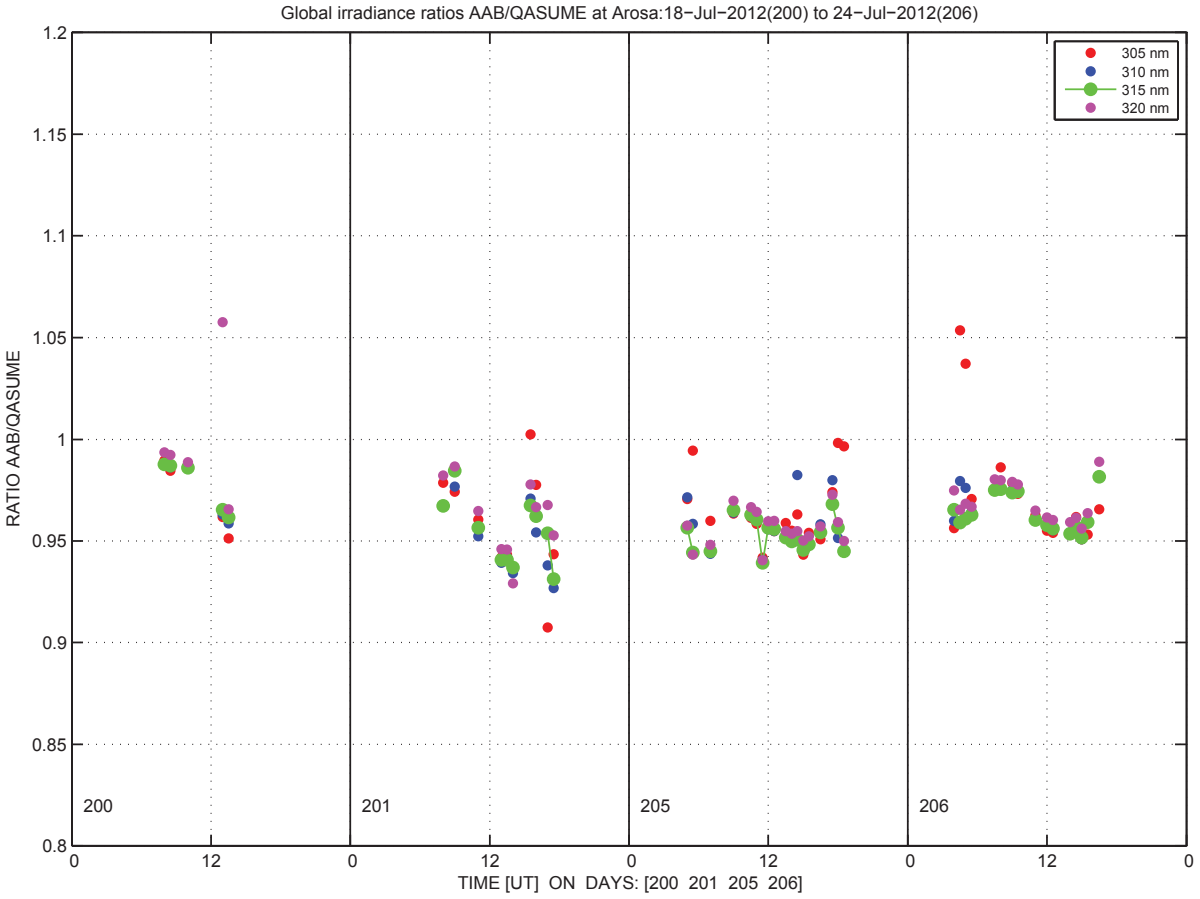

Daily variation. Wavelength bands are± 2.5 nm
60°
28°
86°
TIME [UT](SZA)
2(105)
4(89)
6(70)
8(50)
10(32)
12(28)
14(41)
16(61)
18(81)
20(99)
305 nm
310 nm
320 nm
330 nm
345 nm
358 nm

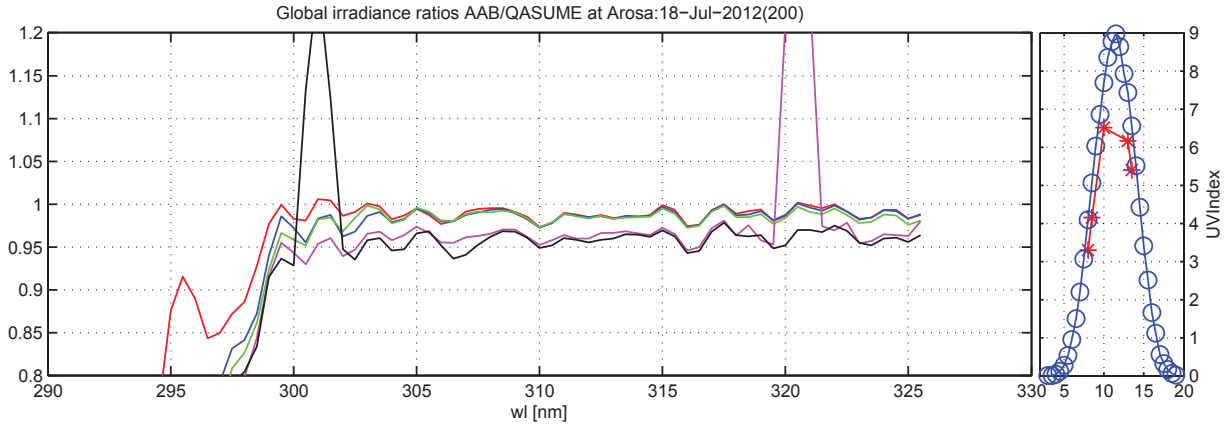

Global irradiance ratios 156/QASUME at Arosa:24−Jul−2012(206)
wl [nm]
UVIndex

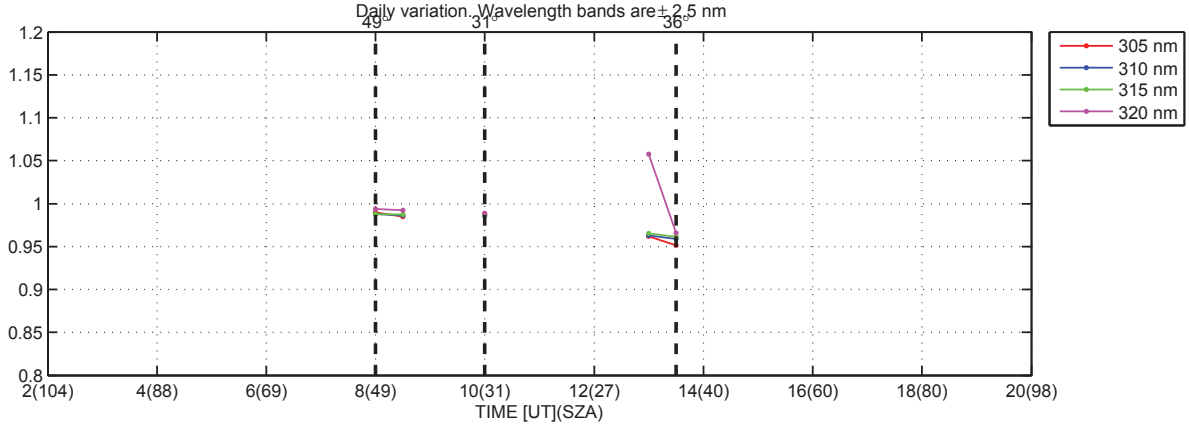

Daily variation. Wavelength bands are± 2.5 nm
85°
28°
86°
305 nm
310 nm
320 nm
330 nm
345 nm
358 nm
TIME [UT](SZA)

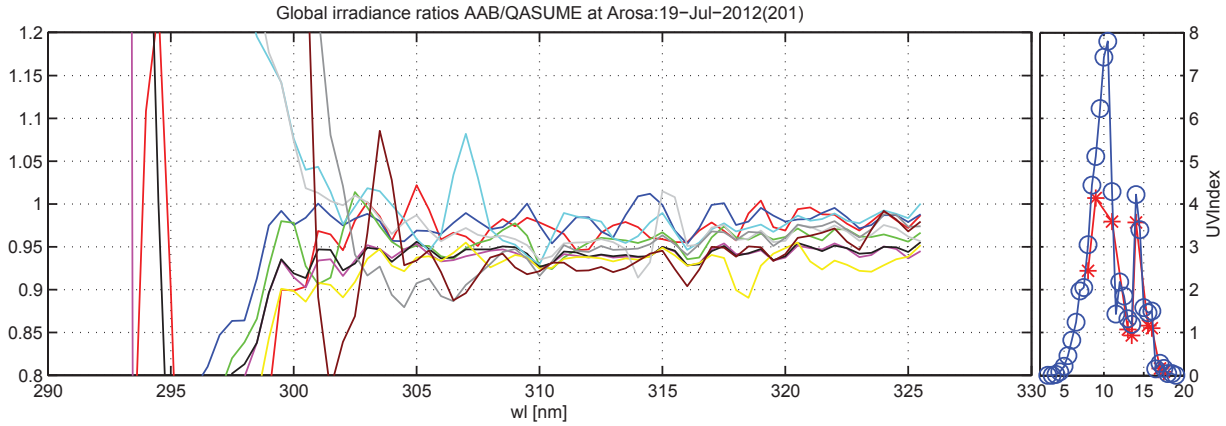

Mean ratio 156/QASUME at Arosa:18−Jul−2012(200) to 24−Jul−2012(206)
Mean ratio SZA<90
Mean ratio SZA<50
5/95th percentile
Range of values
RATIO 156/QASUME
NBSpectra=48
Wavelength [nm]

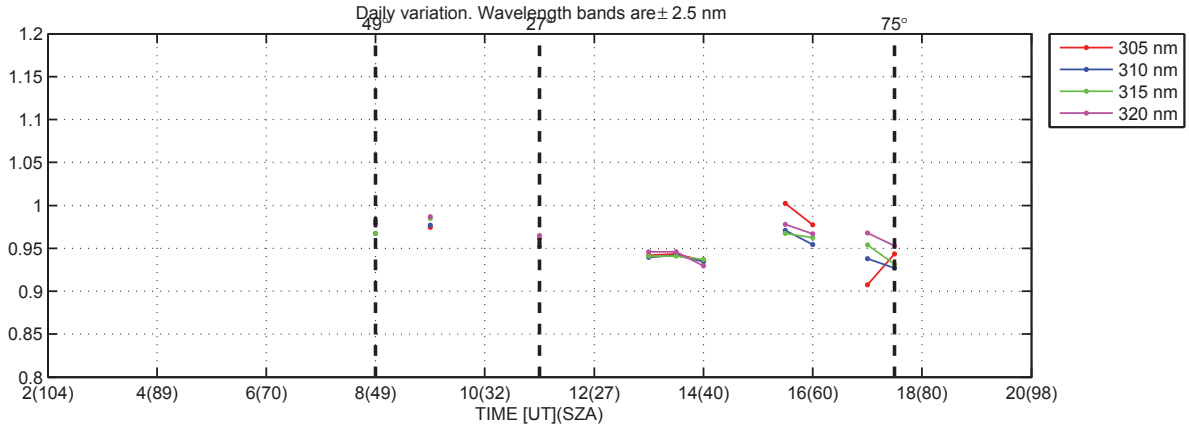

Arosa, 156, July 2012
MEAN
STD
SHICRivm wavelength shift [nm]
0.2
0.15
0.1
0.05
0
−0.05
−0.1
−0.15
290
300
310
320
330
340
350
360
Wavelength [nm]

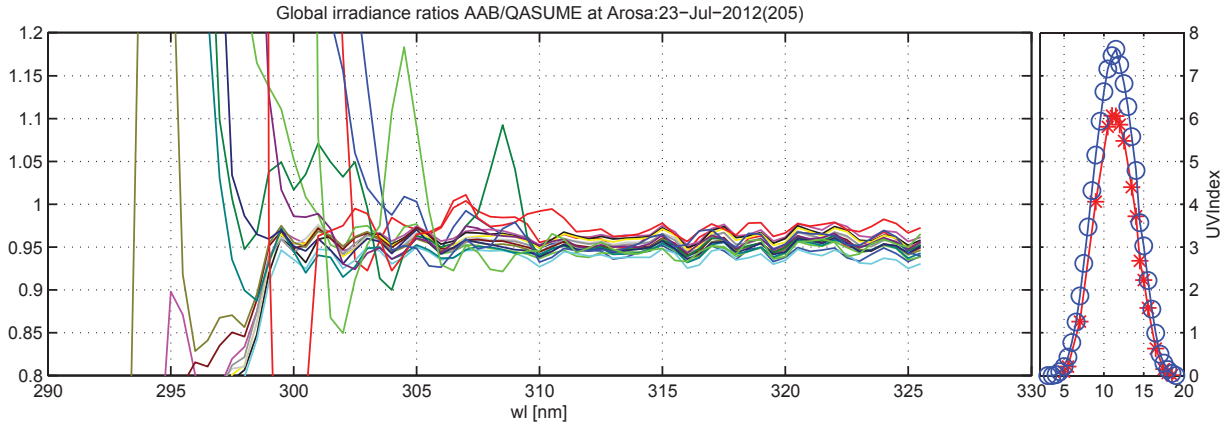

Global irradiance ratios AAB/QASUME at Arosa:18−Jul−2012(200) to 24−Jul−2012(206)
RATIO AAB/QASUME
TIME [UT] ON DAYS: [200 201 205 206]
305 nm
310 nm
315 nm
320 nm
200
201
205
206

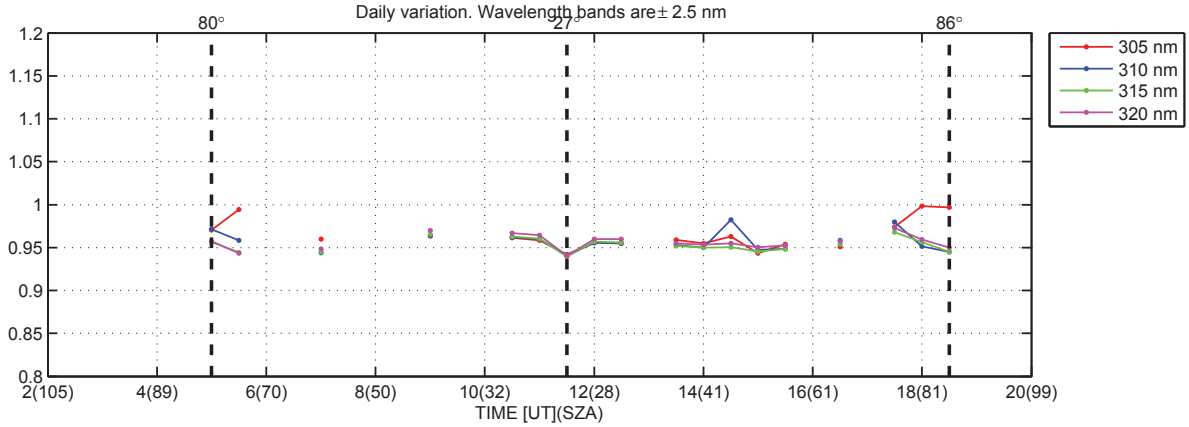

Global irradiance ratios AAB/QASUME at Arosa:18−Jul−2012(200)
wl [nm]
UVIndex

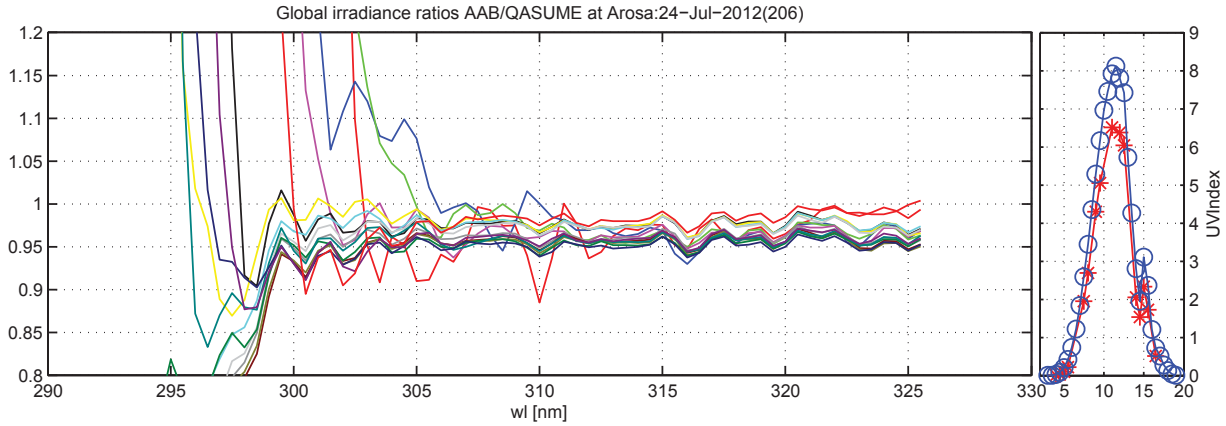

Daily variation. Wavelength bands are ± 2.5 nm
49°
31°
36°
TIME [UT](SZA)
2(104)
4(88)
6(69)
8(49)
10(31)
12(27)
14(40)
16(60)
18(80)
20(98)
305 nm
310 nm
315 nm
320 nm

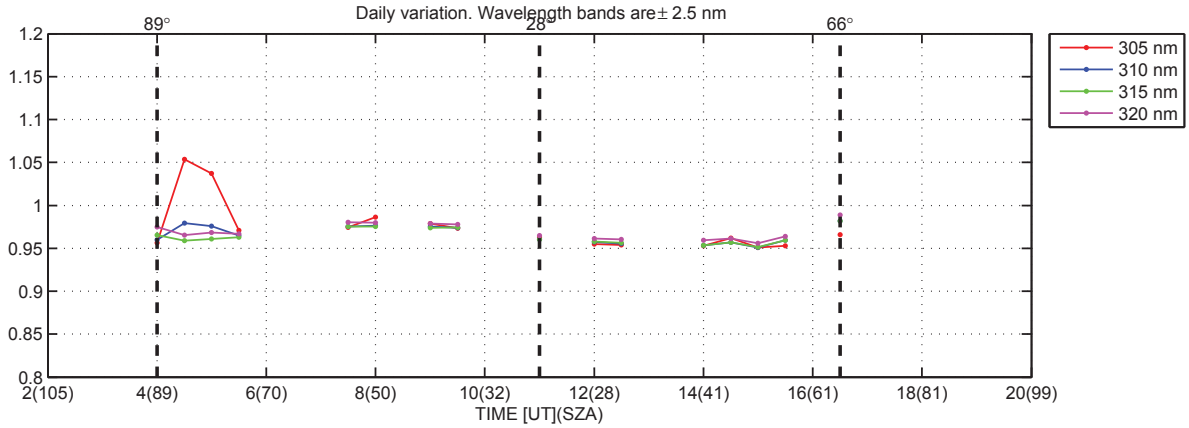

Global irradiance ratios AAB/QASUME at Arosa:19−Jul−2012(201)
wl [nm]
UVIndex

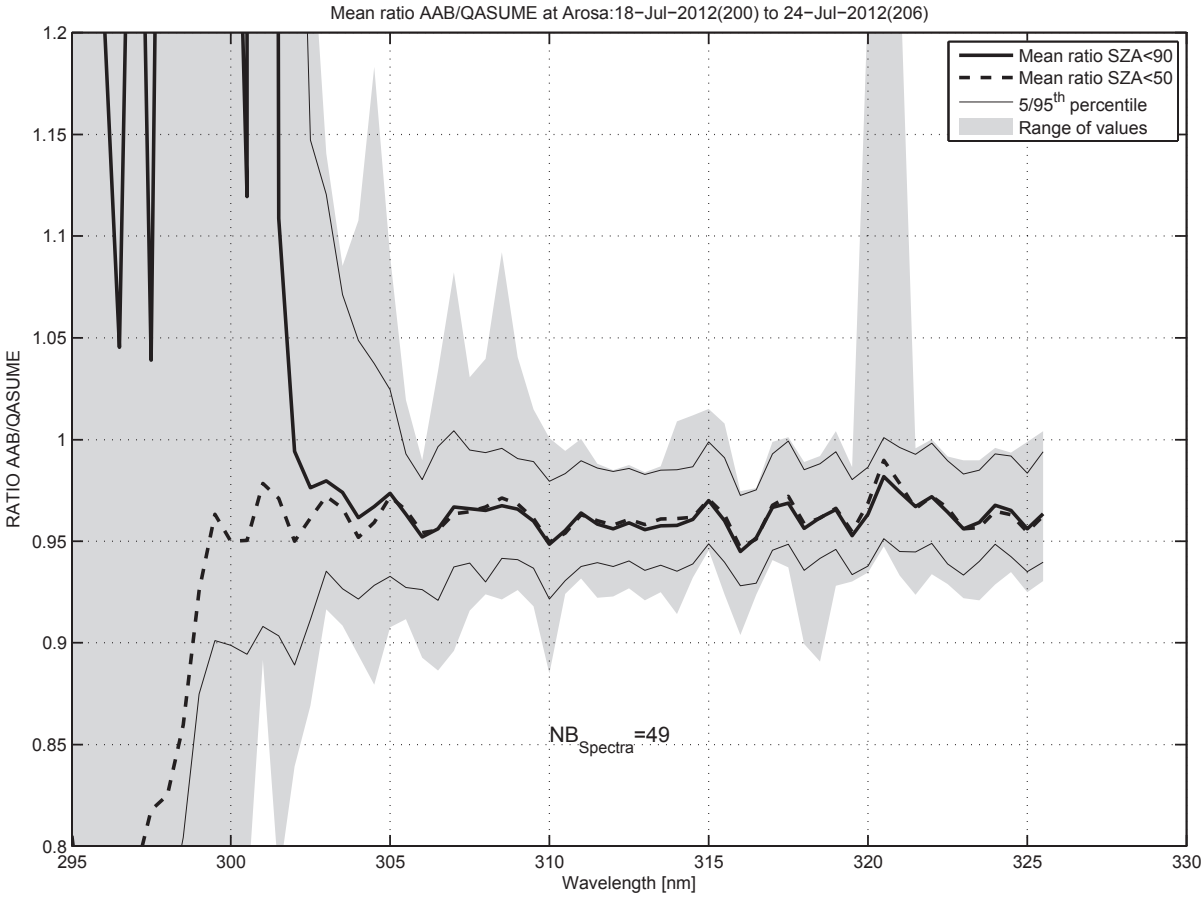

Daily variation. Wavelength bands are± 2.5 nm
49°
27°
75°
305 nm
310 nm
315 nm
320 nm
TIME [UT](SZA)

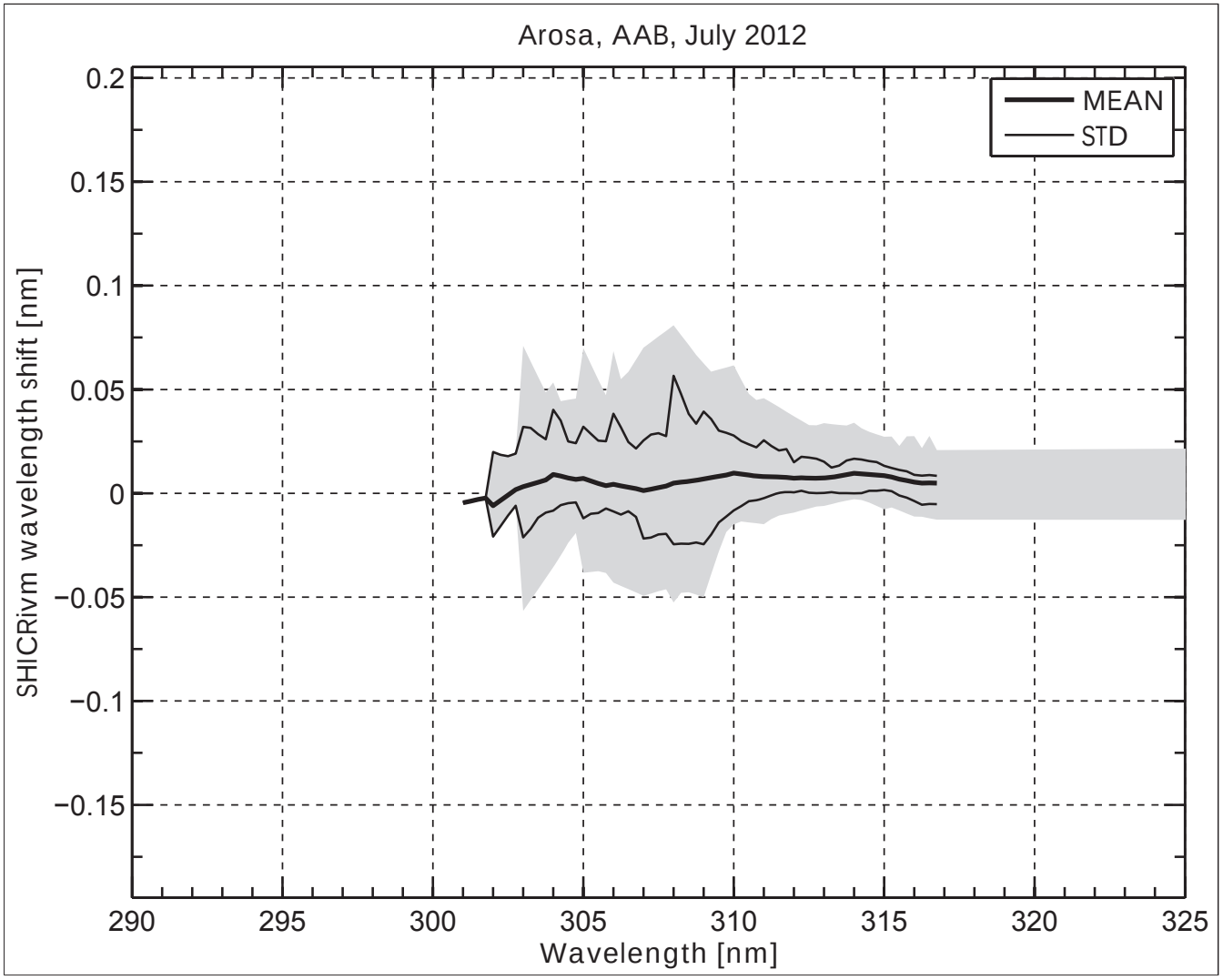

Global irradiance ratios AAB/QASUME at Arosa:23−Jul−2012(205)
wl [nm]
UVIndex

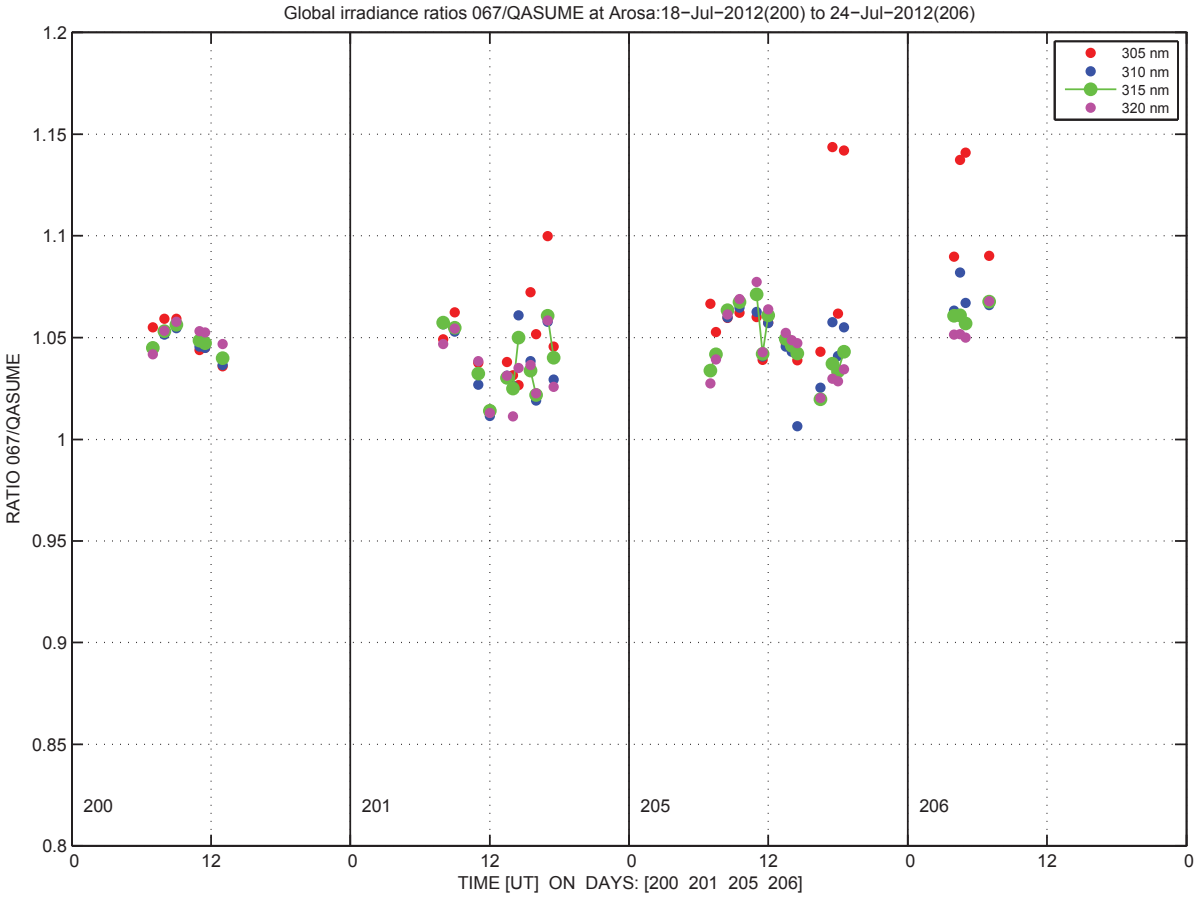

Daily variation. Wavelength bands are± 2.5 nm
80°
27°
86°
305 nm
310 nm
315 nm
320 nm
TIME [UT](SZA)

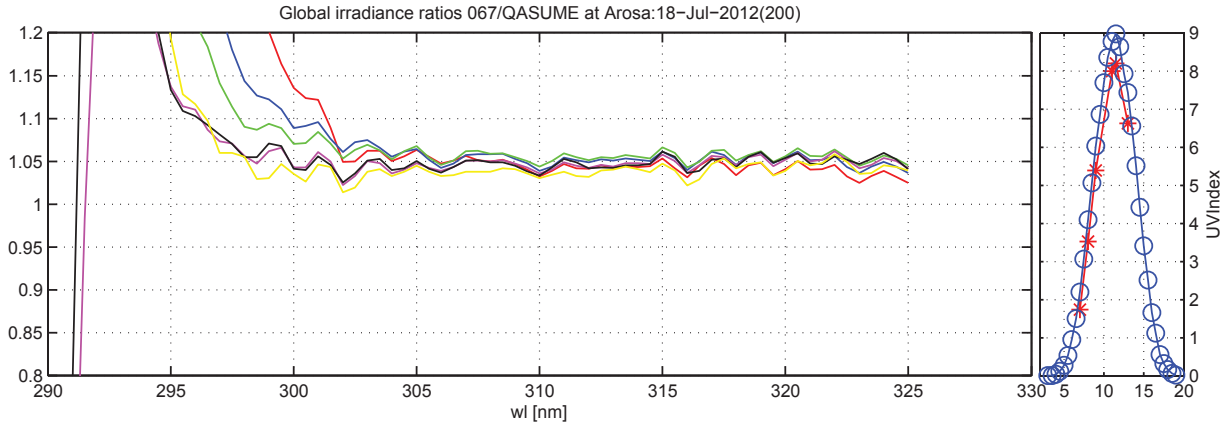

Global irradiance ratios AAB/QASUME at Arosa:24−Jul−2012(206)
wl [nm]
UVIndex

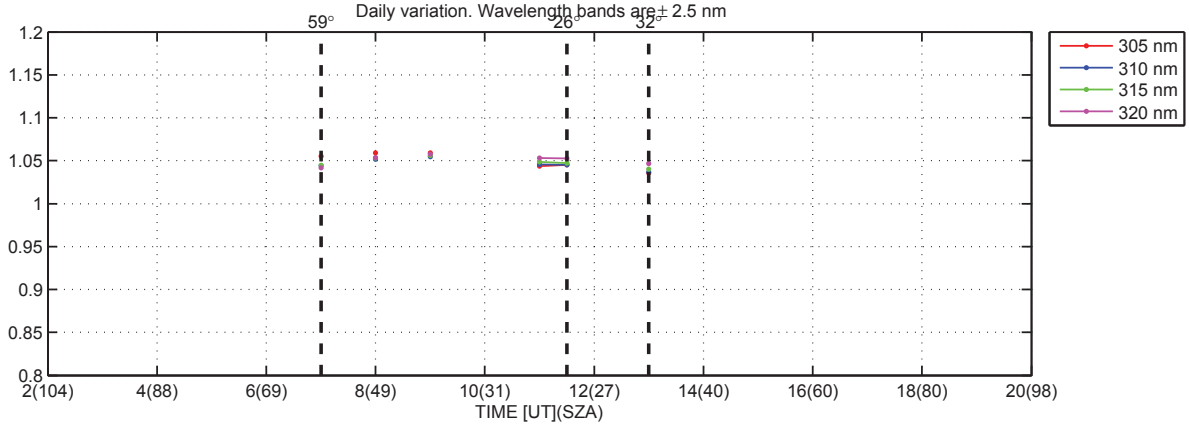

Daily variation. Wavelength bands are± 2.5 nm
89°
28°
66°
305 nm
310 nm
315 nm
320 nm
TIME [UT](SZA)

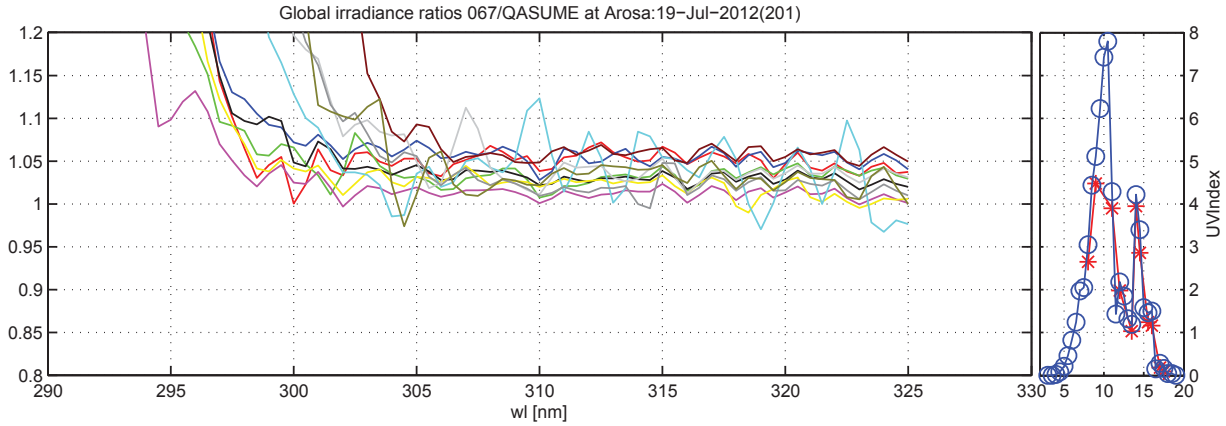

Mean ratio AAB/QASUME at Arosa:18−Jul−2012(200) to 24−Jul−2012(206)
Mean ratio SZA<90
Mean ratio SZA<50
5/95th percentile
Range of values
RATIO AAB/QASUME
NBSpectra=49
Wavelength [nm]

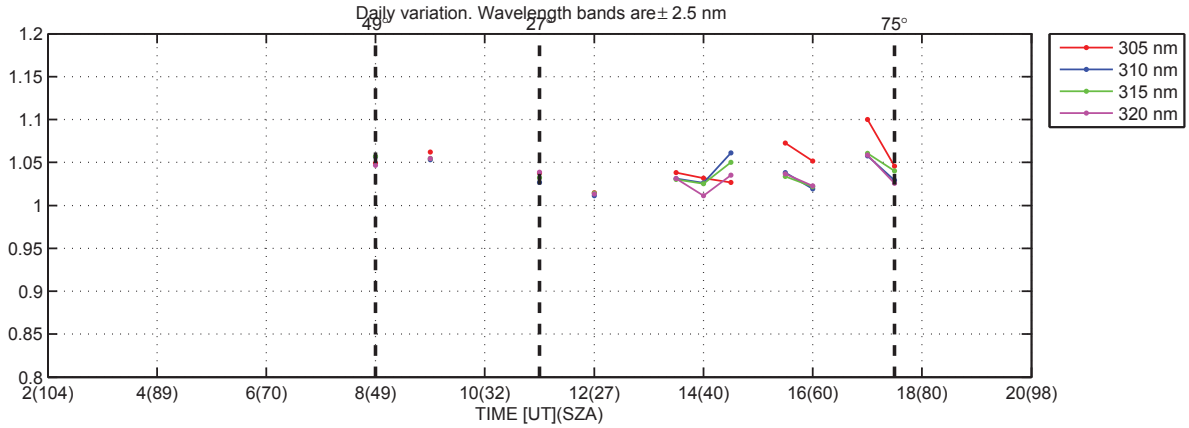

Arosa, AAB, July 2012
MEAN
STD
SHICRivm wavelength shift [nm]
Wavelength [nm]
0.2
0.15
0.1
0.05
0
−0.05
−0.1
−0.15
290
295
300
305
310
315
320
325

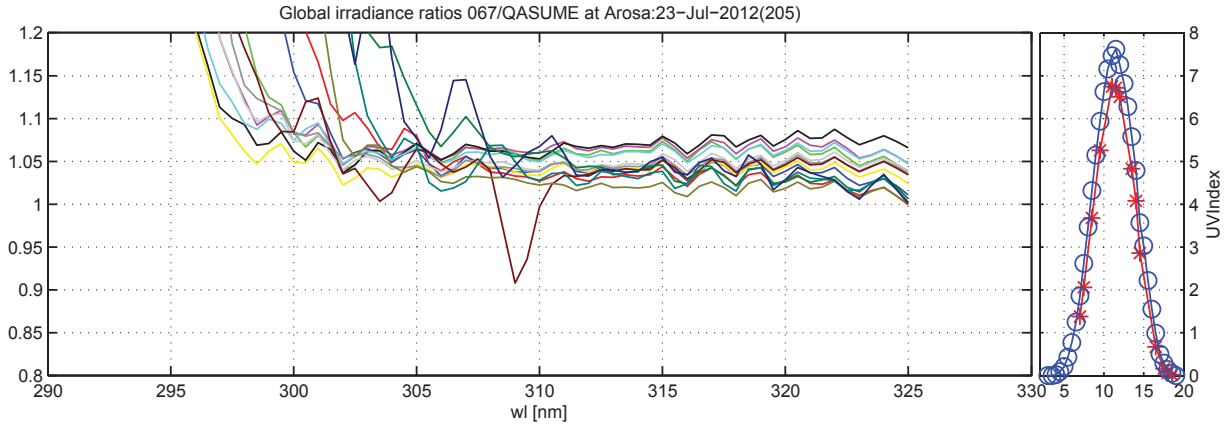

Global irradiance ratios 067/QASUME at Arosa:18−Jul−2012(200) to 24−Jul−2012(206)
RATIO 067/QASUME
TIME [UT] ON DAYS: [200 201 205 206]
305 nm
310 nm
315 nm
320 nm
200
201
205
206

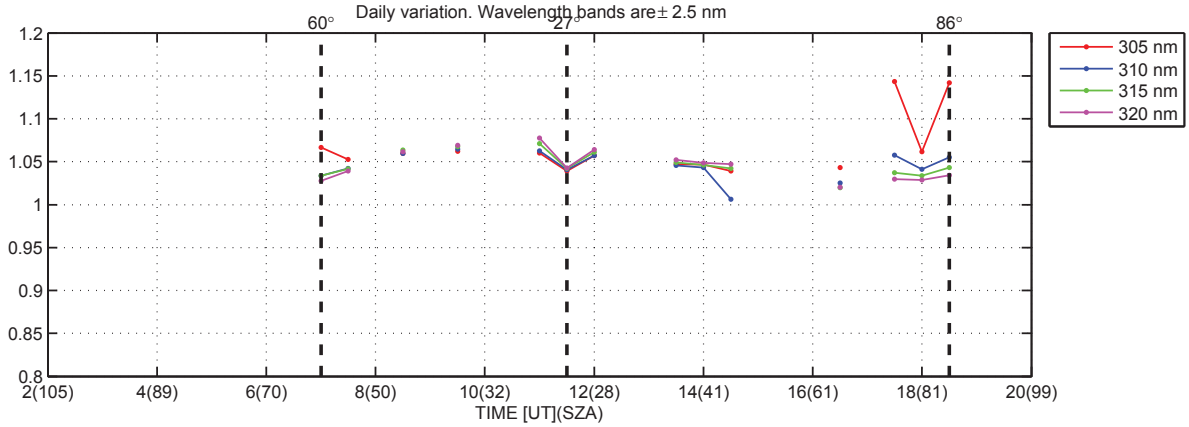

Global irradiance ratios 067/QASUME at Arosa:18−Jul−2012(200)
wl [nm]
UVIndex

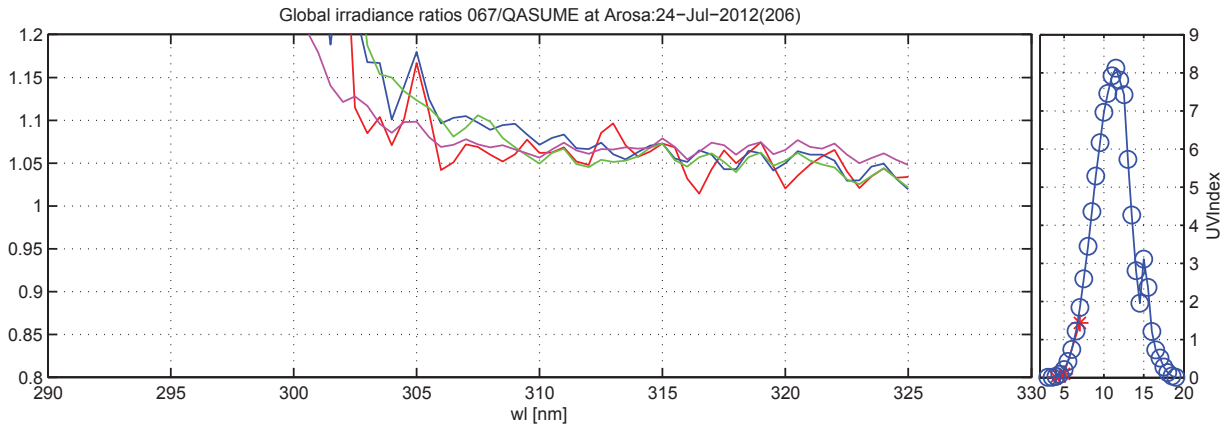

Daily variation. Wavelength bands are ± 2.5 nm
59°
26°
32°
TIME [UT](SZA)
305 nm
310 nm
315 nm
320 nm

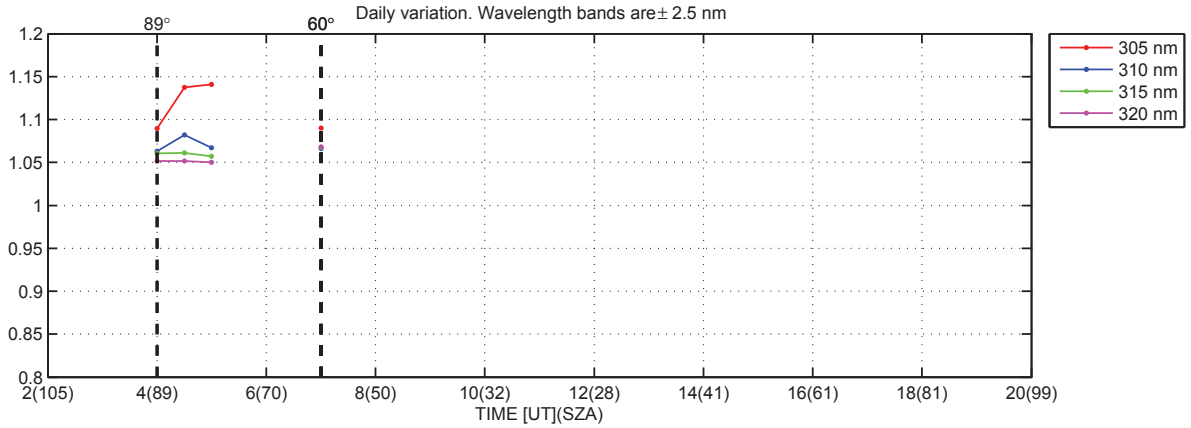

Global irradiance ratios 067/QASUME at Arosa:19−Jul−2012(201)
wl [nm]
UVIndex

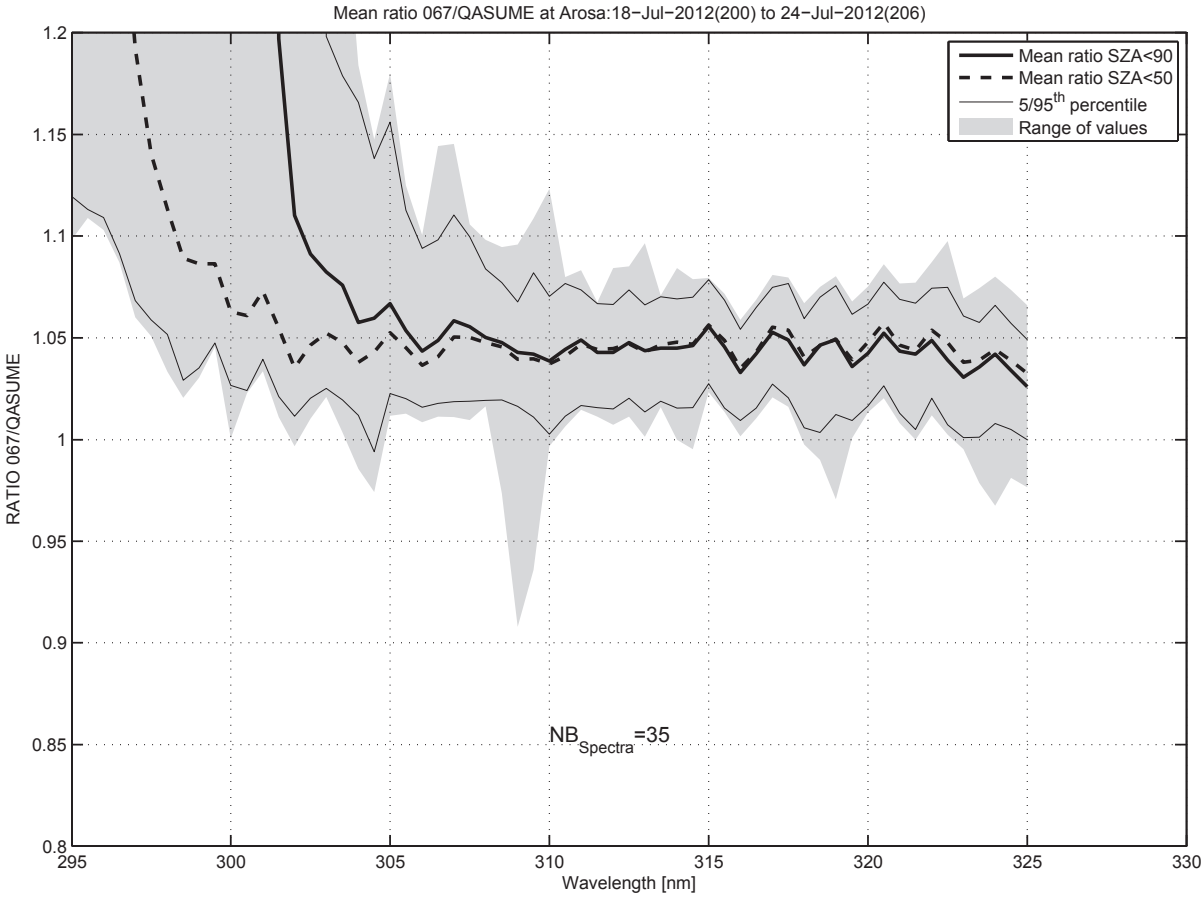

Daily variation. Wavelength bands are± 2.5 nm
49°
27°
75°
305 nm
310 nm
315 nm
320 nm
TIME [UT](SZA)

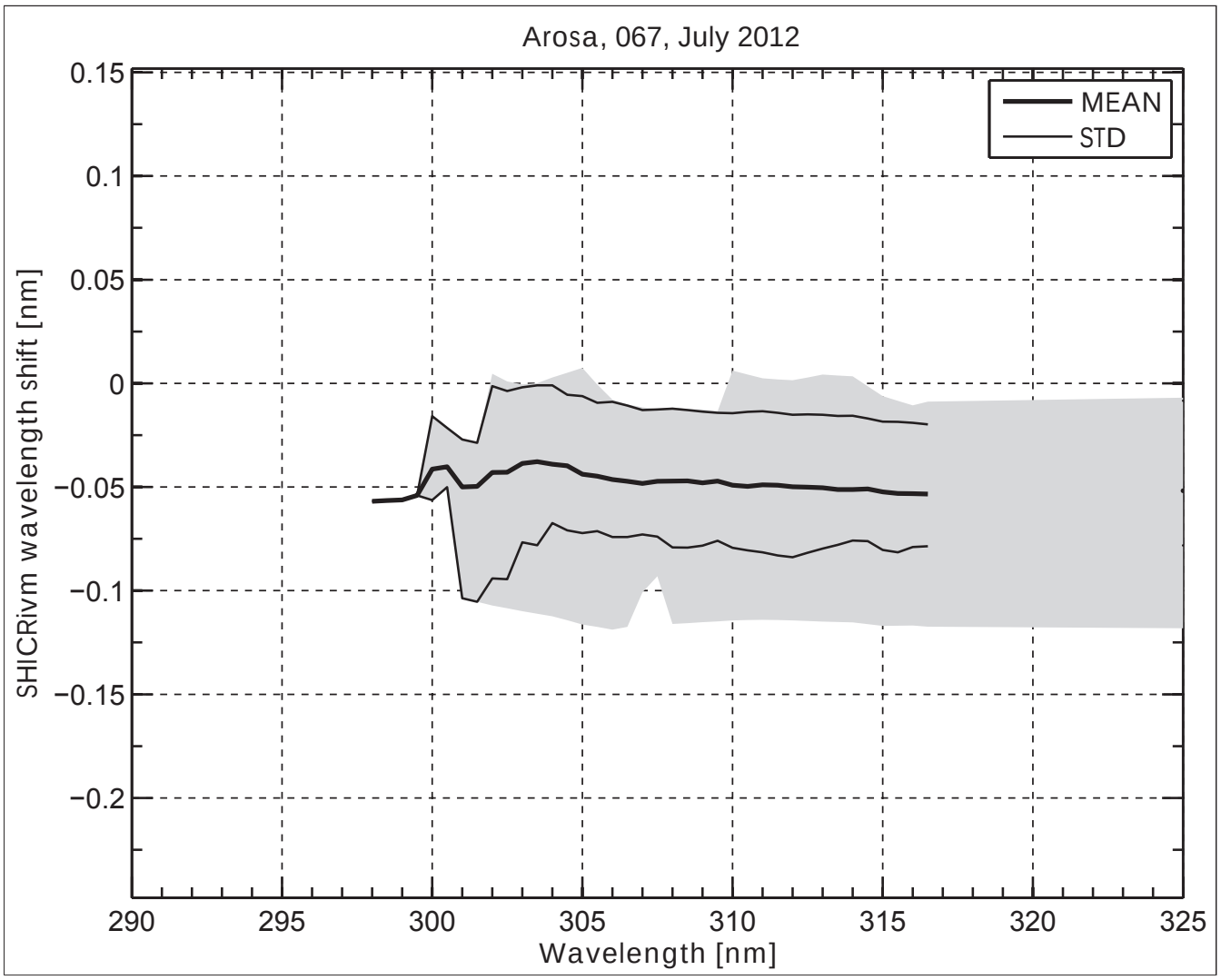

Global irradiance ratios 067/QASUME at Arosa:23−Jul−2012(205)
wl [nm]
UVIndex

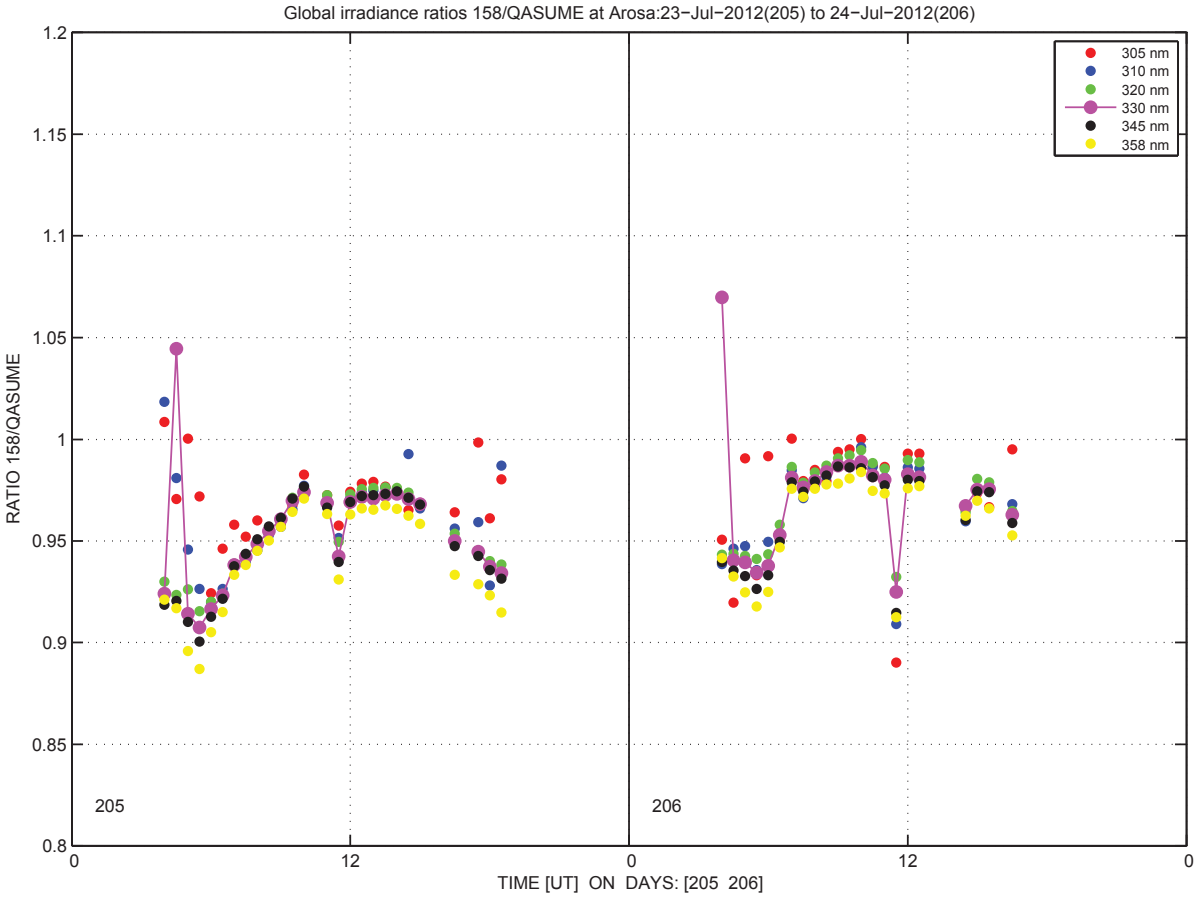

Daily variation. Wavelength bands are± 2.5 nm
60°
27°
86°
305 nm
310 nm
315 nm
320 nm
TIME [UT](SZA)

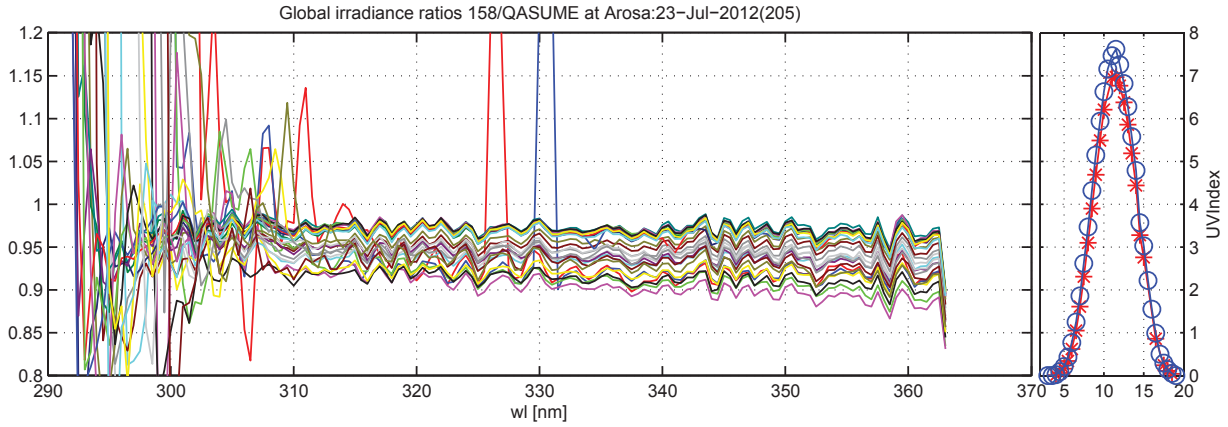

Global irradiance ratios 067/QASUME at Arosa:24−Jul−2012(206)
wl [nm]
UVIndex

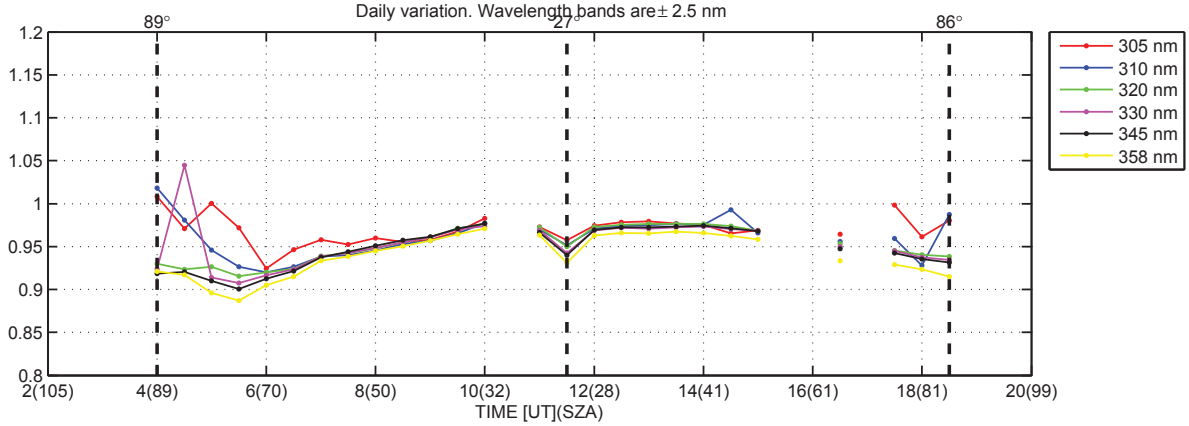

Daily variation. Wavelength bands are± 2.5 nm
89°
60°
305 nm
310 nm
315 nm
320 nm
TIME [UT](SZA)

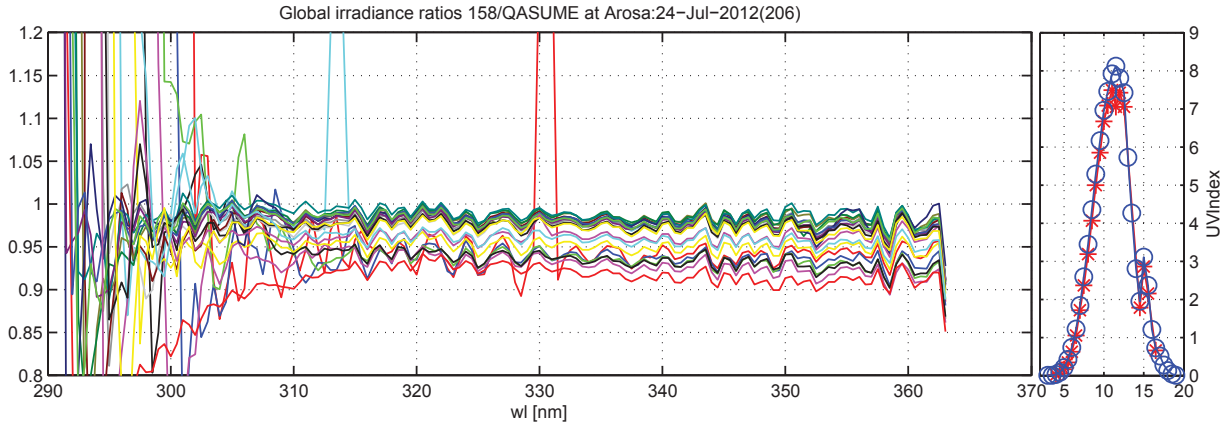

Mean ratio 067/QASUME at Arosa:18−Jul−2012(200) to 24−Jul−2012(206)
Mean ratio SZA<90
Mean ratio SZA<50
5/95th percentile
Range of values
RATIO 067/QASUME
NBSpectra=35
Wavelength [nm]

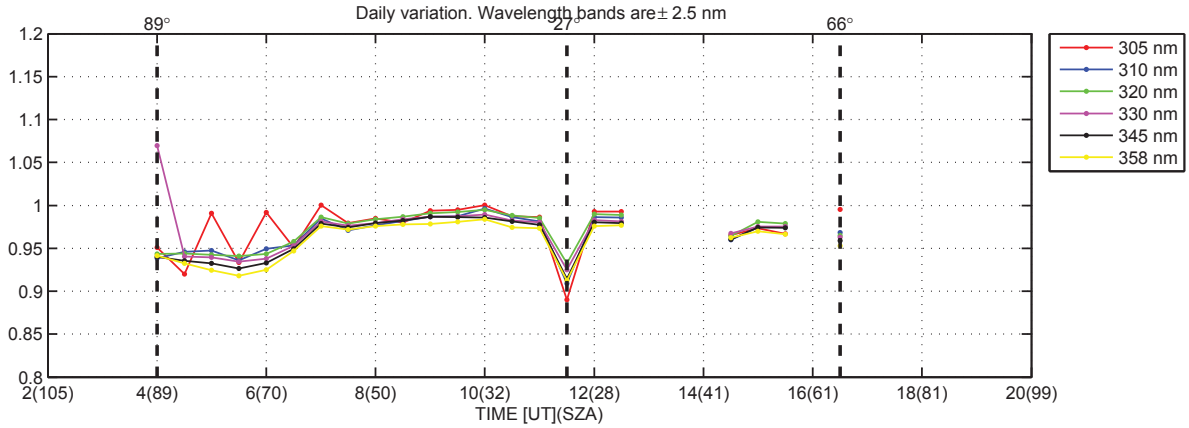

Arosa, 067, July 2012
MEAN
STD
SHICRivm wavelength shift [nm]
Wavelength [nm]
0.15
0.1
0.05
0
−0.05
−0.1
−0.15
−0.2
290
295
300
305
310
315
320
325

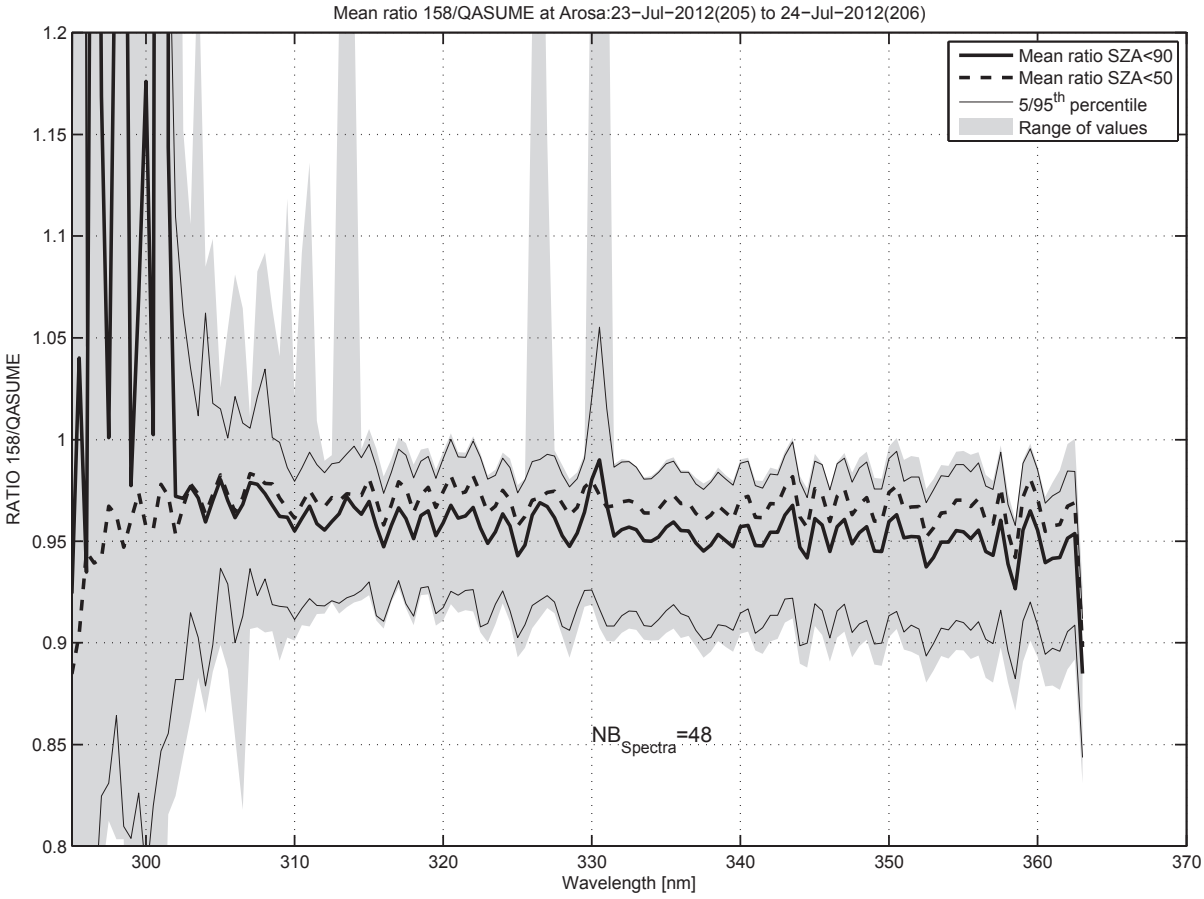

Global irradiance ratios 158/QASUME at Arosa:23−Jul−2012(205) to 24−Jul−2012(206)
RATIO 158/QASUME
TIME [UT] ON DAYS: [205 206]
205
206
305 nm
310 nm
320 nm
330 nm
345 nm
358 nm

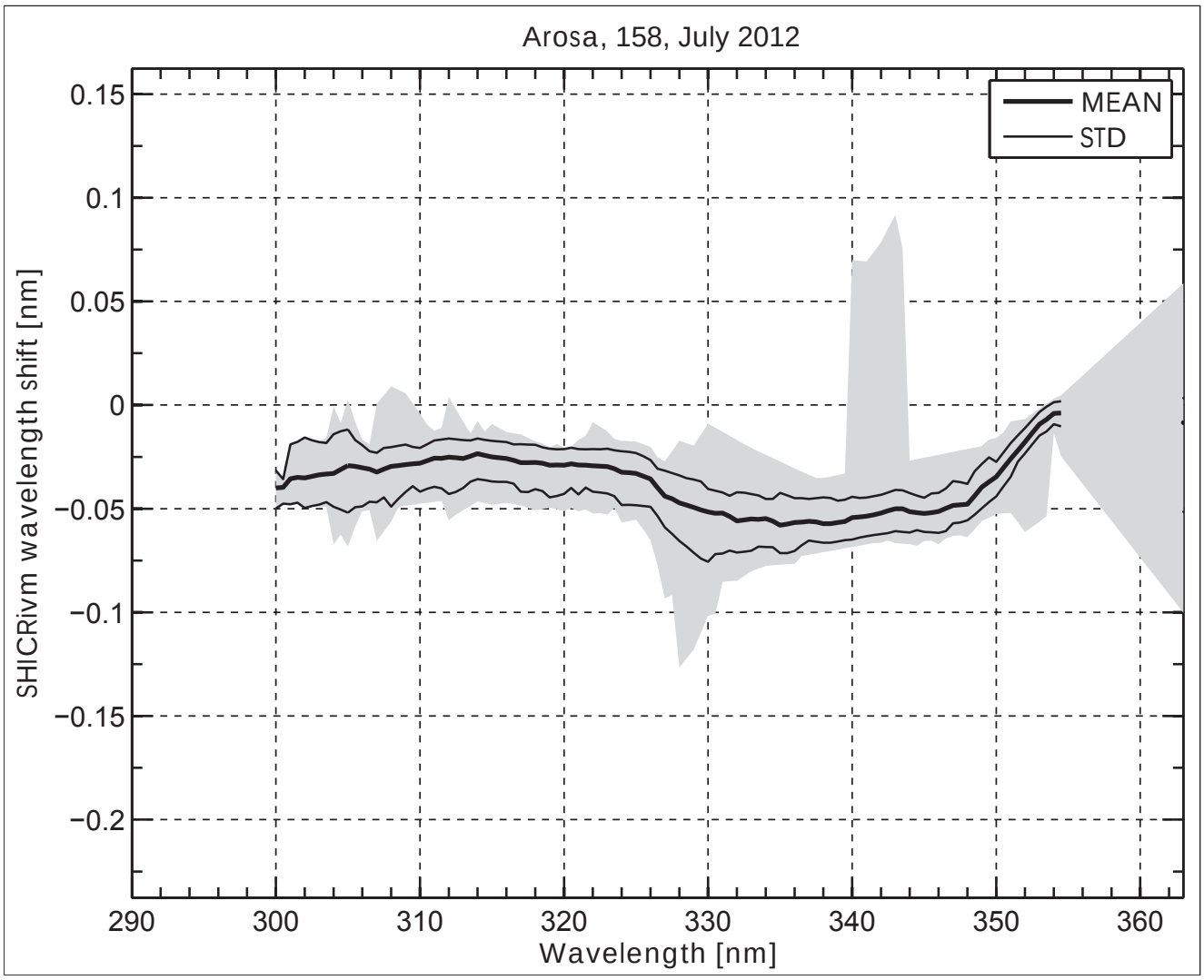

Global irradiance ratios 158/QASUME at Arosa:23−Jul−2012(205)
wl [nm]
UVIndex

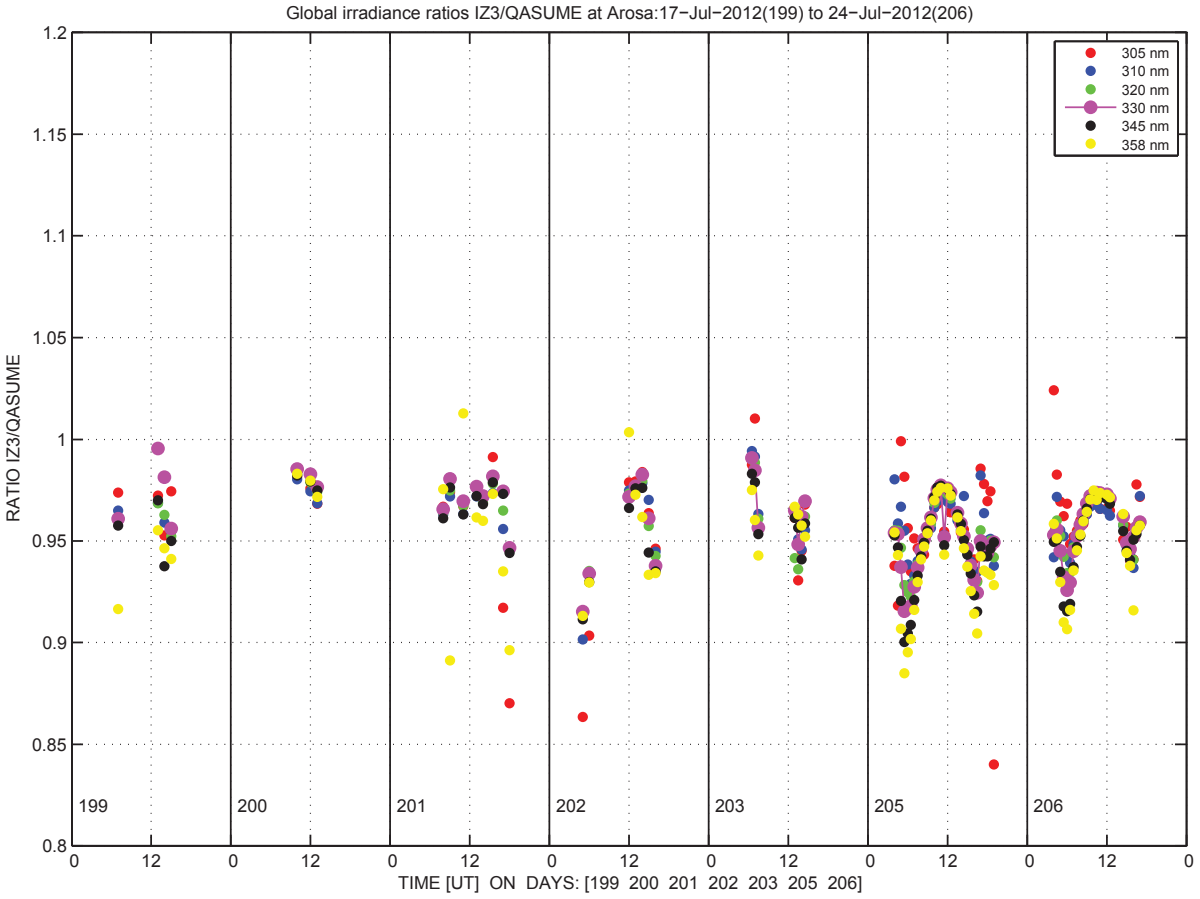

Daily variation. Wavelength bands are± 2.5 nm
89°
27°
86°
TIME [UT](SZA)
2(105)
4(89)
6(70)
8(50)
10(32)
12(28)
14(41)
16(61)
18(81)
20(99)
305 nm
310 nm
320 nm
330 nm
345 nm
358 nm

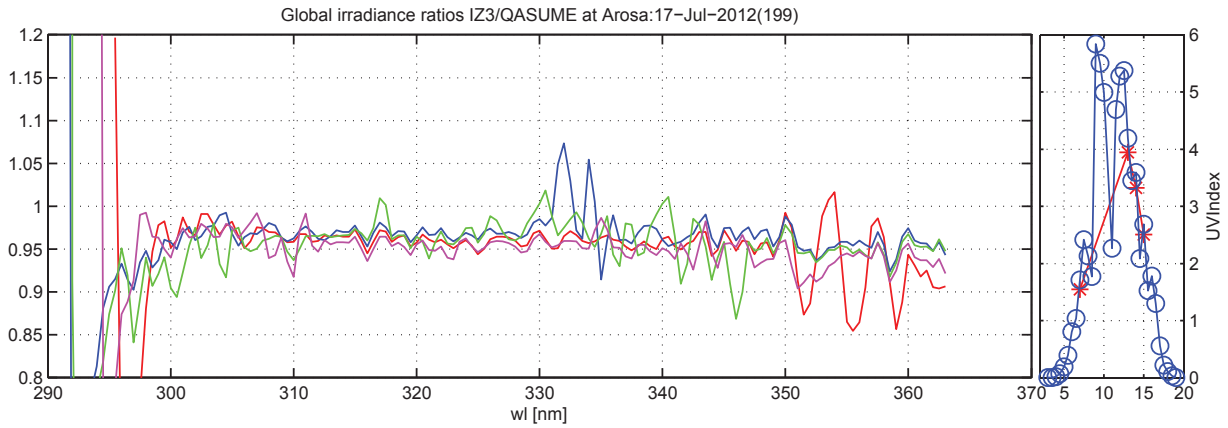

Global irradiance ratios 158/QASUME at Arosa:24−Jul−2012(206)
wl [nm]
UVIndex

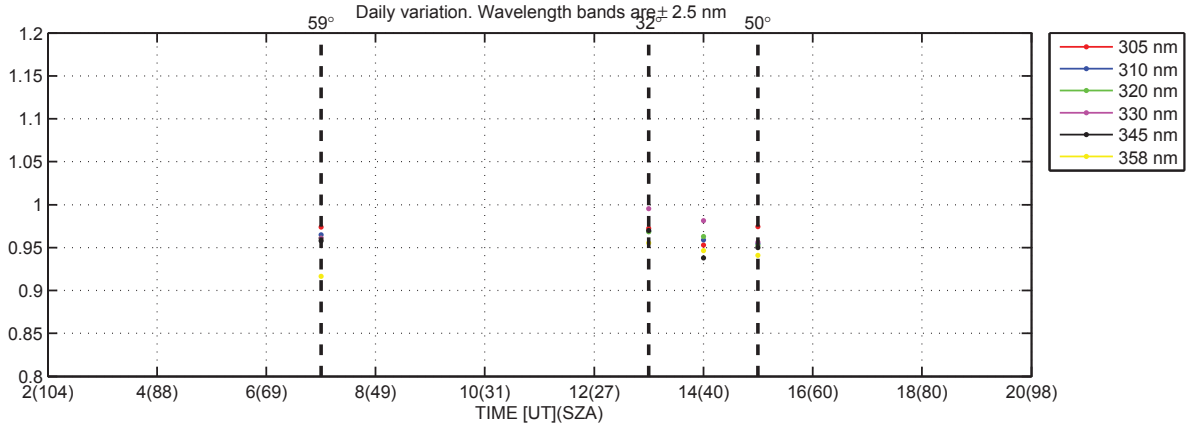

Daily variation. Wavelength bands are± 2.5 nm
89°
27°
66°
305 nm
310 nm
320 nm
330 nm
345 nm
358 nm
TIME [UT](SZA)

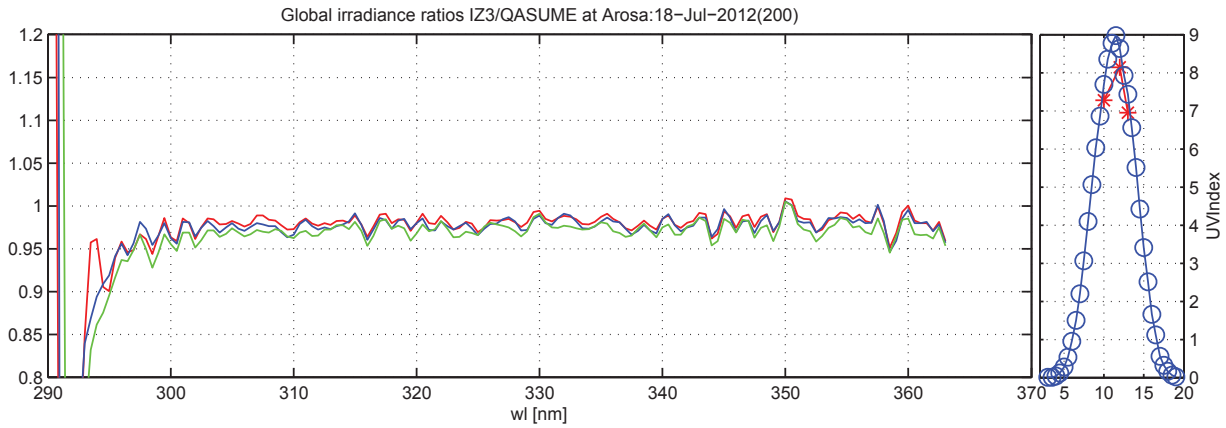

Mean ratio 158/QASUME at Arosa:23−Jul−2012(205) to 24−Jul−2012(206)
Mean ratio SZA<90
Mean ratio SZA<50
5/95th percentile
Range of values
RATIO 158/QASUME
NBSpectra=48
Wavelength [nm]

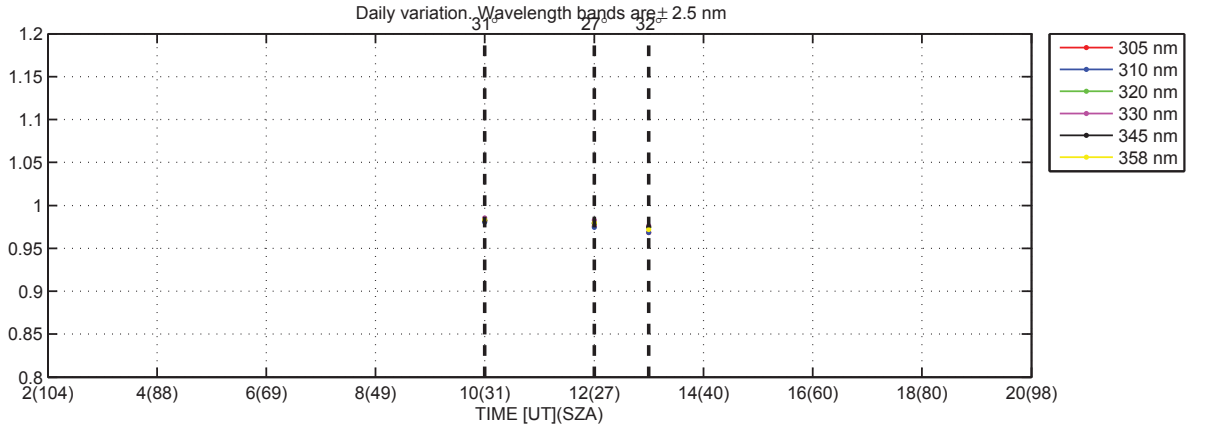

Arosa, 158, July 2012
MEAN
STD
SHICRivm wavelength shift [nm]
Wavelength [nm]
0.15
0.1
0.05
0
−0.05
−0.1
−0.15
−0.2
290
300
310
320
330
340
350
360

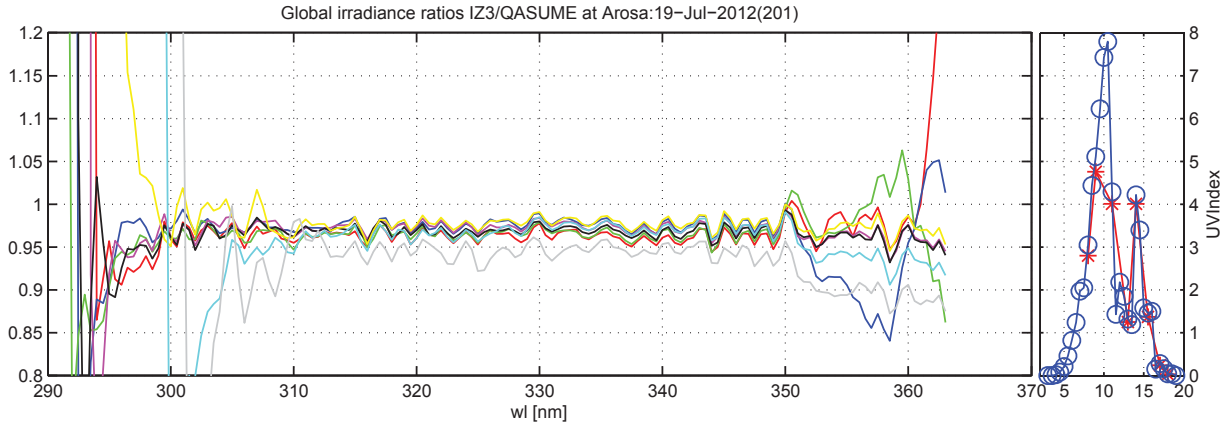

Global irradiance ratios IZ3/QASUME at Arosa:17−Jul−2012(199) to 24−Jul−2012(206)
RATIO IZ3/QASUME
TIME [UT] ON DAYS: [199 200 201 202 203 205 206]
305 nm
310 nm
320 nm
330 nm
345 nm
358 nm
199
200
201
202
203
205
206

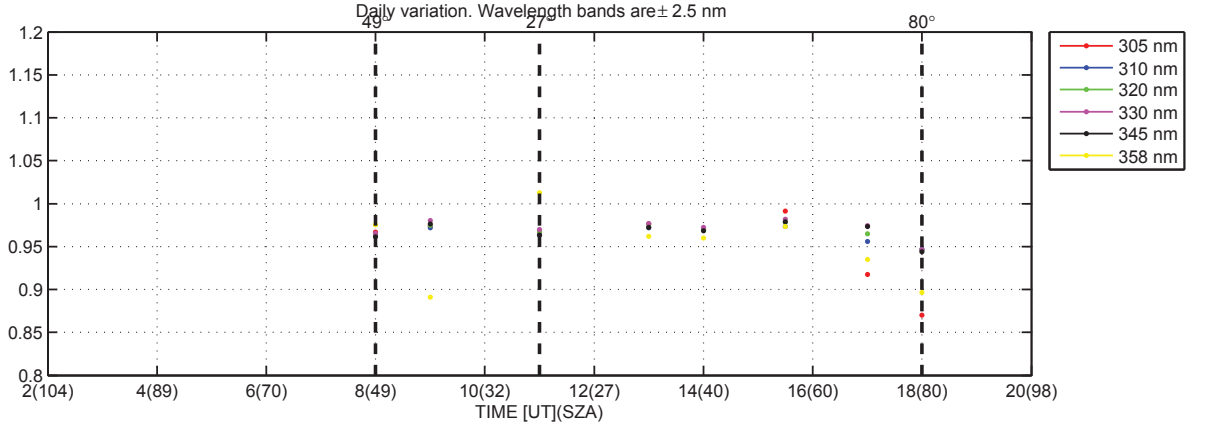

Global irradiance ratios IZ3/QASUME at Arosa:17−Jul−2012(199)
wl [nm]
UVIndex

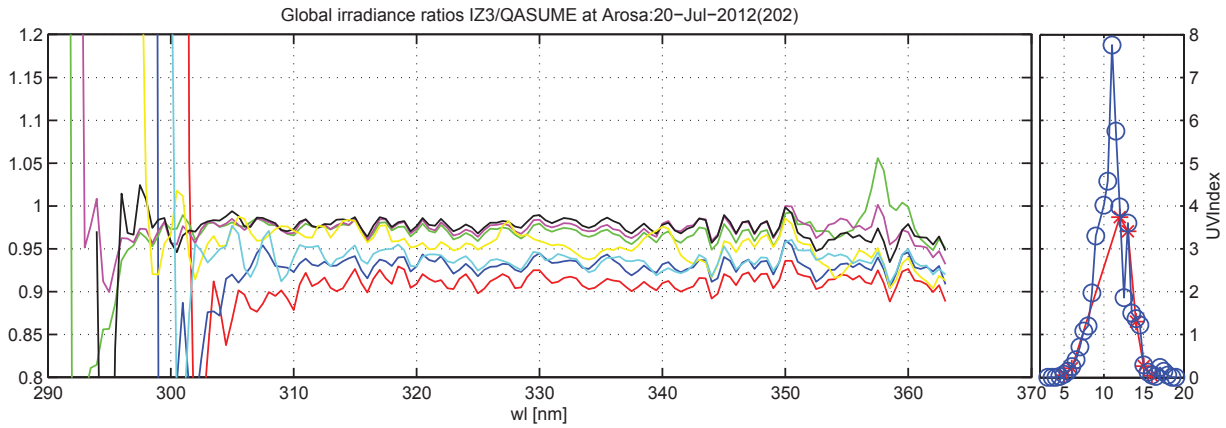

Daily variation. Wavelength bands are ± 2.5 nm
59°
32°
50°
TIME [UT](SZA)
2(104)
4(88)
6(69)
8(49)
10(31)
12(27)
14(40)
16(60)
18(80)
20(98)
305 nm
310 nm
320 nm
330 nm
345 nm
358 nm

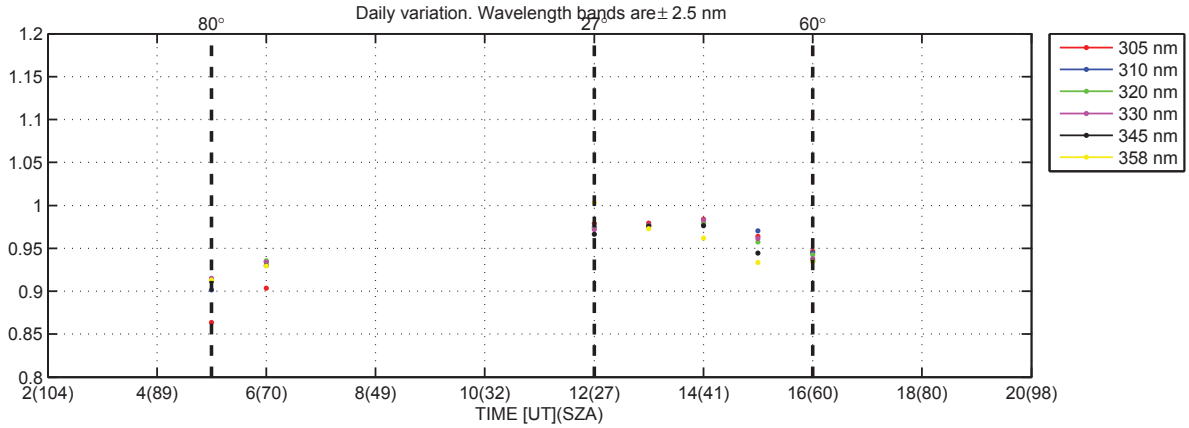

Global irradiance ratios IZ3/QASUME at Arosa:18−Jul−2012(200)
wl [nm]
UVIndex

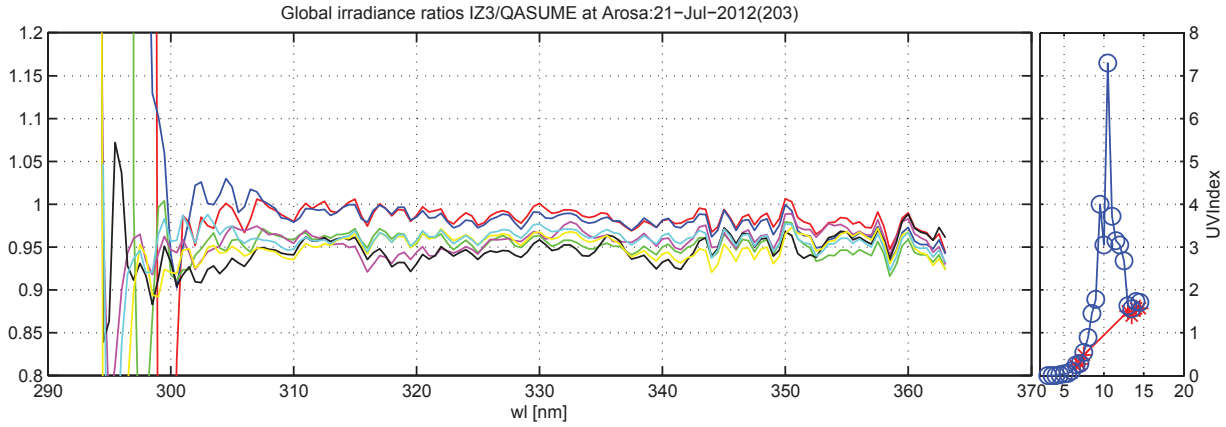

Daily variation. Wavelength bands are± 2.5 nm
31°
27°
32°
305 nm
310 nm
320 nm
330 nm
345 nm
358 nm
TIME [UT](SZA)

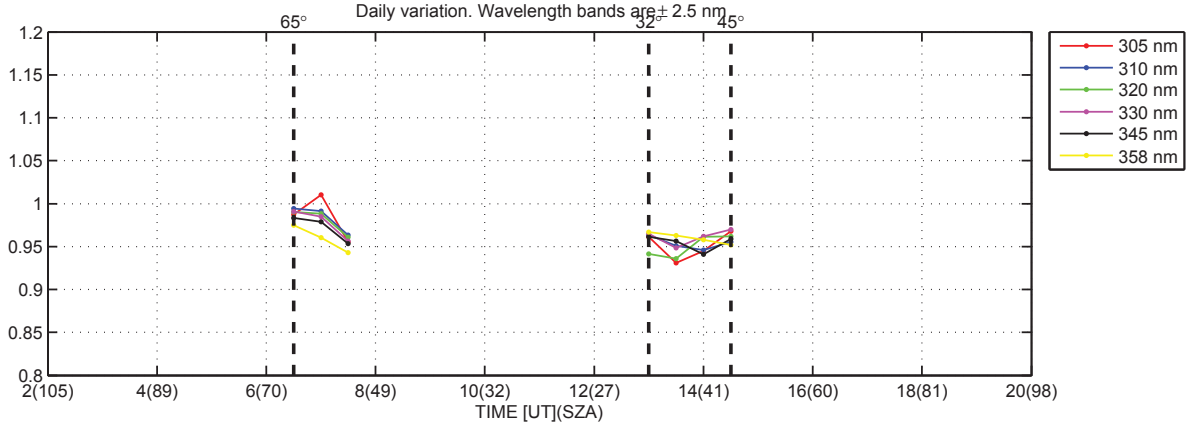

Global irradiance ratios IZ3/QASUME at Arosa:19−Jul−2012(201)
wl [nm]
UVIndex

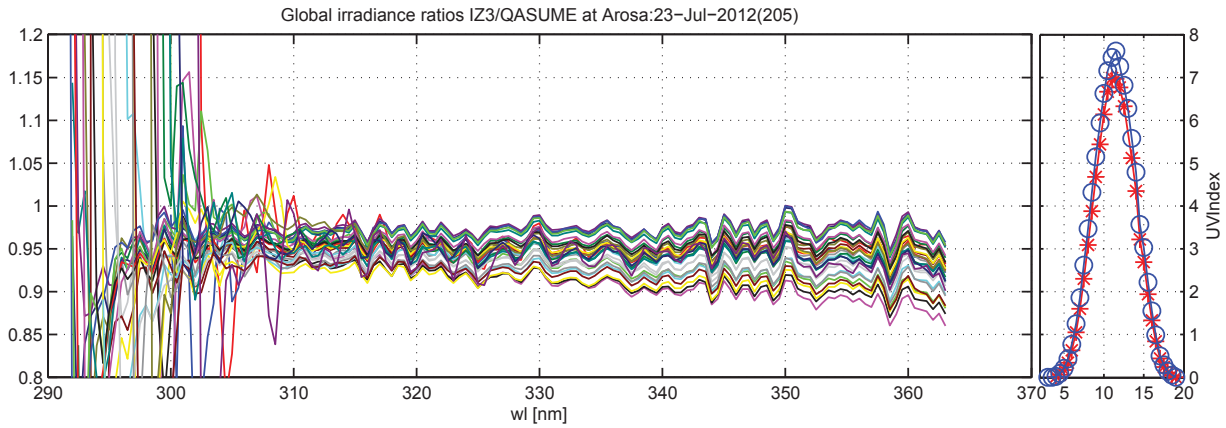

Daily variation. Wavelength bands are± 2.5 nm
49°
27°
80°
305 nm
310 nm
320 nm
330 nm
345 nm
358 nm
TIME [UT](SZA)

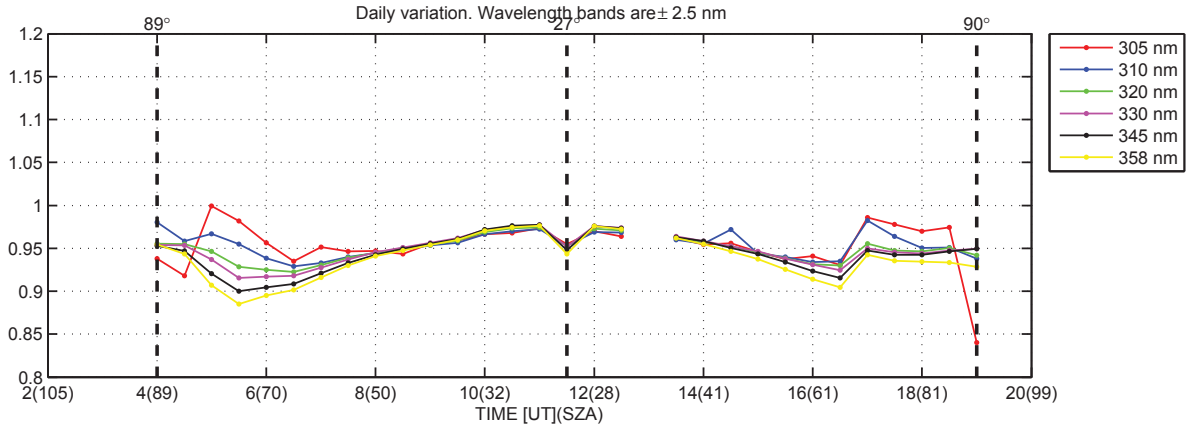

Global irradiance ratios IZ3/QASUME at Arosa:20−Jul−2012(202)
wl [nm]
UVIndex

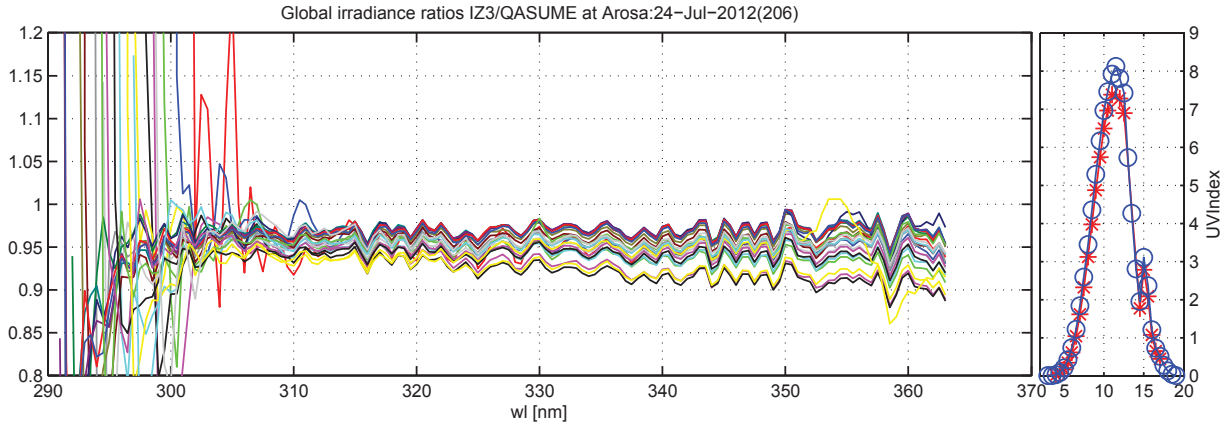

Daily variation. Wavelength bands are± 2.5 nm
80°
27°
60°
305 nm
310 nm
320 nm
330 nm
345 nm
358 nm
TIME [UT](SZA)

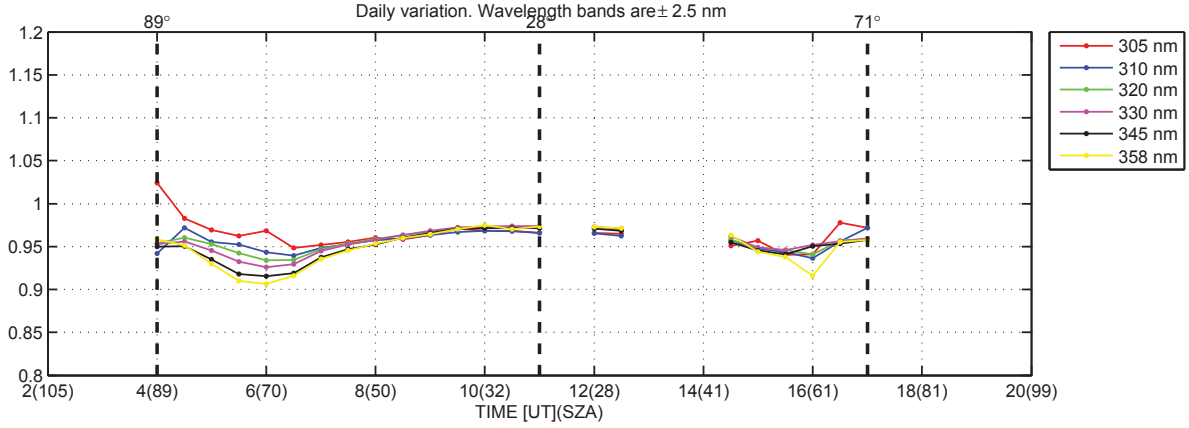

Global irradiance ratios IZ3/QASUME at Arosa:21−Jul−2012(203)
wl [nm]
UVIndex

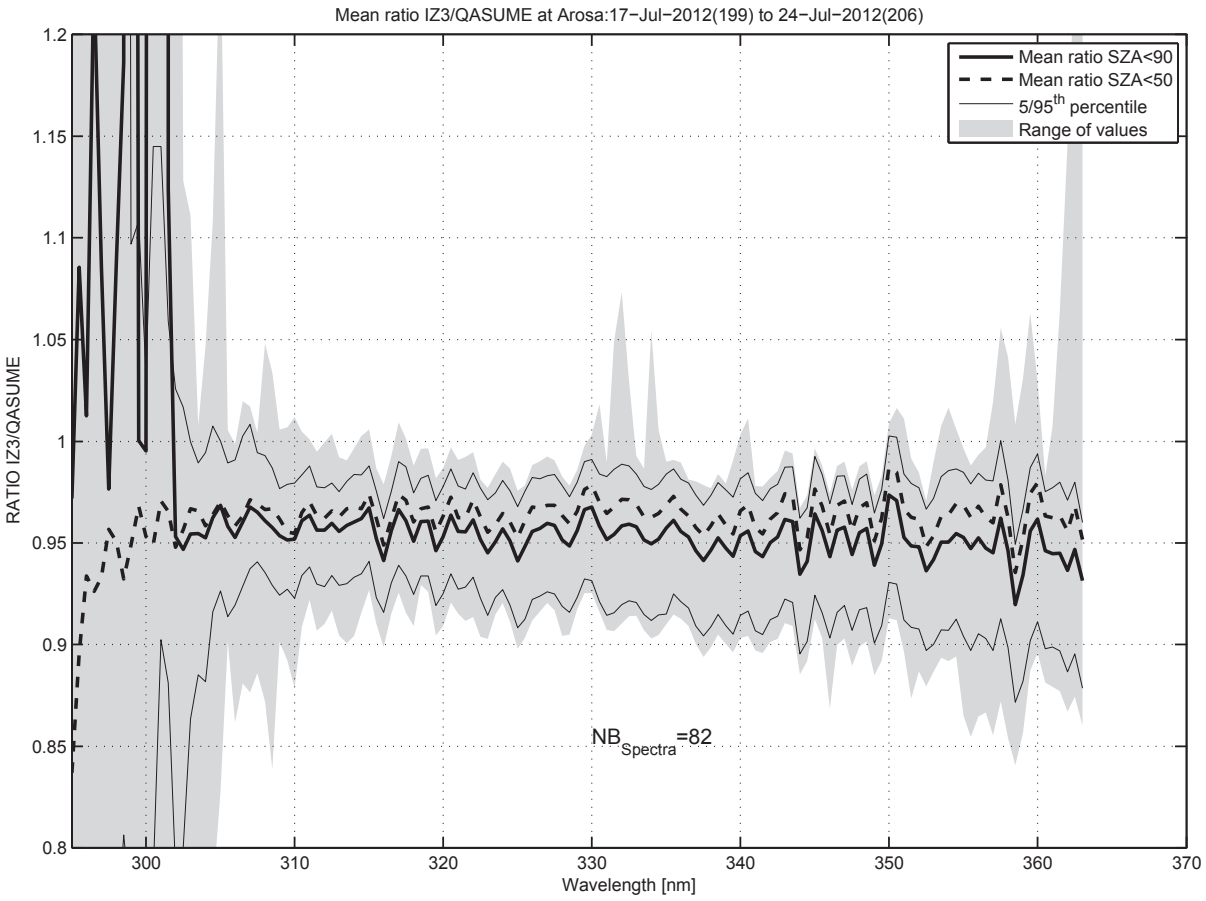

Daily variation. Wavelength bands are± 2.5 nm
65°
32°
45°
305 nm
310 nm
320 nm
330 nm
345 nm
358 nm
TIME [UT](SZA)

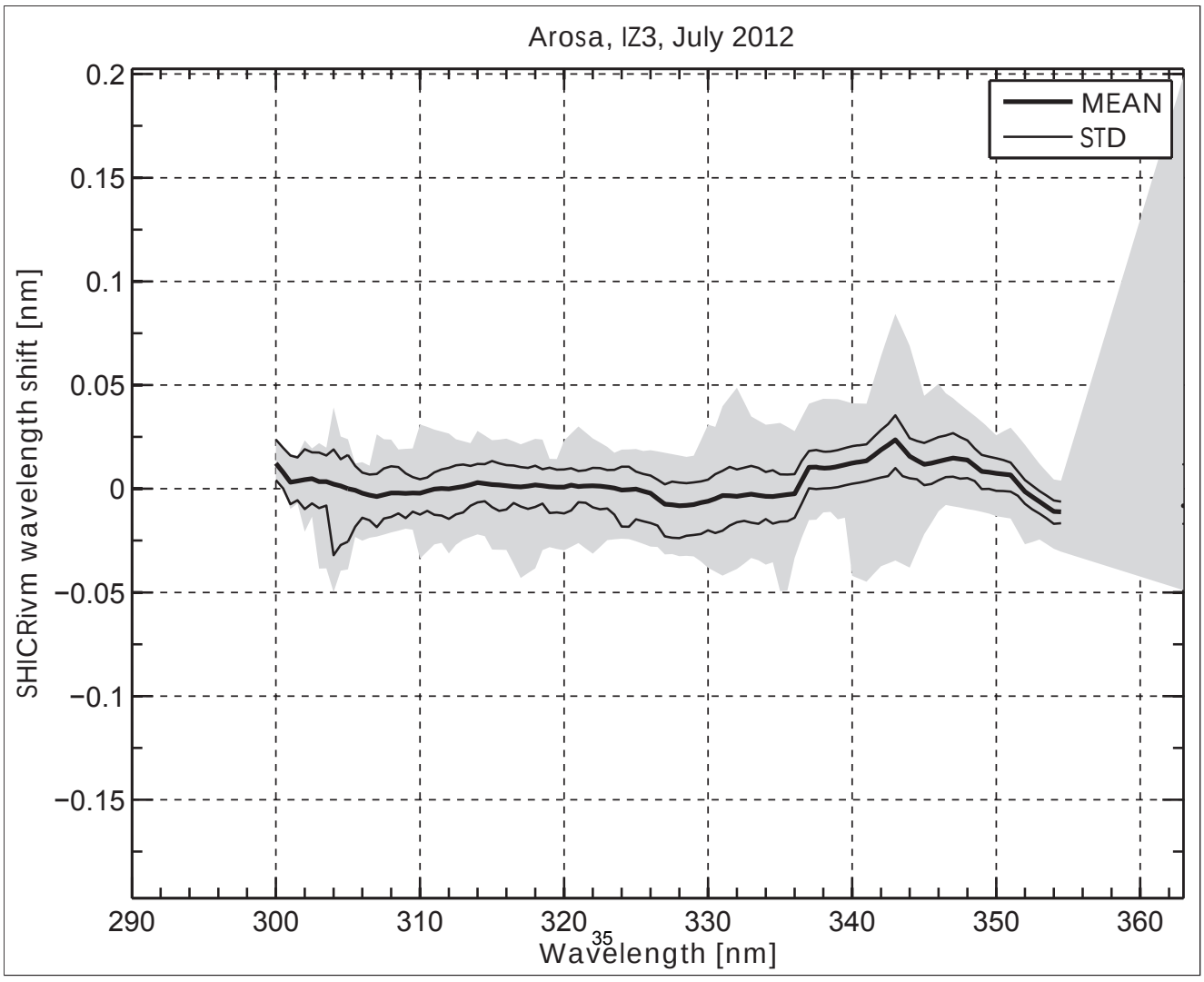

Global irradiance ratios IZ3/QASUME at Arosa:23−Jul−2012(205)
wl [nm]
UVIndex

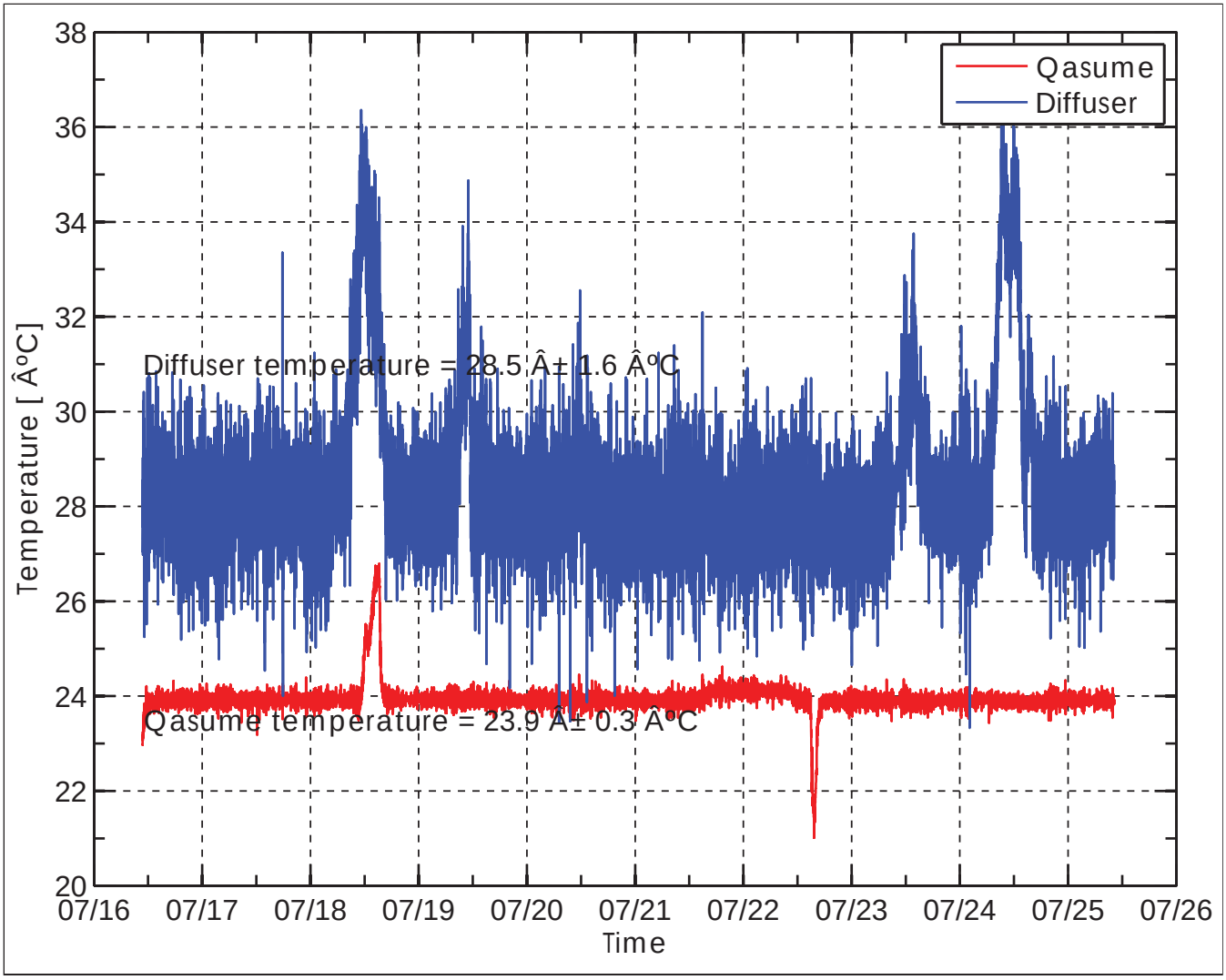

Daily variation. Wavelength bands are± 2.5 nm
89°
27°
90°
305 nm
310 nm
320 nm
330 nm
345 nm
358 nm
TIME [UT](SZA)

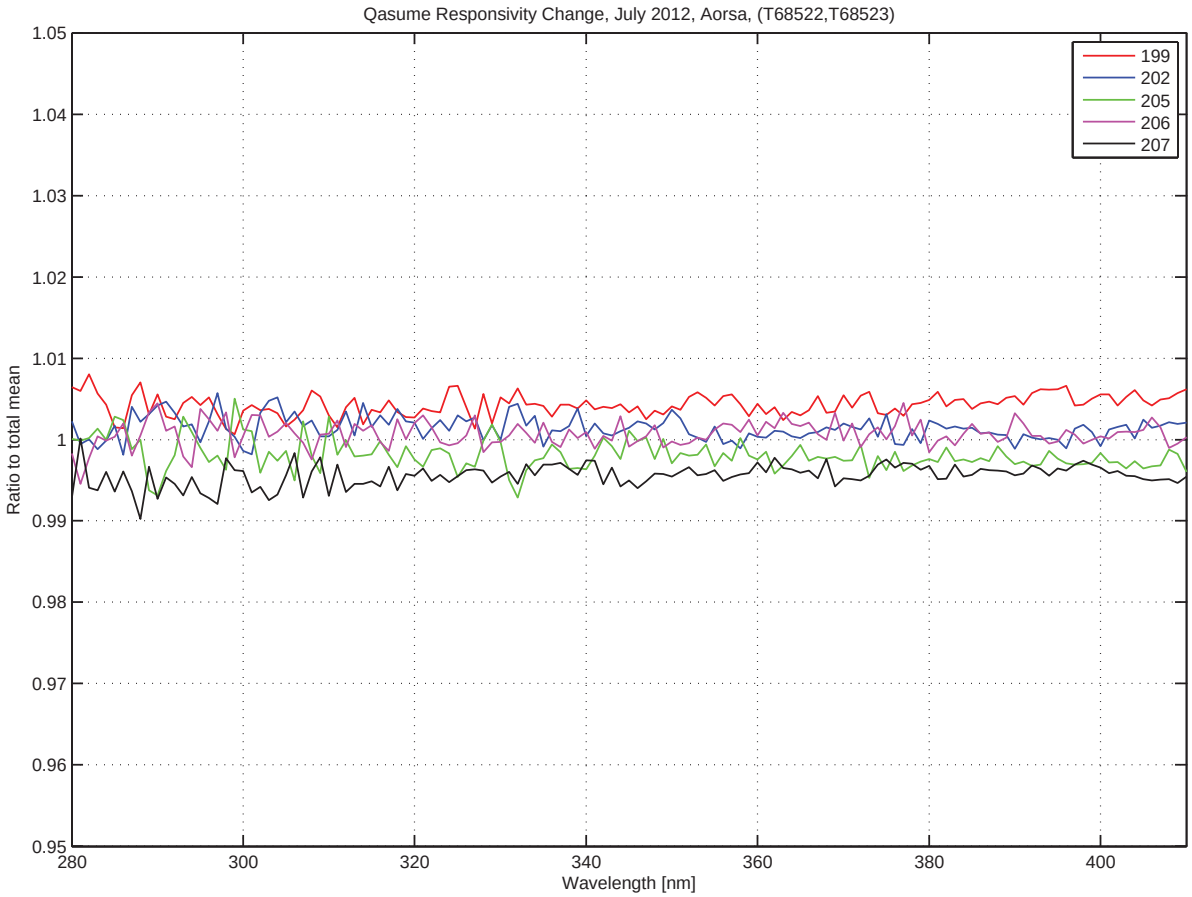

Global irradiance ratios IZ3/QASUME at Arosa:24−Jul−2012(206)
wl [nm]
UVIndex


Daily variation. Wavelength bands are± 2.5 nm
89°
28°
71°
305 nm
310 nm
320 nm
330 nm
345 nm
358 nm
TIME [UT](SZA)


Mean ratio IZ3/QASUME at Arosa:17−Jul−2012(199) to 24−Jul−2012(206)
Mean ratio SZA<90
Mean ratio SZA<50
5/95th percentile
Range of values
RATIO IZ3/QASUME
NBSpectra=82
Wavelength [nm]


Arosa, IZ3, July 2012
MEAN
STD
SHICRivm wavelength shift [nm]
Wavelength [nm]


Qasume
Diffuser
Diffuser temperature = 28.5 Â± 1.6 ÂºC
Qasume temperature = 23.9 Â± 0.3 ÂºC
Temperature [ÂºC]
Time
38
36
34
32
30
28
26
24
22
20
07/16
07/17
07/18
07/19
07/20
07/21
07/22
07/23
07/24
07/25
07/26


Qasume Responsivity Change, July 2012, Aorsa, (T68522,T68523)
199
202
205
206
207
Ratio to total mean
Wavelength [nm]
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


185_IZ
163_ISQ
156
072
040