

Protocol of the solar UV intercomparison at INTA, El Arenosillo, Spain from September 6 to September 15, 2021, with the travelling reference spectroradiometer QASUME from PMOD/WRC

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The purpose of the visit was the comparison of spectral global solar irradiance measurements between the 14 spectrophotometers participating at the 16th Regional Brewer Calibration Center – Europe (RBCC-E) Campaign and the travel reference spectroradiometer QASUME. The measurement site is located at El Arenosillo; Latitude 37.10 N, Longitude 6.73 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 19:00 UT have been analysed.

QASUME arrived at INTA in the morning of September 6, 2021. The spectroradiometer was installed in line to the Brewer spectrophotometers with the entrance optic of QASUME between 2 and 20 m away from the other instruments. The measurement campaign lasted nine days, from morning of September 6 to the afternoon of September 15.

QASUME was calibrated several times during the intercomparison period using a portable calibration system. Three lamps (T16573, T68522 and T685240) 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 2 % during the intercomparison period.

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.

Table 1: Participating Brewer spectrophotometers; 6 single and 8 double monochromators.

Instrument ID	Institution	Operator	Country
#005-MKII	Thessaloniki	Alkis Bias	Greece
#033-MKIV	AEMET Santa Cruz	Jose Maria	Spain
#070-MKIV	AEMET Coruna	Jose Maria	Spain
#075-MKIV	UKMO	John Rimmer	U.K.
#117-MKIV	INM MURCIA	Jose Maria	Spain
#126-MKII	UKMO	John Rimmer	U.K.
#150-MKIII	INTA HUELVA	Jose Manuel Vilaplana	Spain
#151-MKIV	AEMET Madrid	Jose Maria	Spain
#166-MKIV	AEMET Zargoza	Jose Maria	Spain
#172-MKIII	UKMO	John Rimmer	U.K.
#185-MKIII (IZ3)	AEMET IZAÑA	Alberto Redondas	Spain
#186-MKIII	AEMET Madrid	Jose Maria	Spain
#202-MKIII	DNK	Nils	Denmark
#228-MKIII	DNK	Nils	Denmark

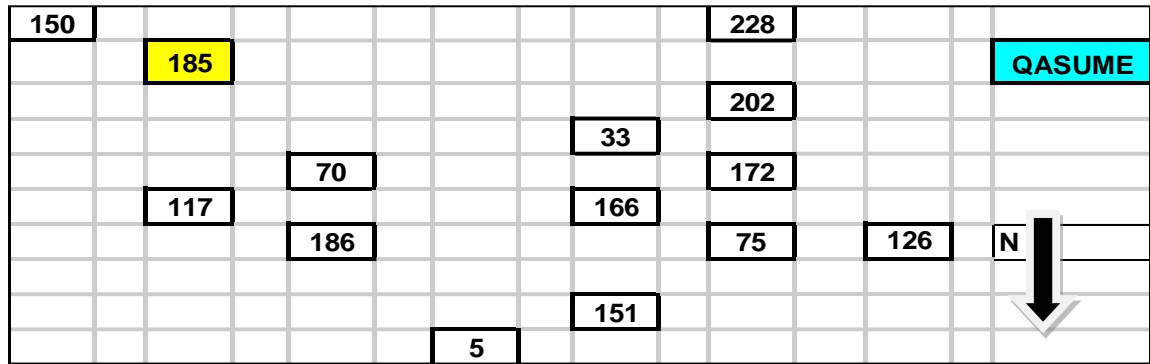


Figure 1: Roof setup at INTA

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. The official UV days were scheduled from 12 to 15 September. Because of the weather conditions expected during those days, UV scans were performed throughout the campaign.

Direct irradiance was recorded for DOY 249, 250 and 253 between 290 to 400nm or between 290 and 550 nm.

DOY	Date	DAY	Weather	Mode	Comment (time in UT)
249	6-Sep	Monday	Diffuse Sky	DIR	Installed at 08:15 Calibrated: 08:47 using T685240
250	7-Sep	Tuesday	Clear Sky	DIR	Calibrated: 14:43 using T685240
251	8-Sep	Wednesday	Clear Sky	(DIR) GLO	Calibrated: 07:39 using T685240 Calibrated: 16:14 using T685240
252	9-Sep	Thursday	Overcast (morning) Clear Sky	GLO	Calibrated: 17:13 using T685240
253	10-Sep	Friday	Clear Sky Clouds (afternoon)	DIR	Calibrated: 09:48 using T685240
254	11-Sep	Saturday	Clouds (morning) Clear Sky	GLO	Calibrated: 08:45 using T685240 Calibrated: 09:19 using T16573 Calibrated: 09:48 using T68522
255	12-Sep	Sunday	Clear Sky Fog (morning)	GLO	Calibrated: 15:00 using T68522
256	13-Sep	Monday	Overcast Rain shower (morning)	GLO	Calibrated: 15:00 using T68522
257	14-Sep	Tuesday	Overcast Rain (Morning)	GLO	Calibrated: 15:00 using T68522
258	15-Sep	Wednesday	Mix of sun & Clouds	GLO	Calibrated: 15:00 using T68522
					End of Campaign 16:00

Results:

Up to 151 synchronised simultaneous spectra from QASUME and the Brewer spectrophotometers are available from the measurement period. Measurements between 6:00 and 19:00 UT have been analysed (SZA smaller than 90°) using matSHIC.

Remarks:

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

Brewer 202 and 223 have not been calibrated. The data shown in the Annex reflect the stability and general performance of the UV measurements from these two instruments.

No UV data is available for Brewer 005, 075 and 126.

Conclusion:

The angular response correction was not applied to the solar UV spectra and would considerably improve the comparison to QASUME. Remaining uncertainties are the stray-light for single monochromator brewers and the temperature dependence.

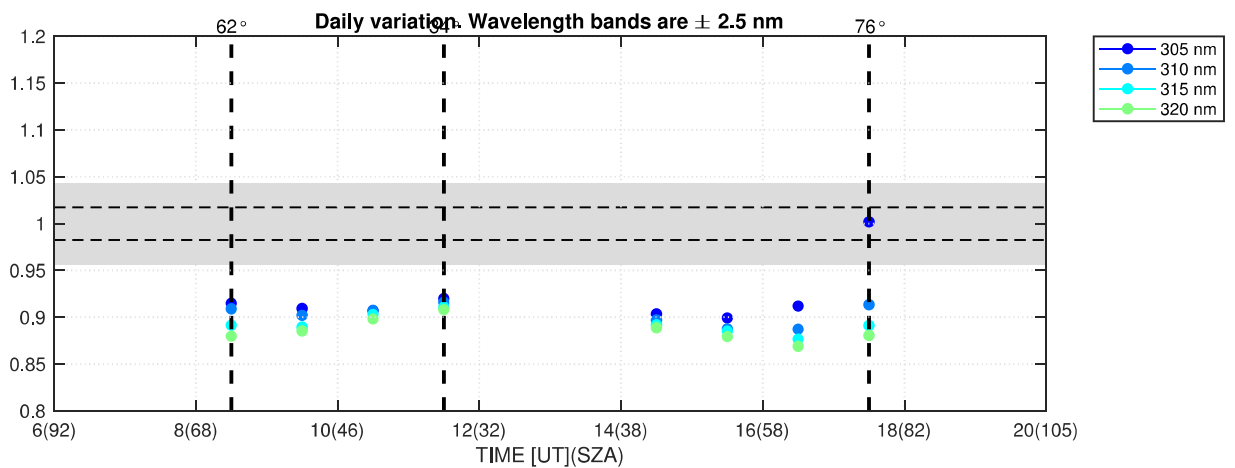
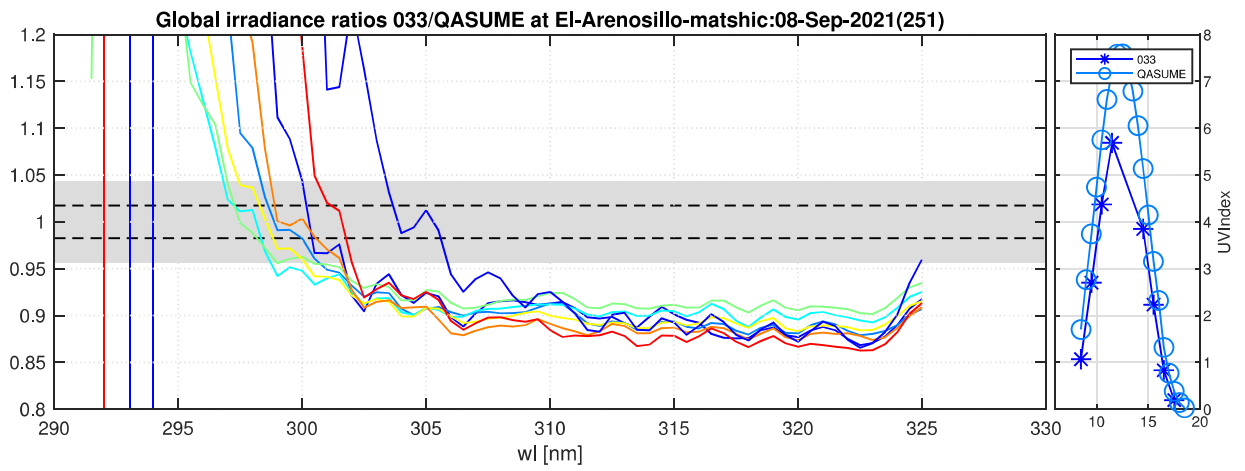
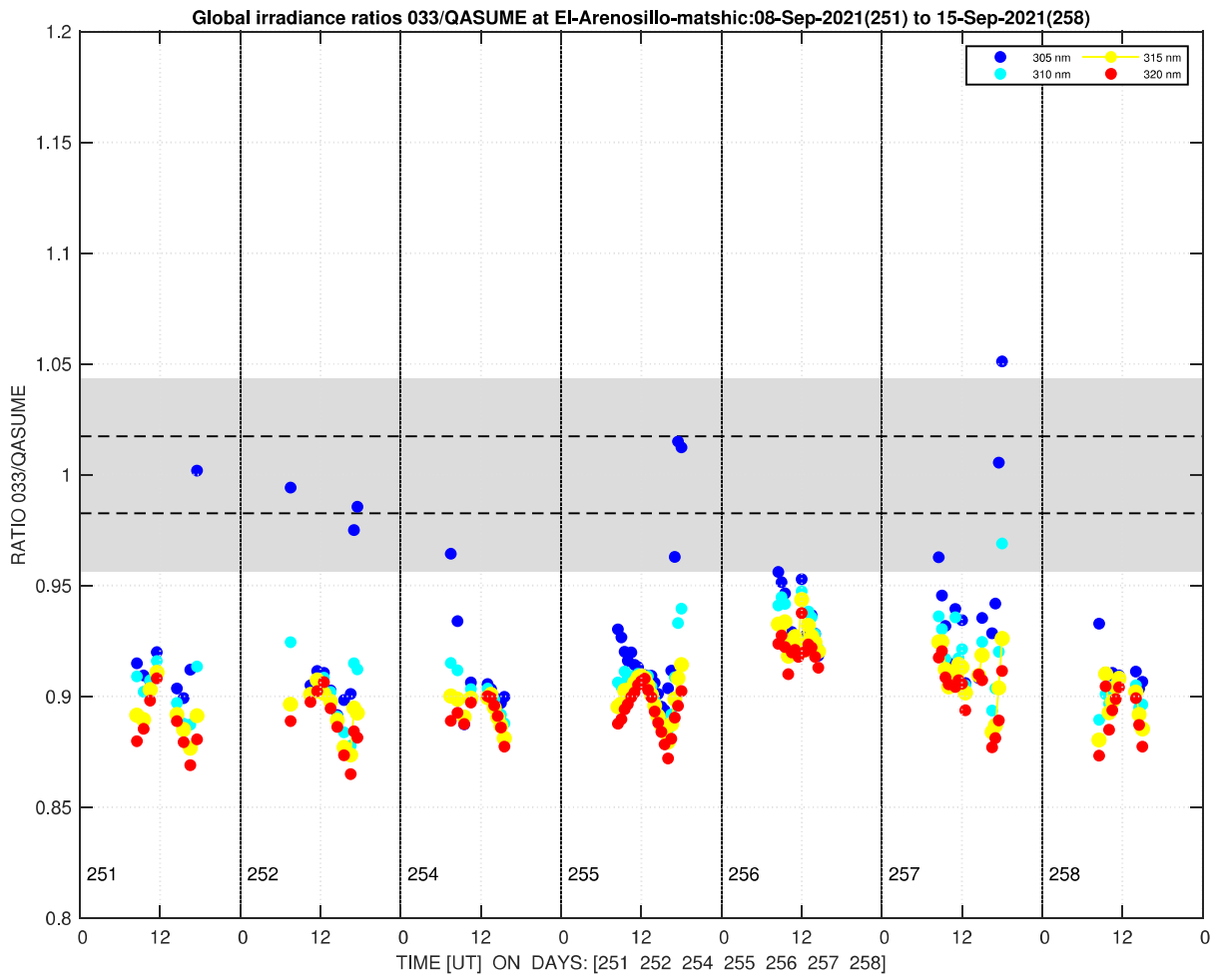
Brewer 185 will send a revised dataset including the angular response correction.

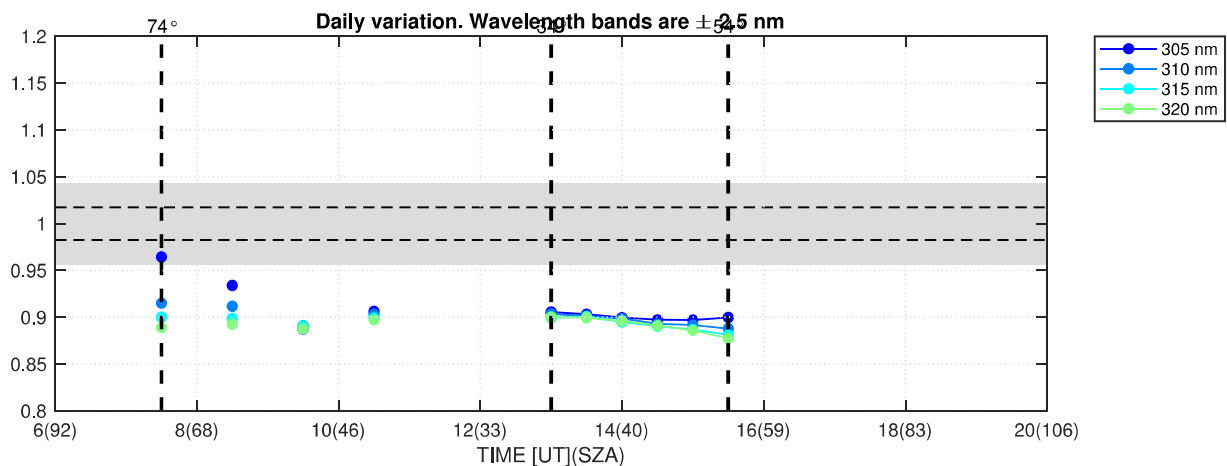
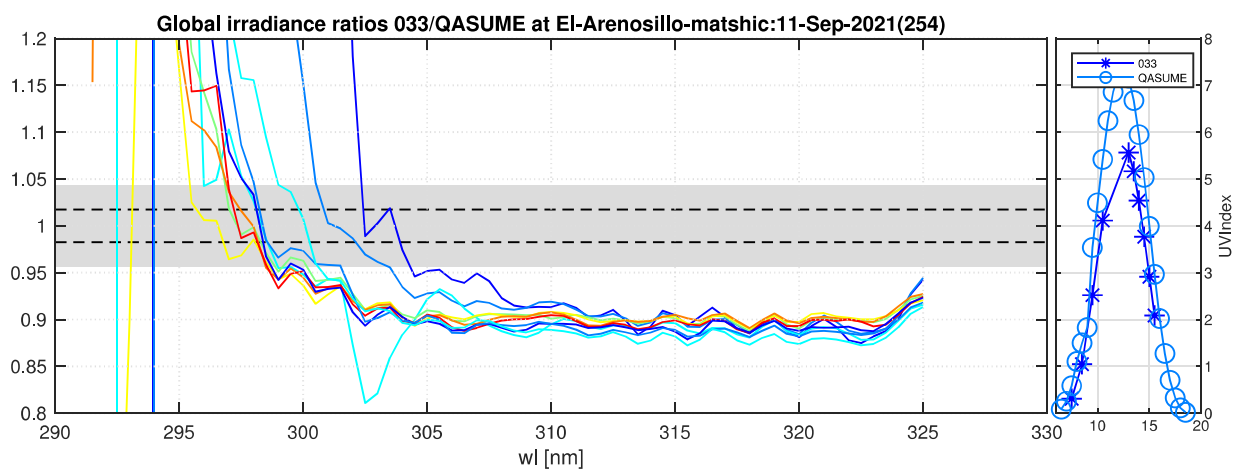
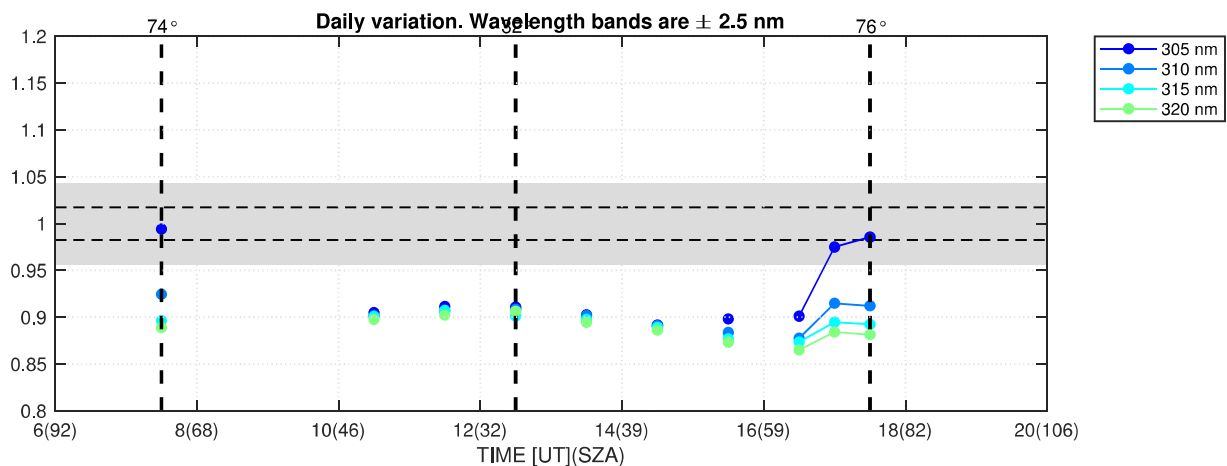
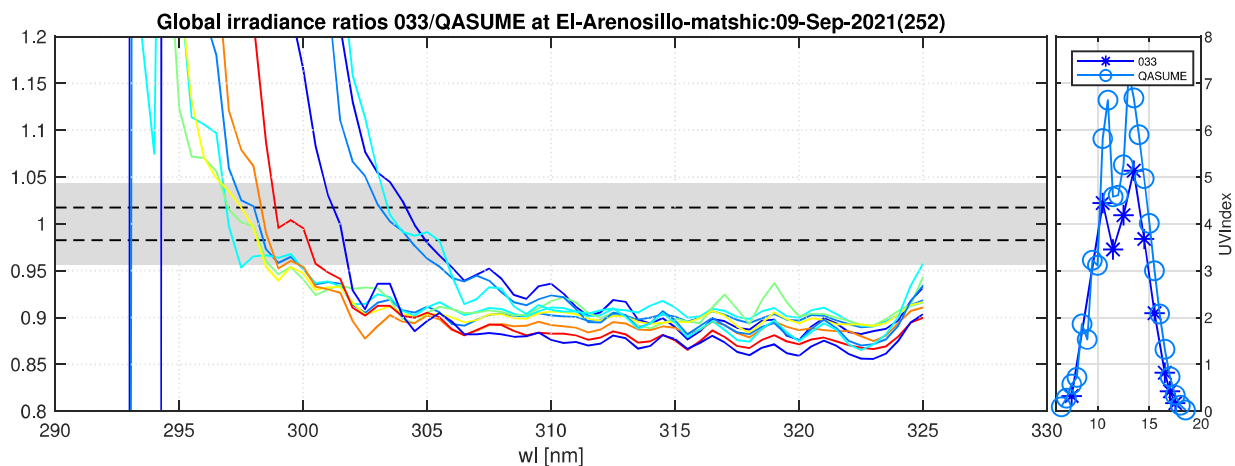
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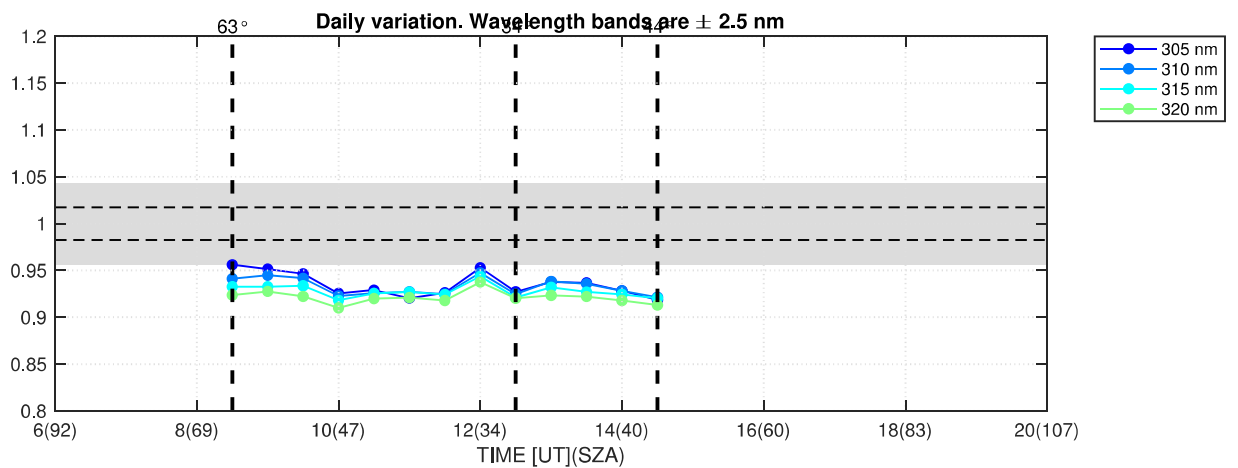
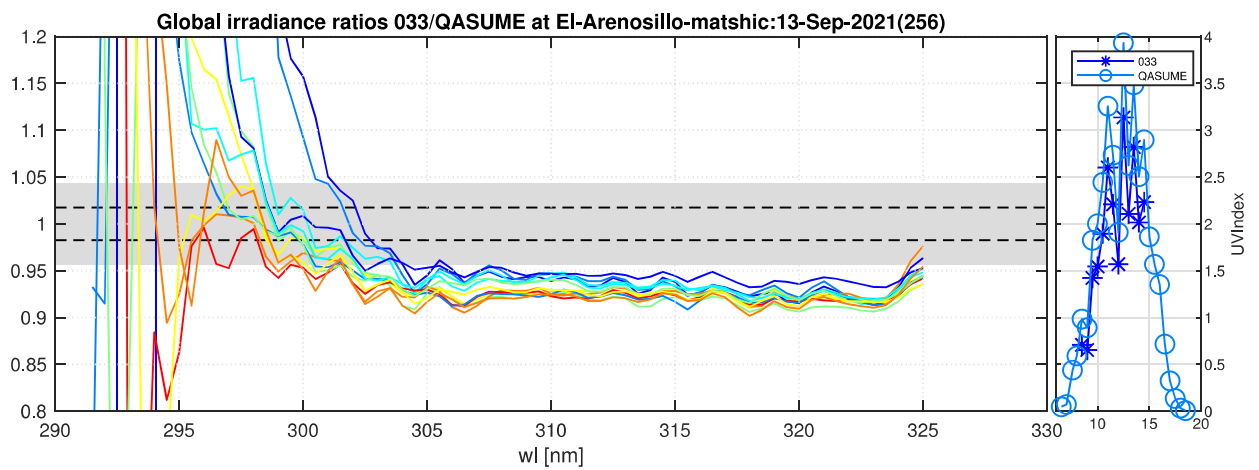
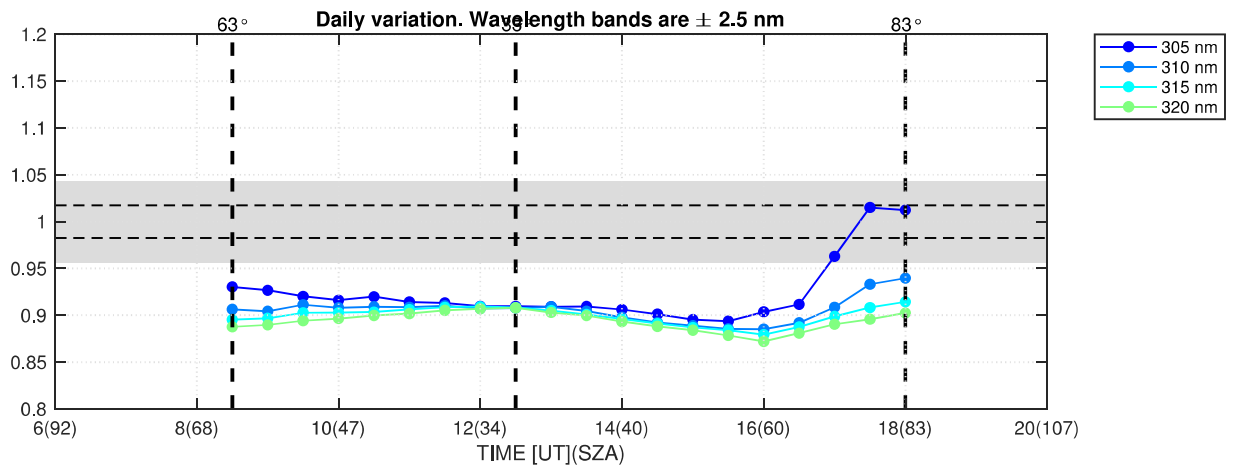
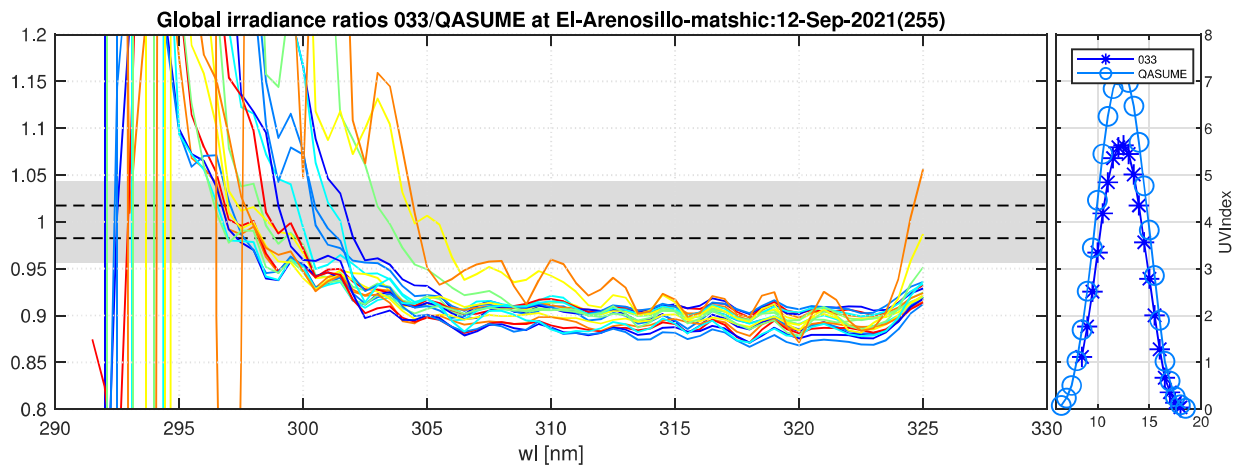
Gröbner, J., Kröger, I., Egli, L., Hülsen, G., Riechelmann, S., and Sperfeld, P.: The high-resolution extraterrestrial solar spectrum (QASUMEFTS) determined from ground-based solar irradiance measurements, *Atmos. Meas. Tech.*, 10, 3375-3383, <https://doi.org/10.5194/amt-10-3375-2017>, 2017.

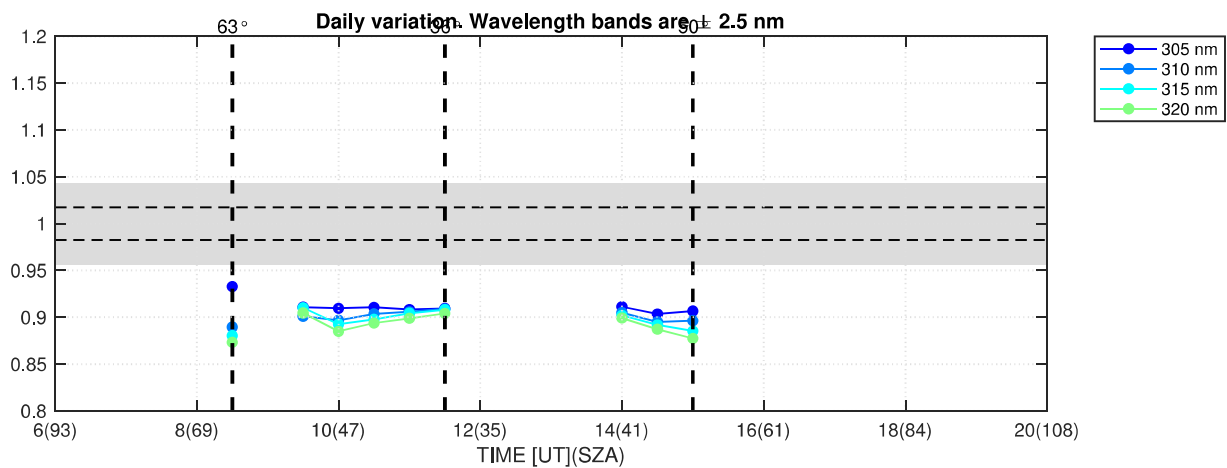
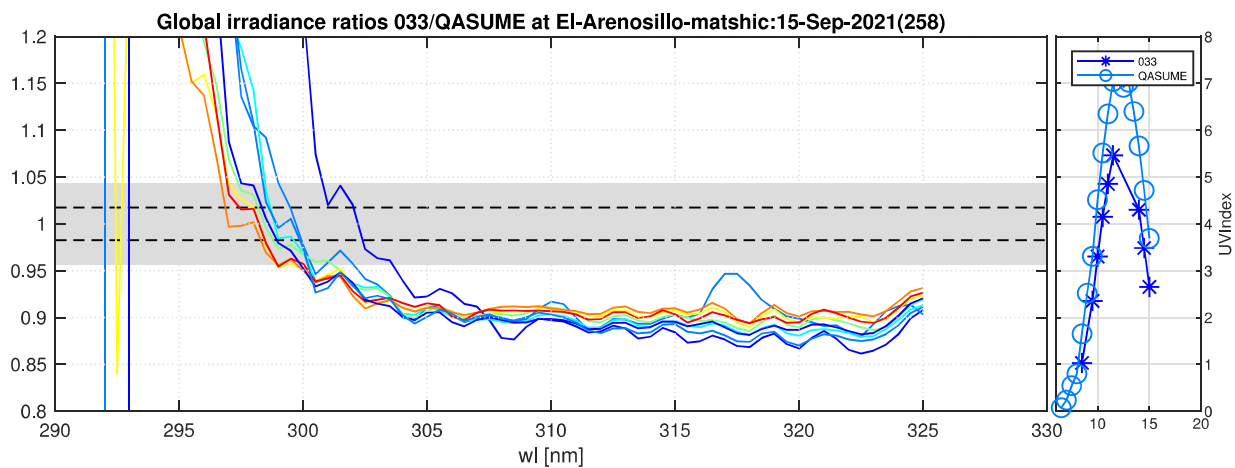
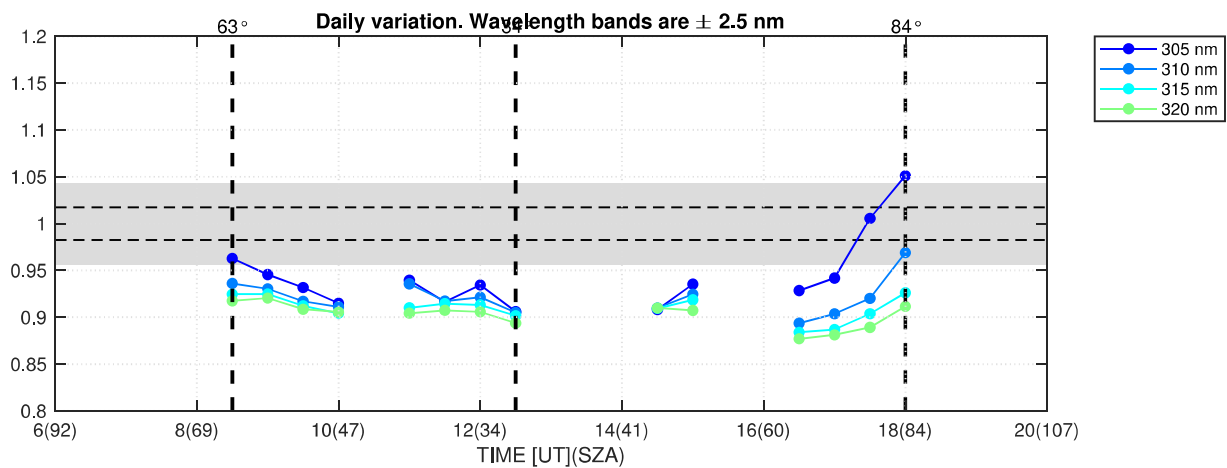
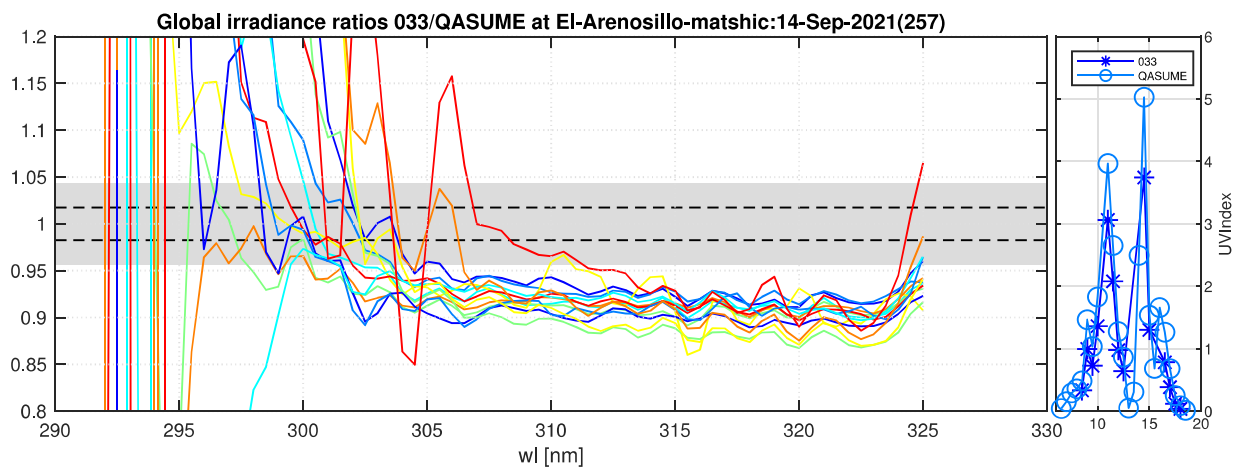
Appendix

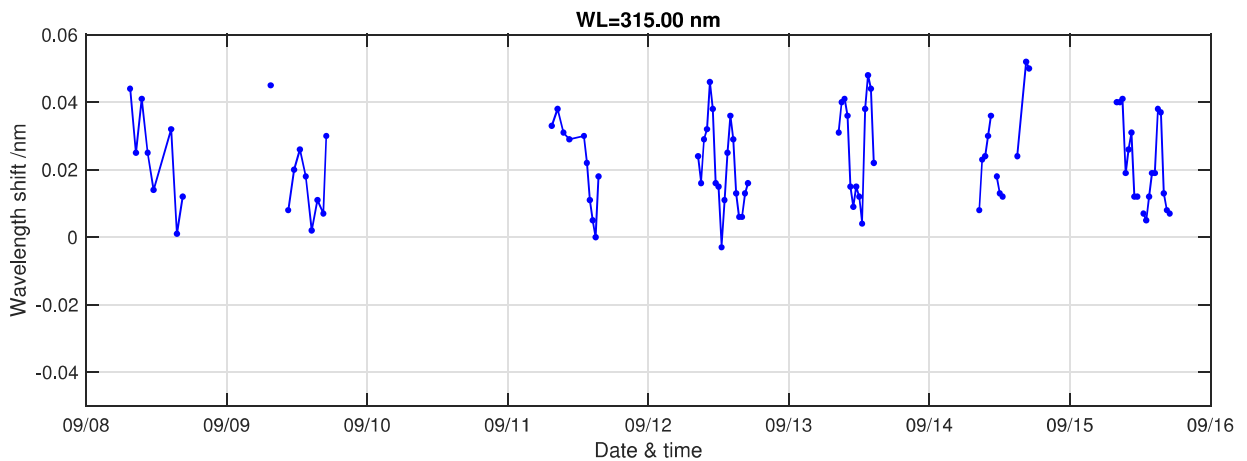
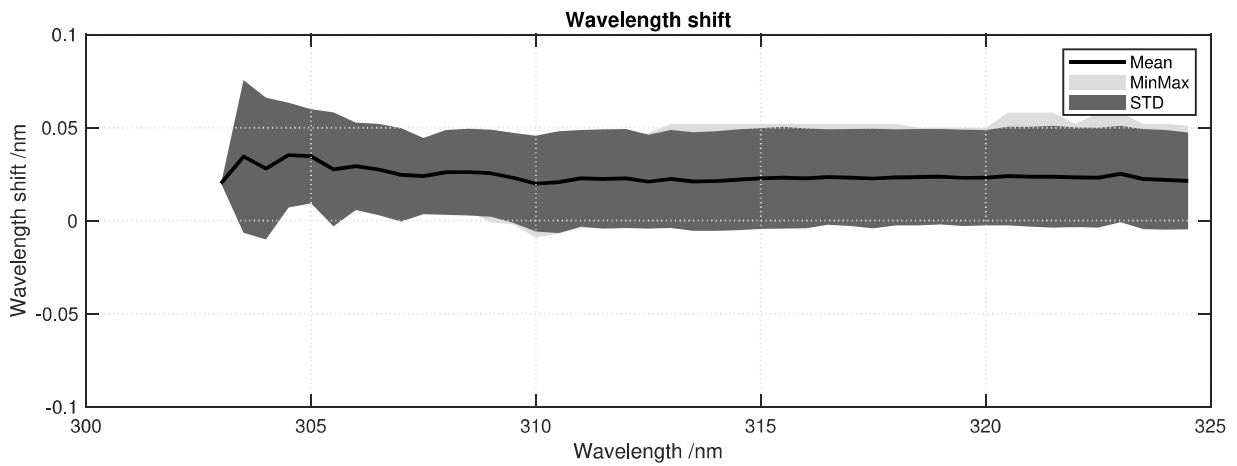
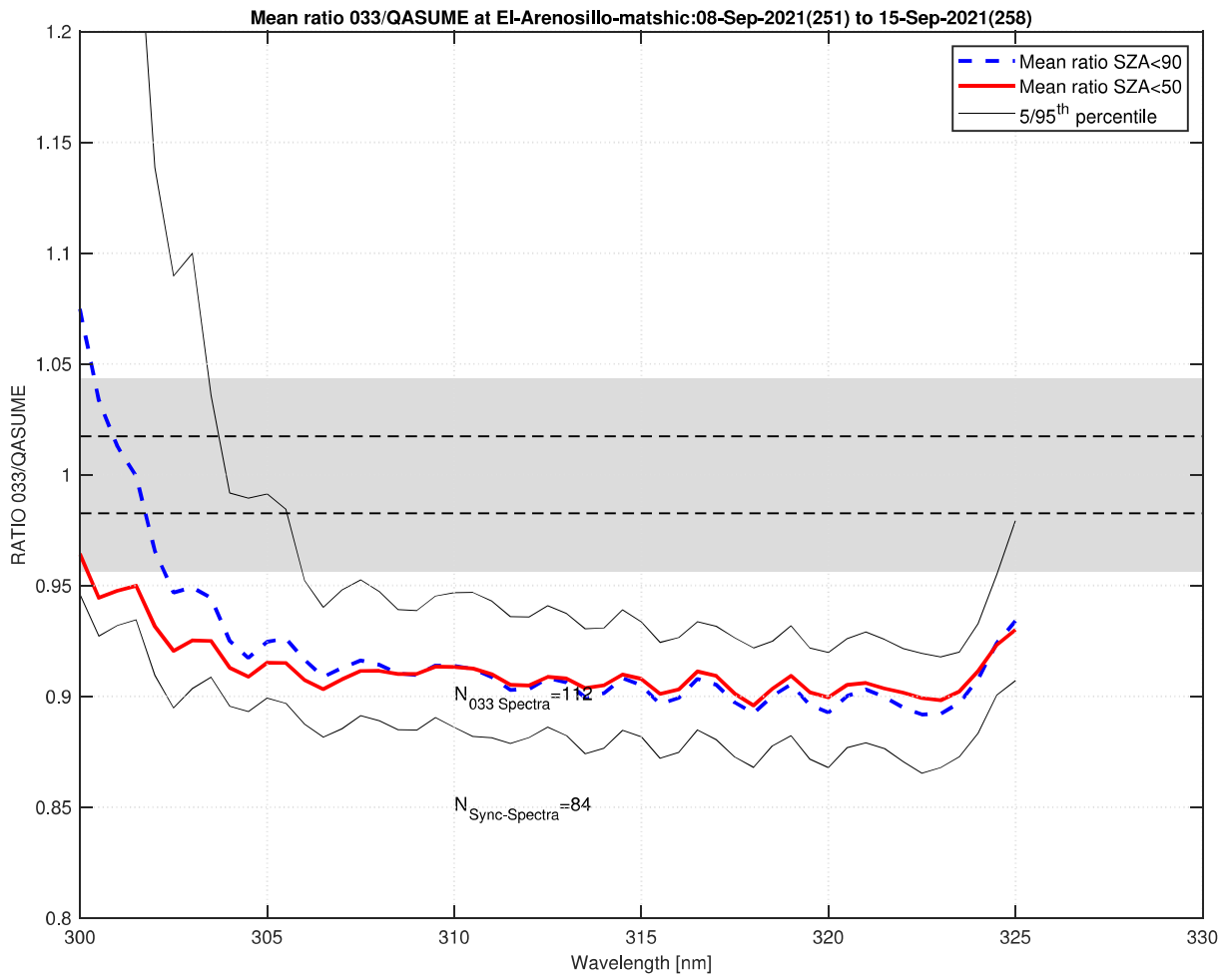
Detailed results for all Brewer spectrophotometers with respect to the reference spectroradiometer QASUME

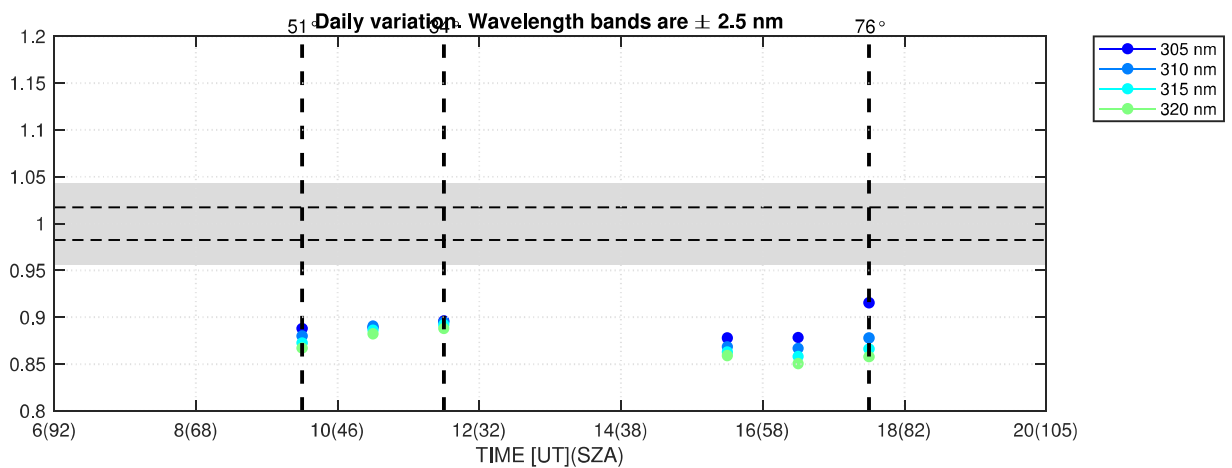
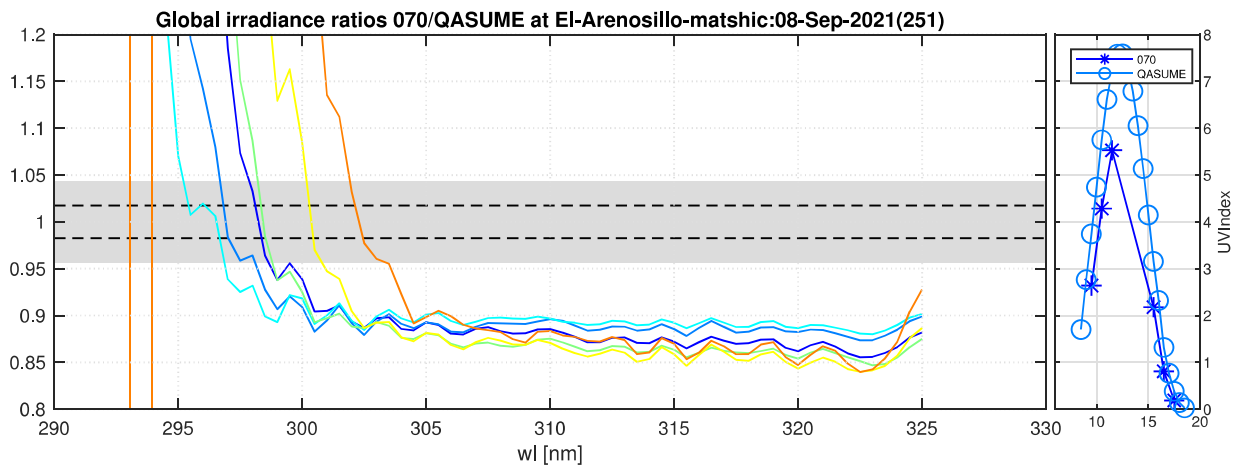
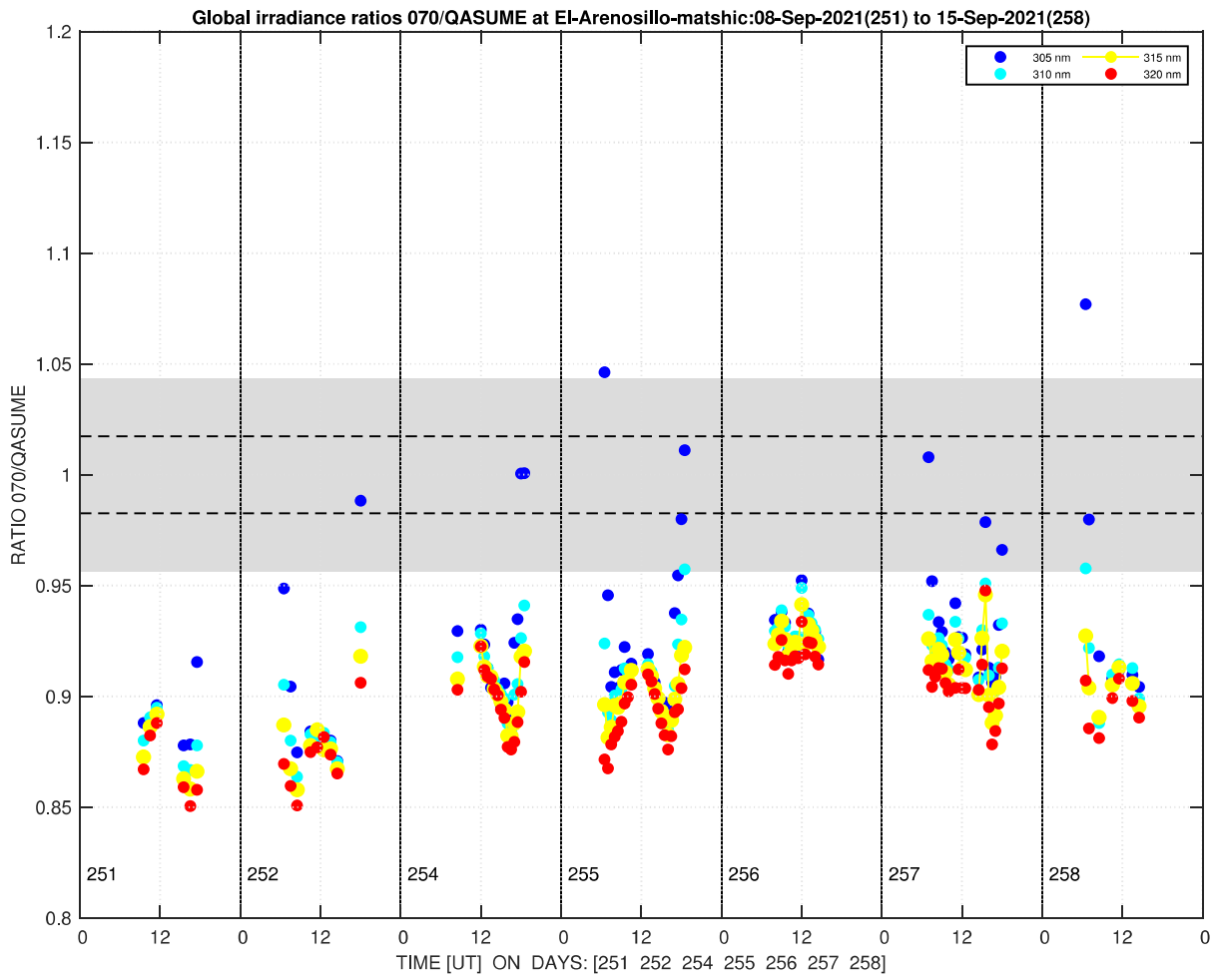


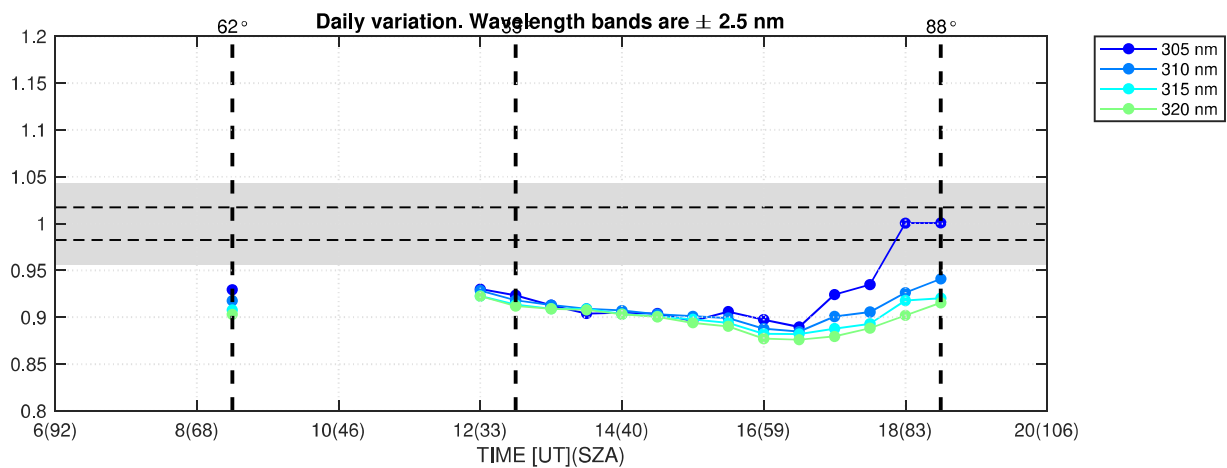
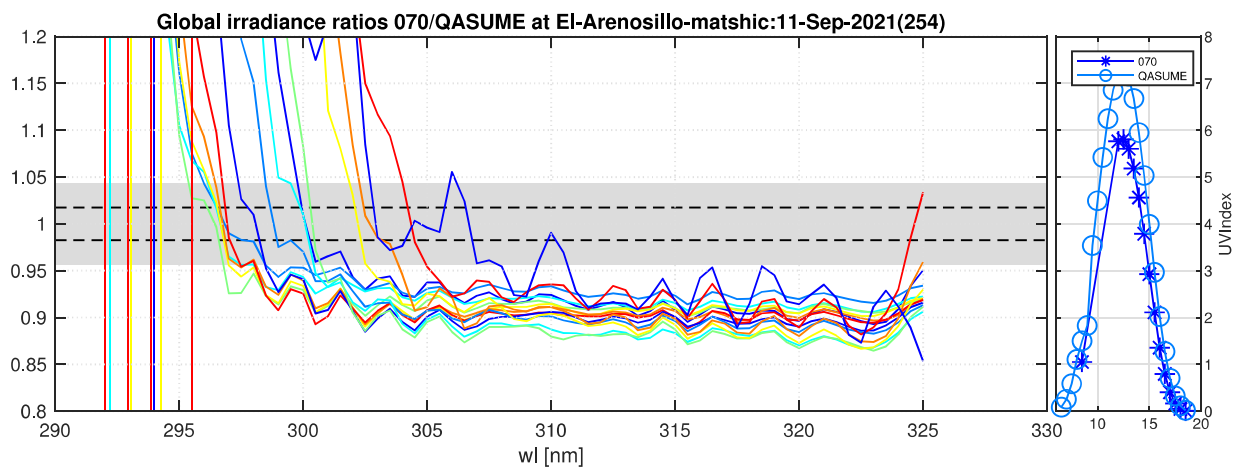
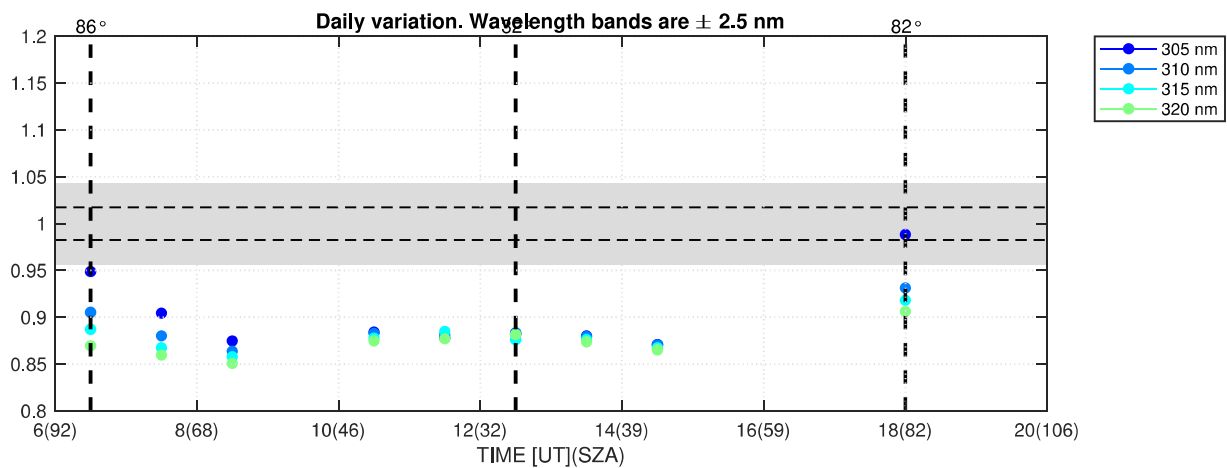
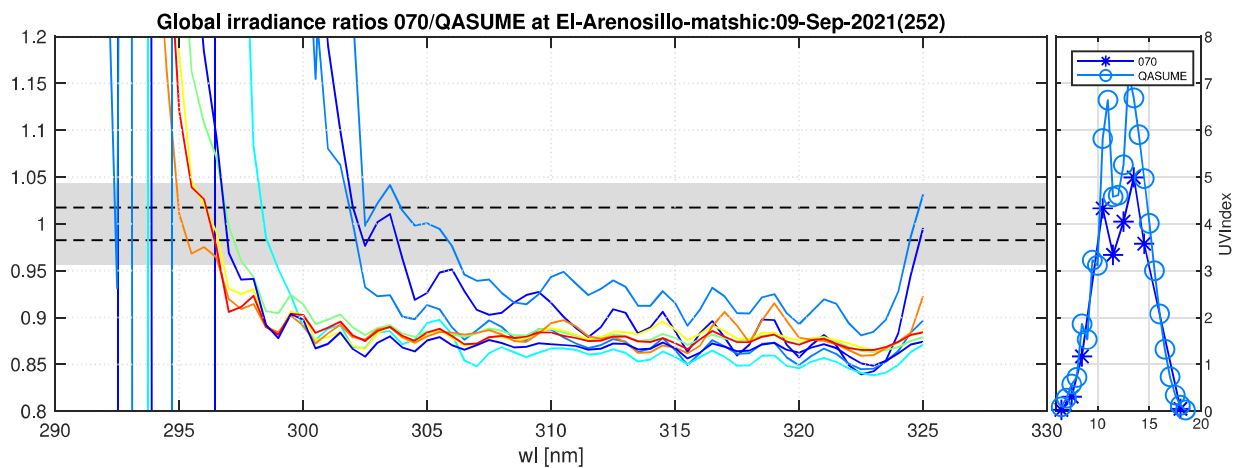


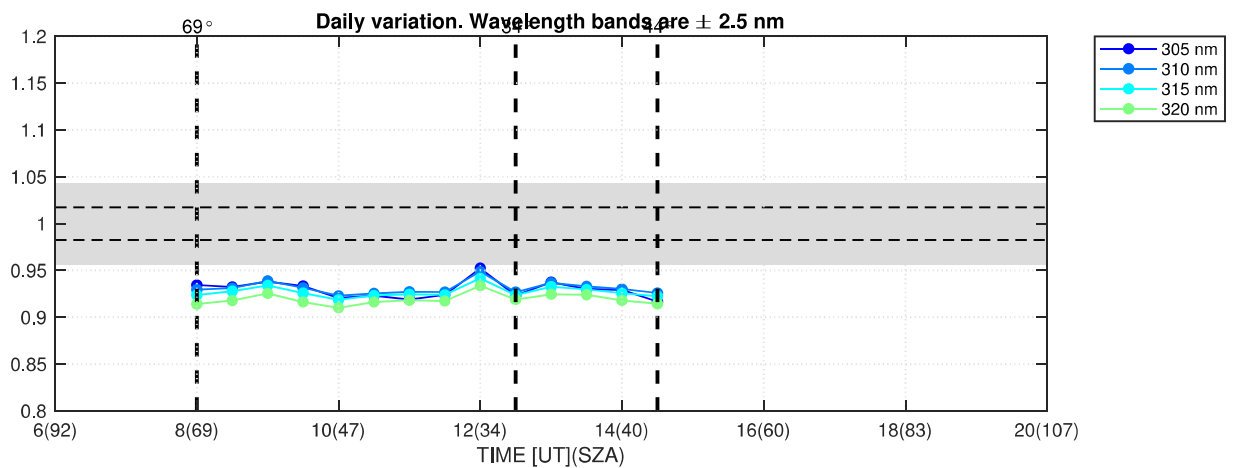
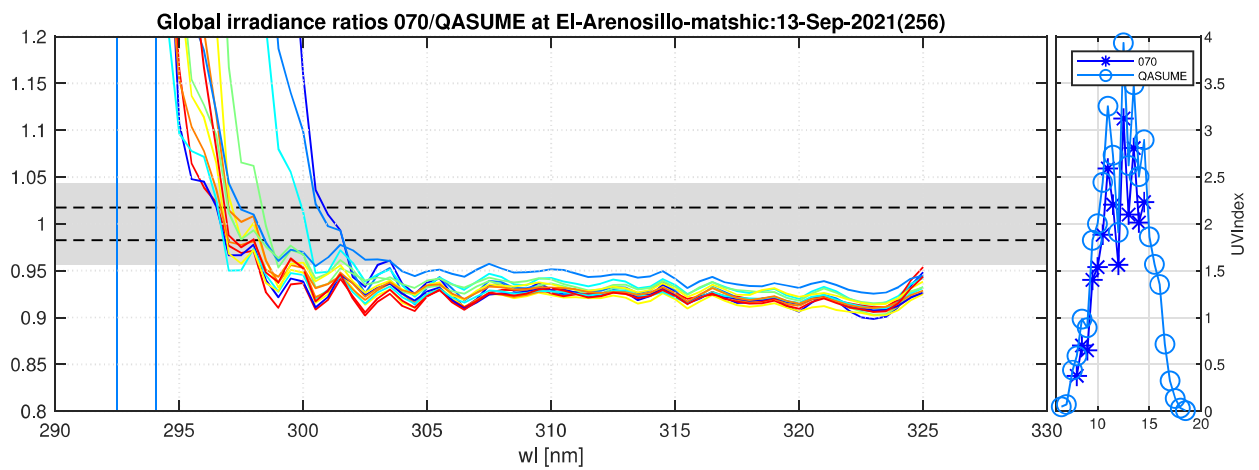
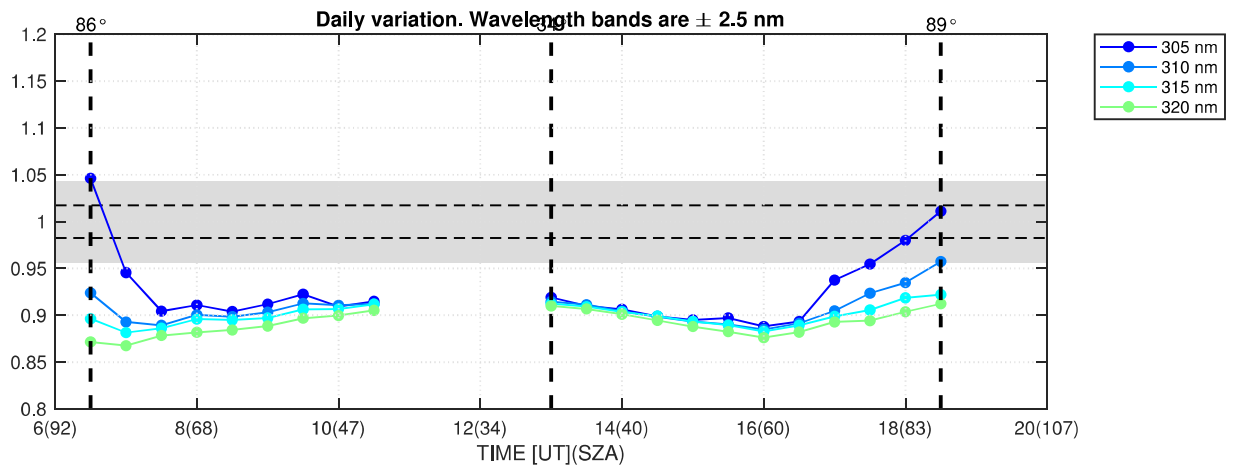
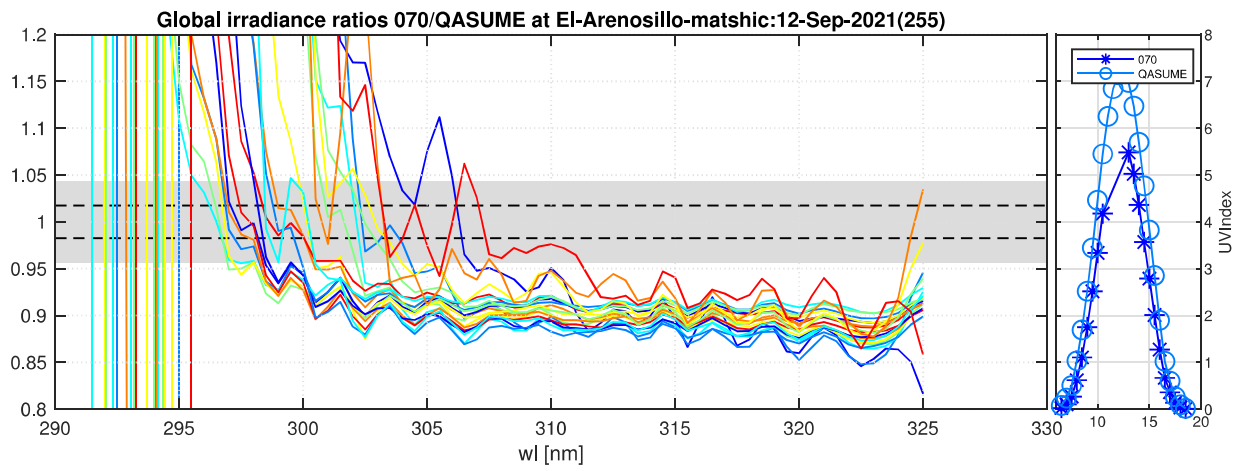


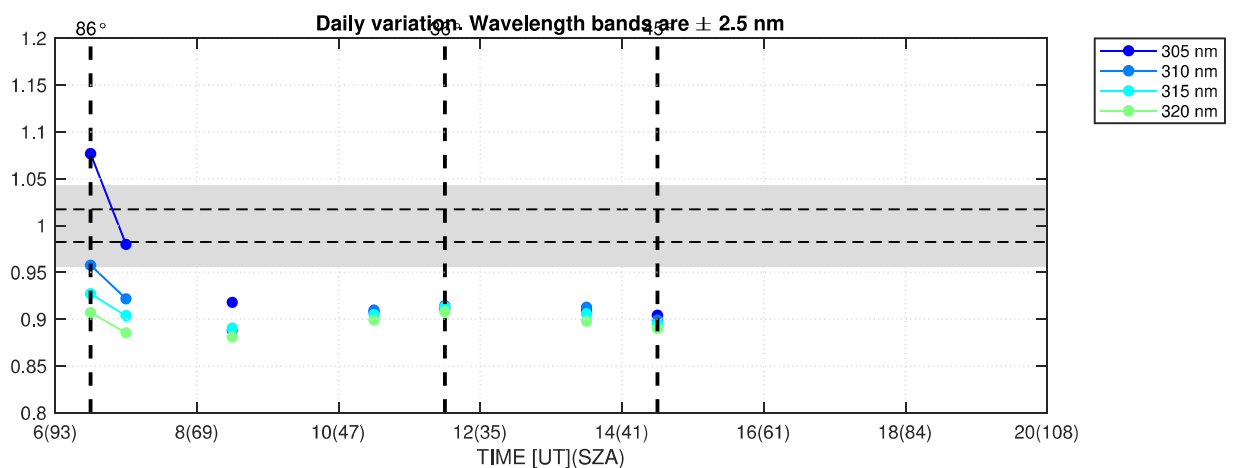
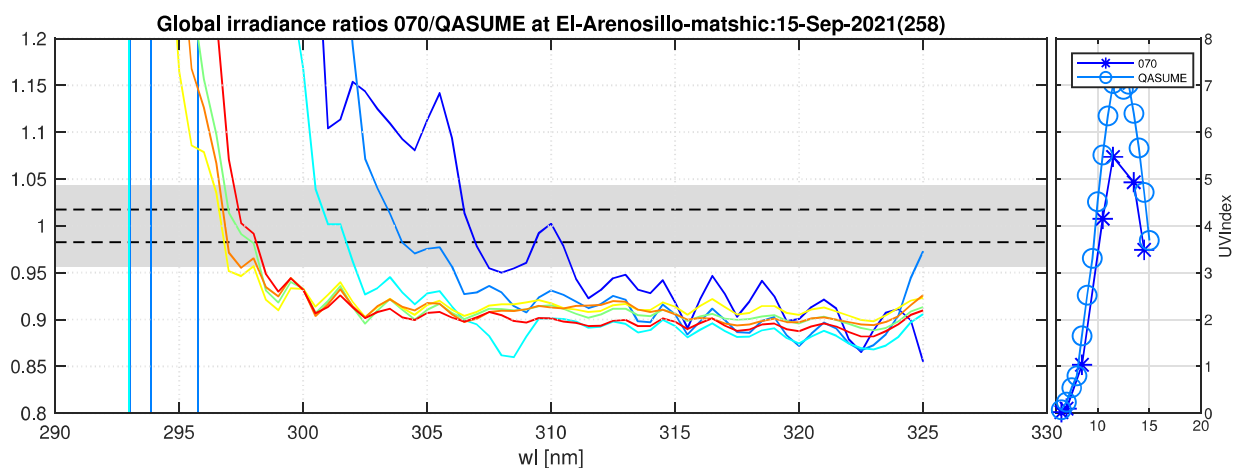
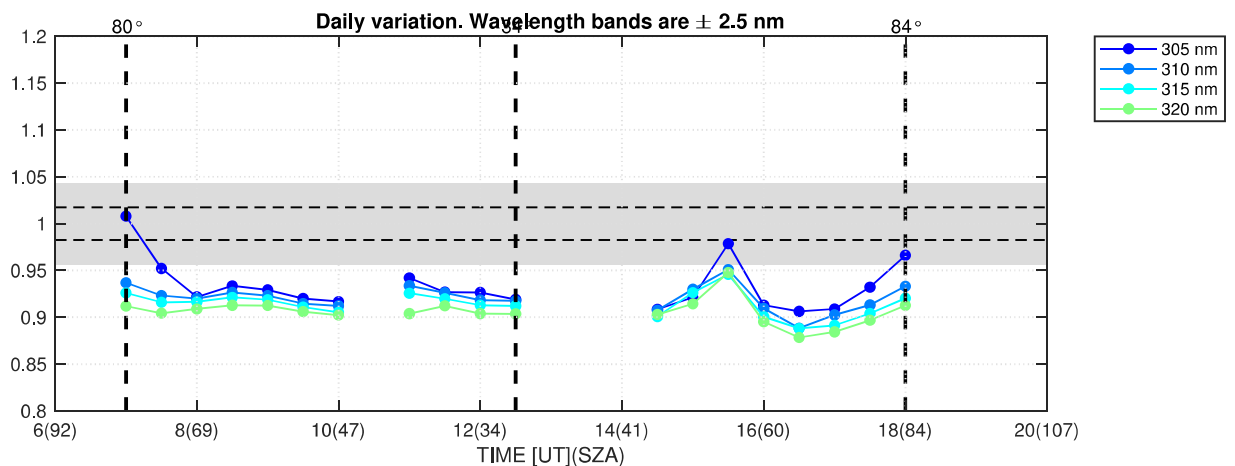
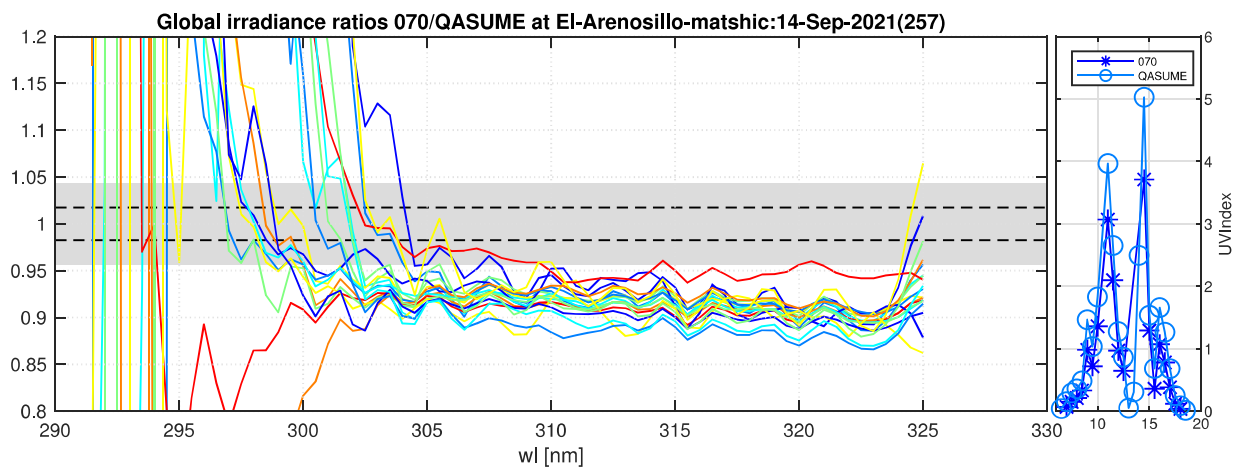


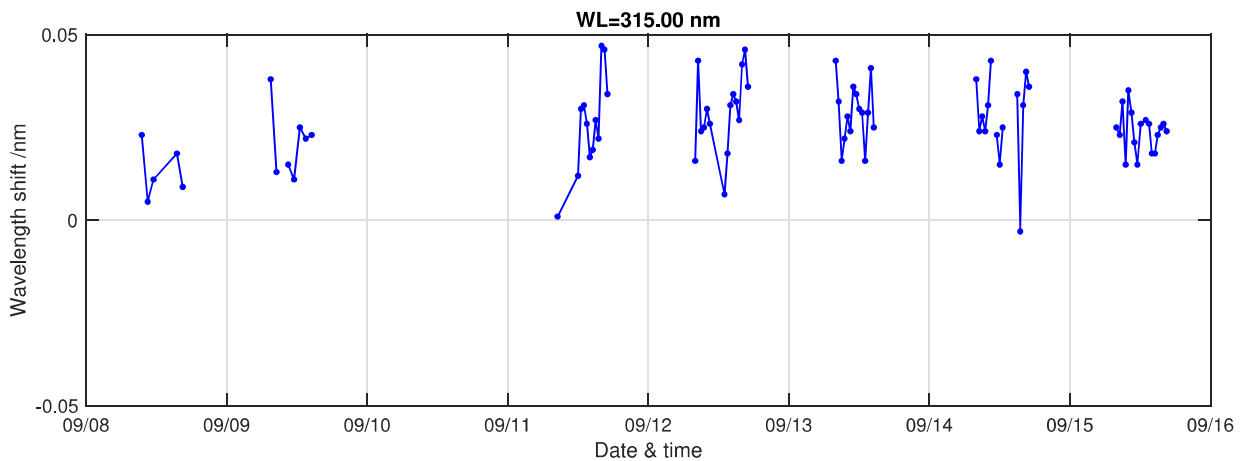
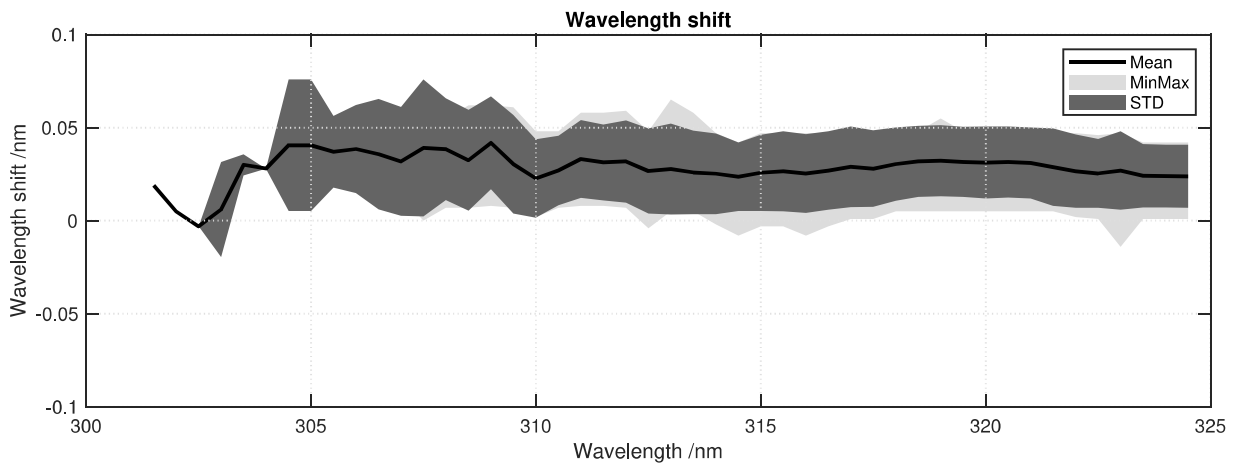
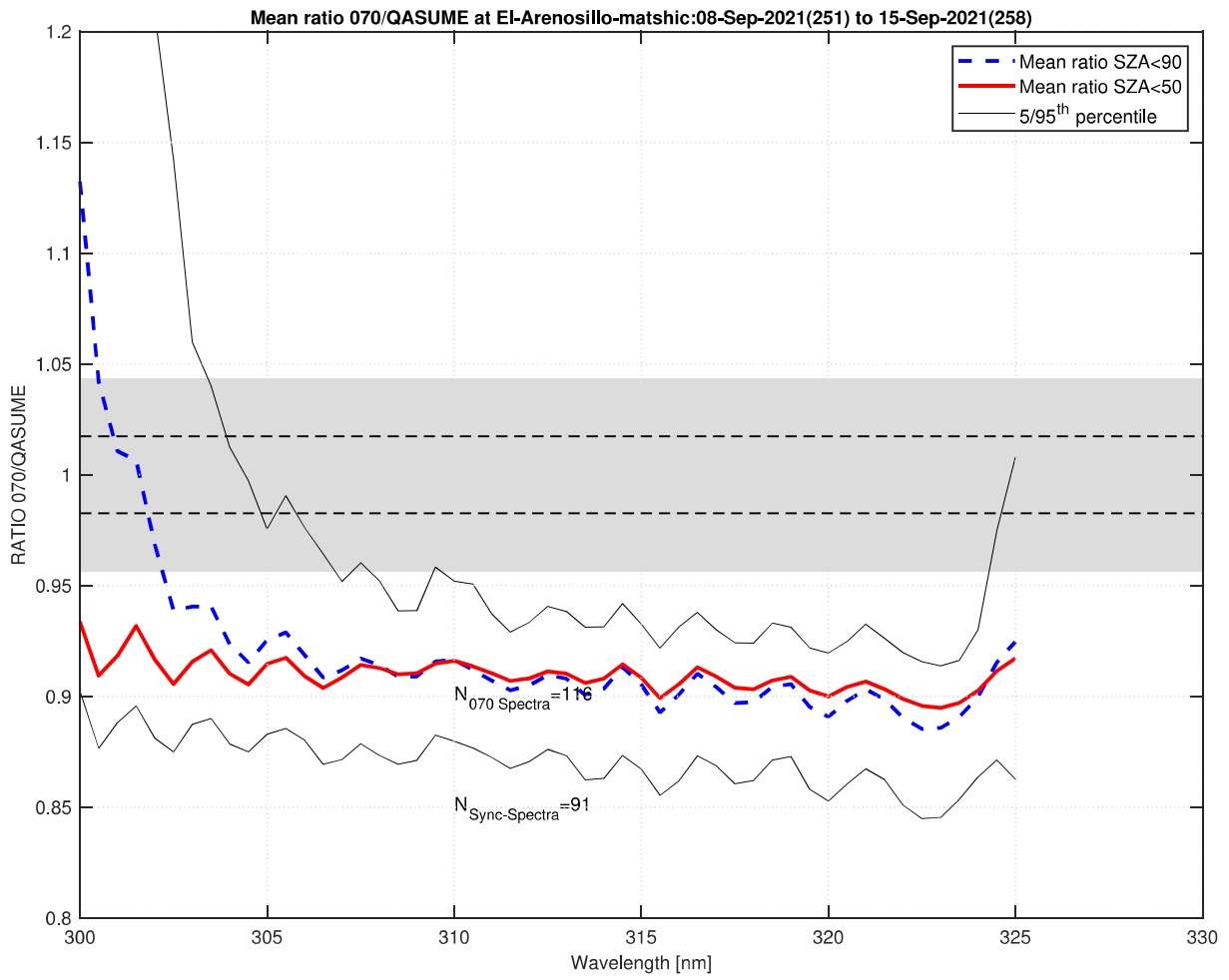


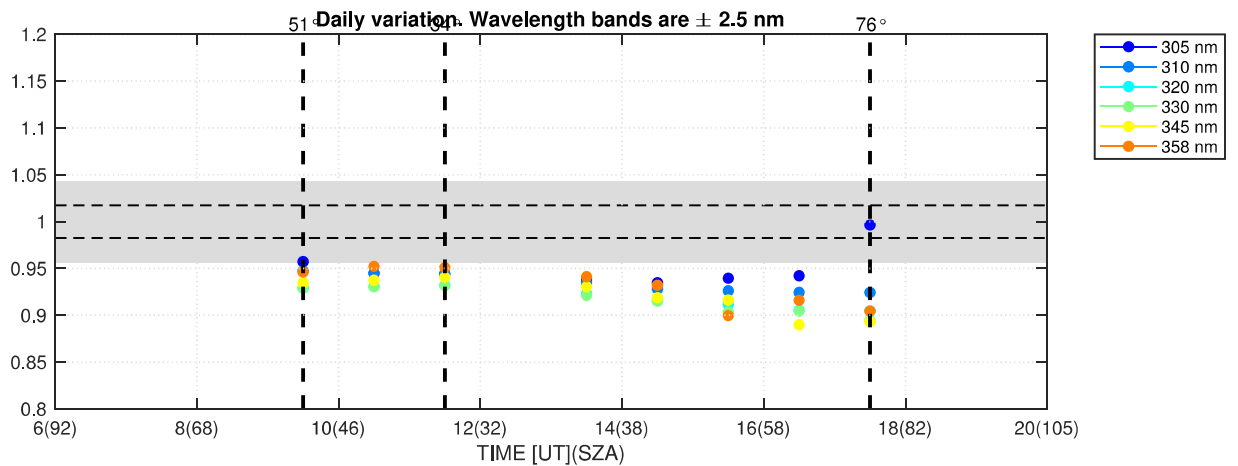
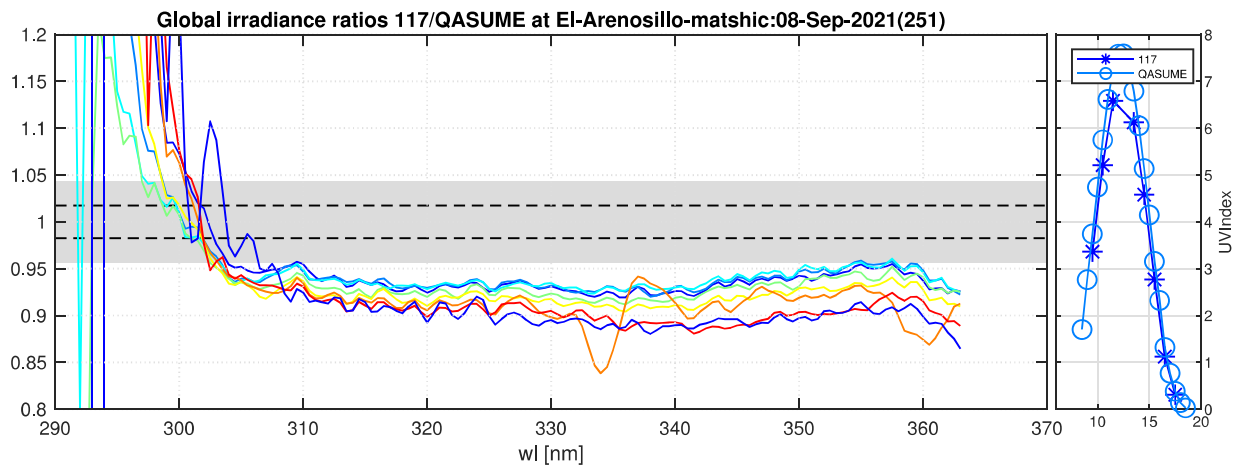
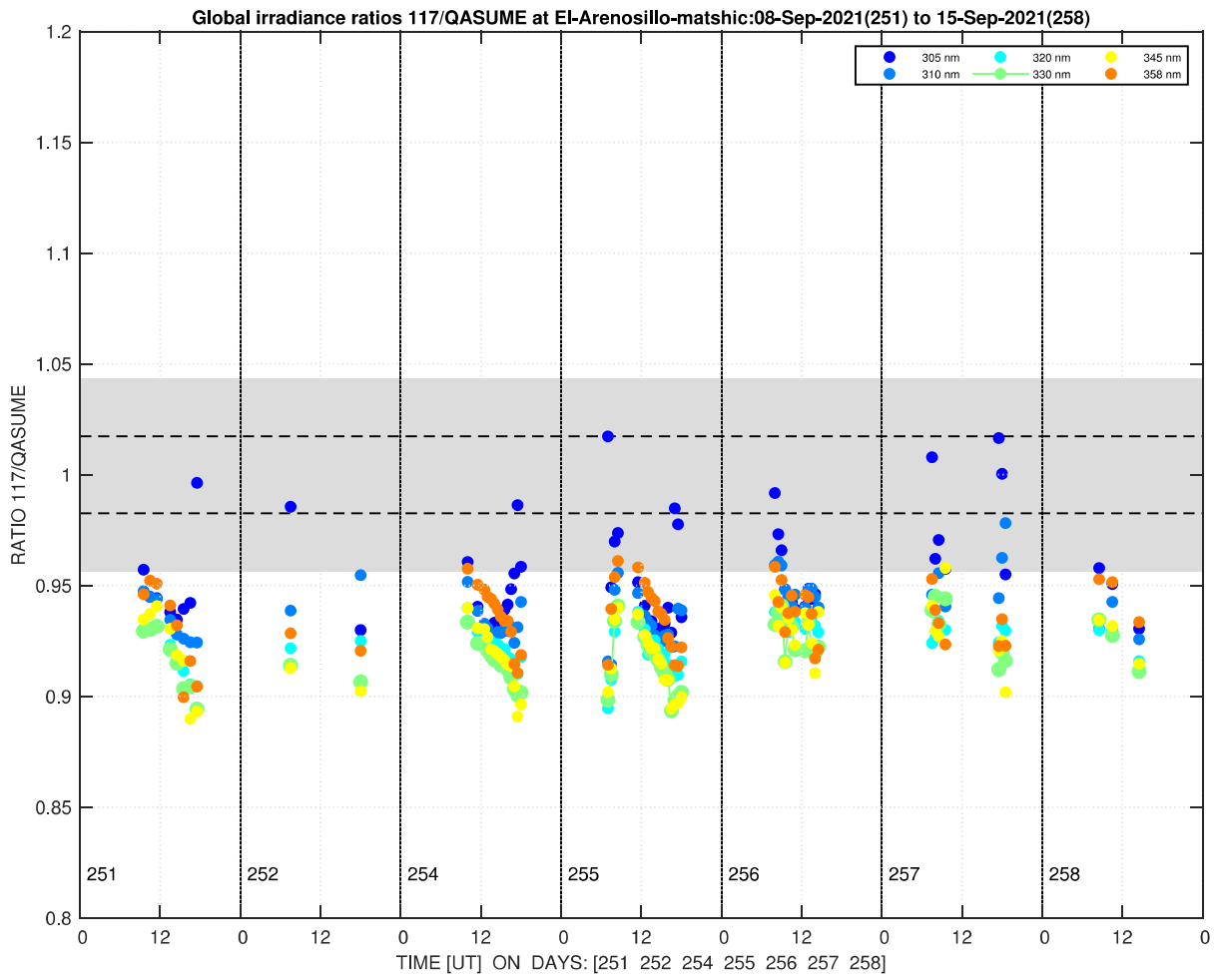


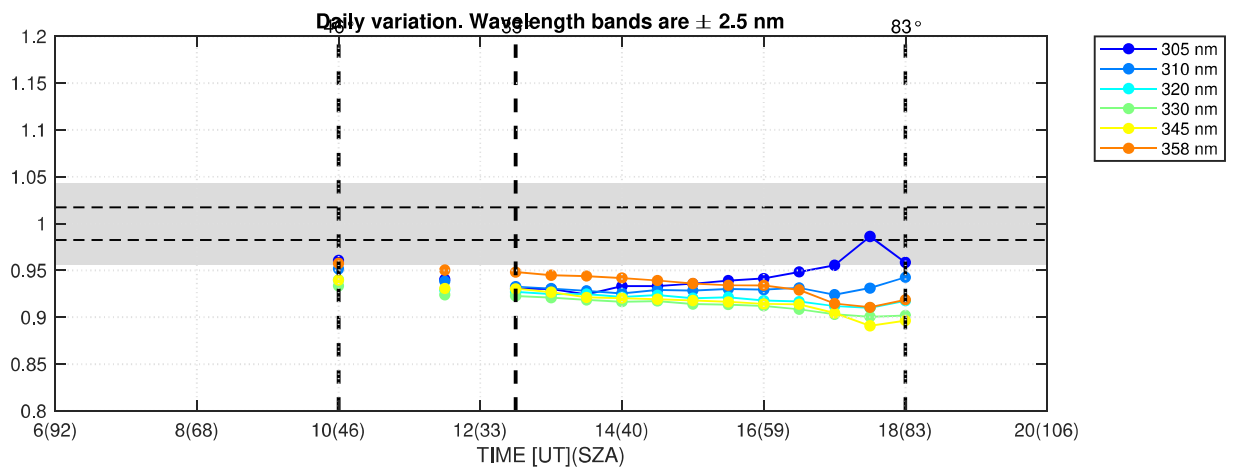
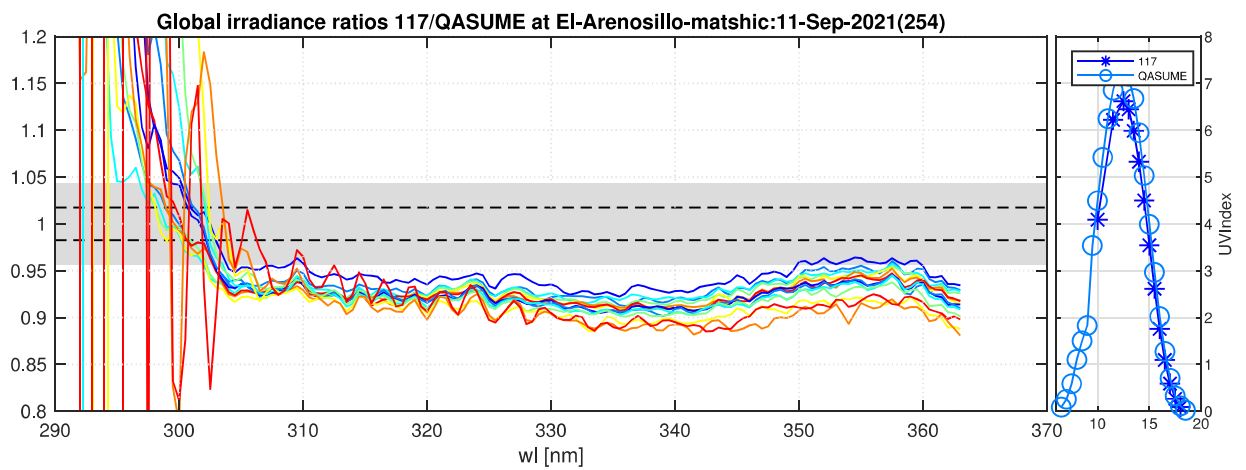
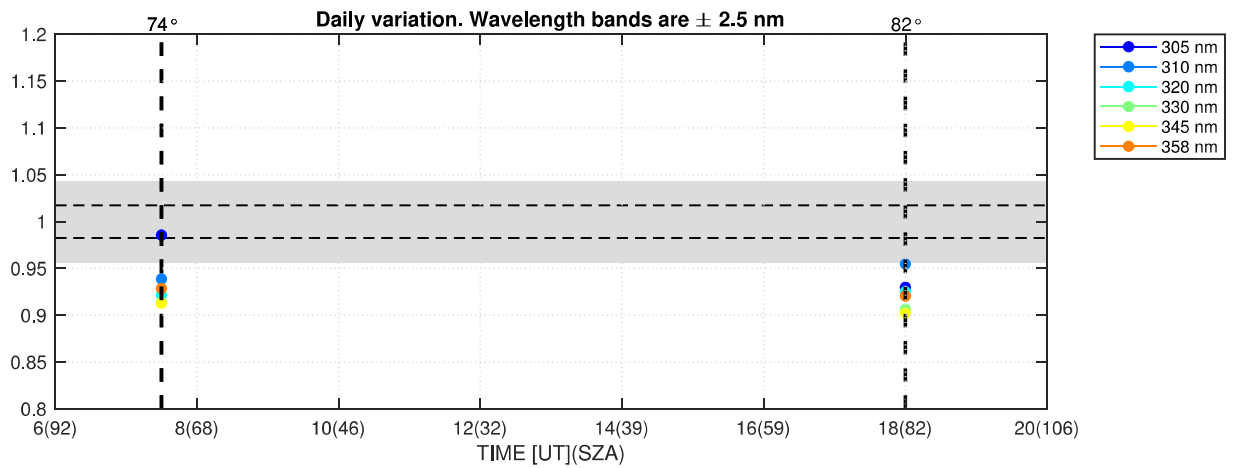
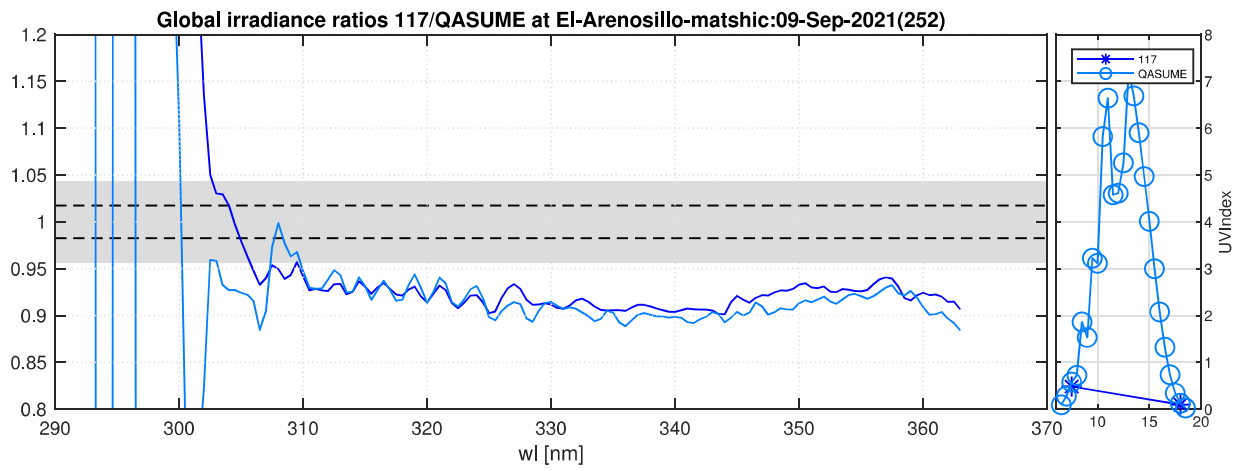


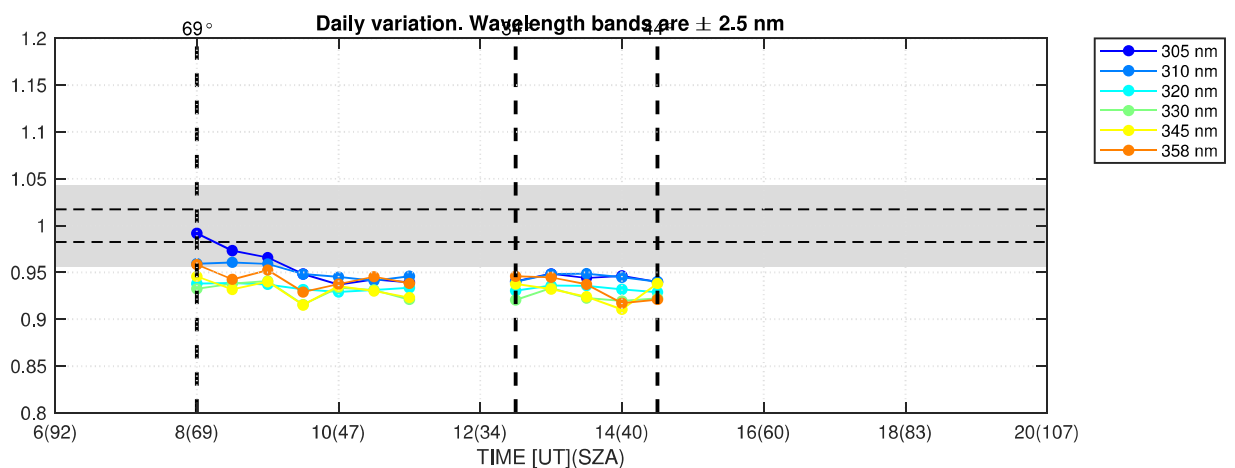
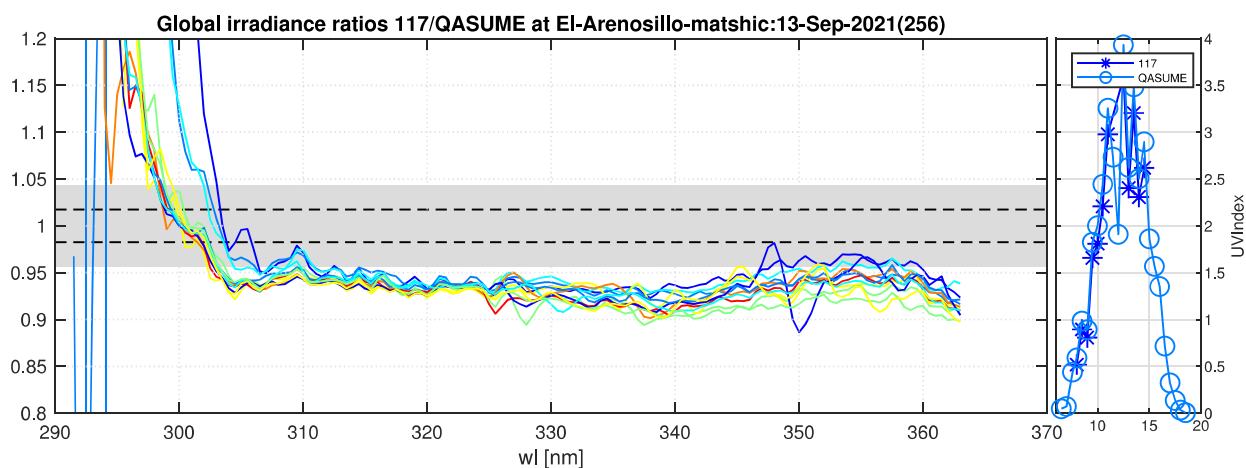
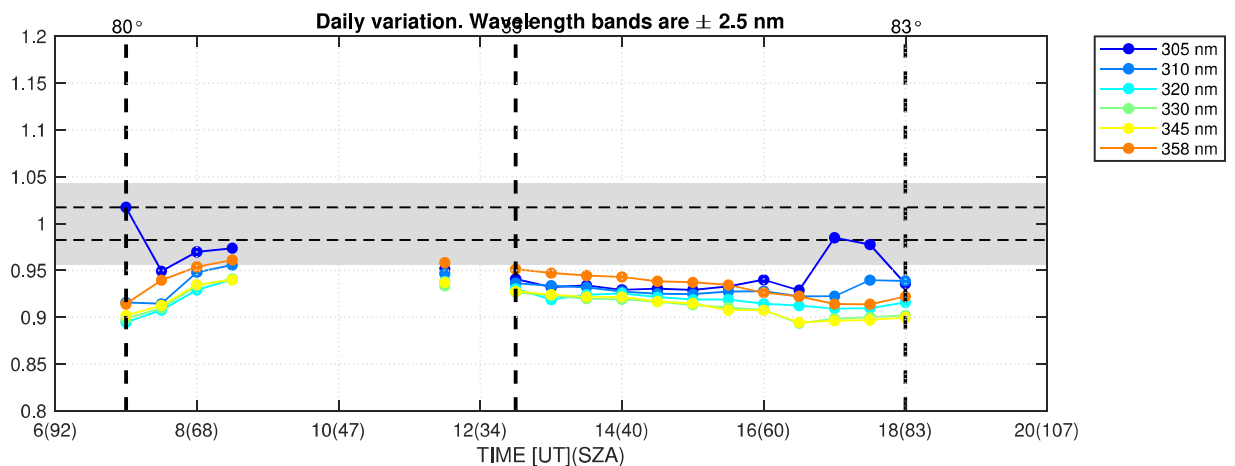
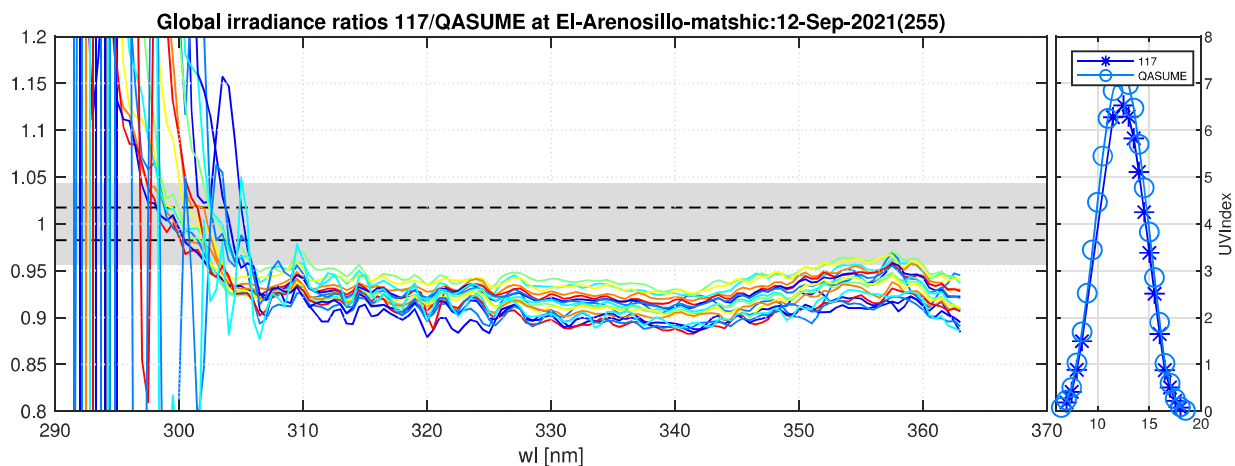


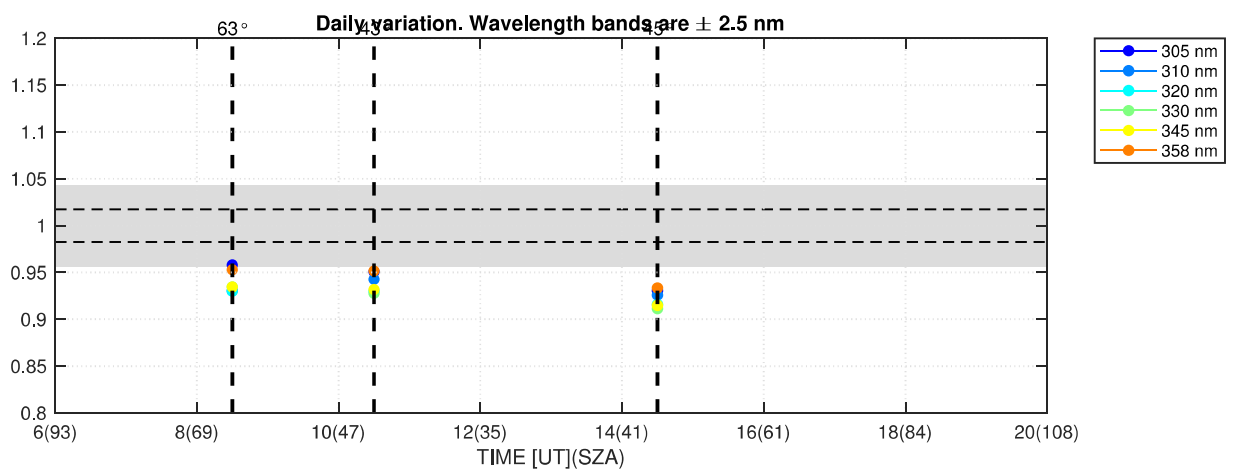
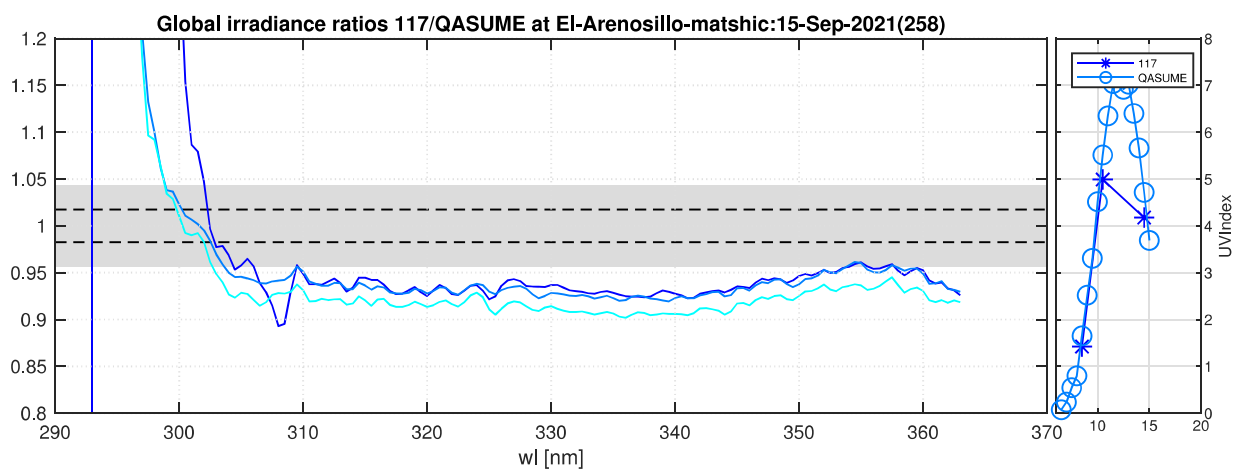
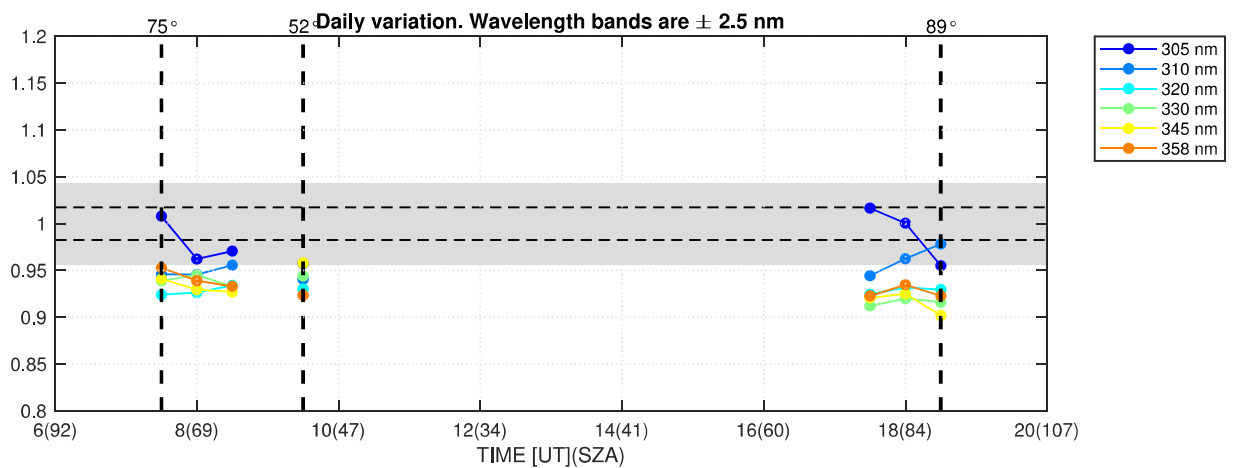
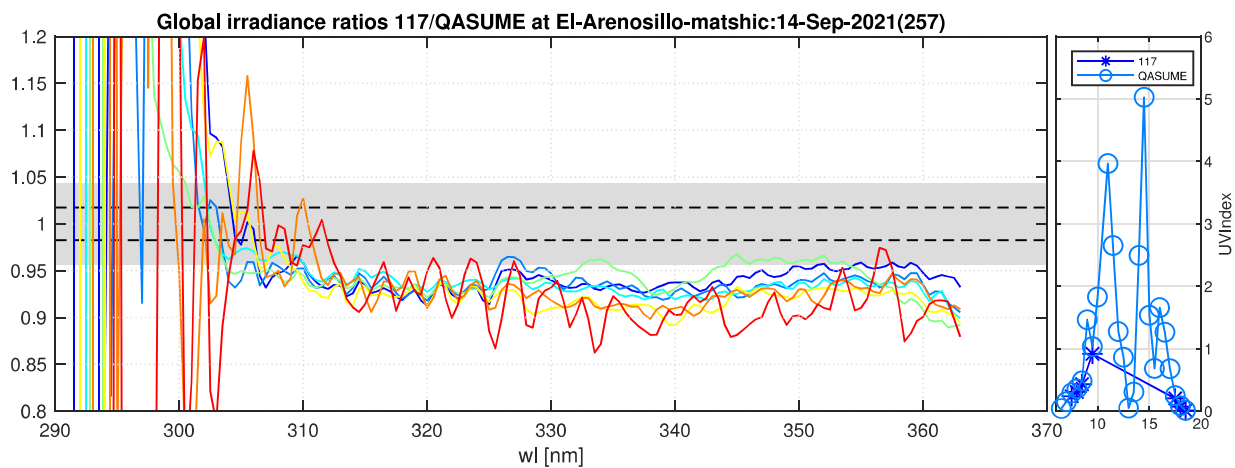


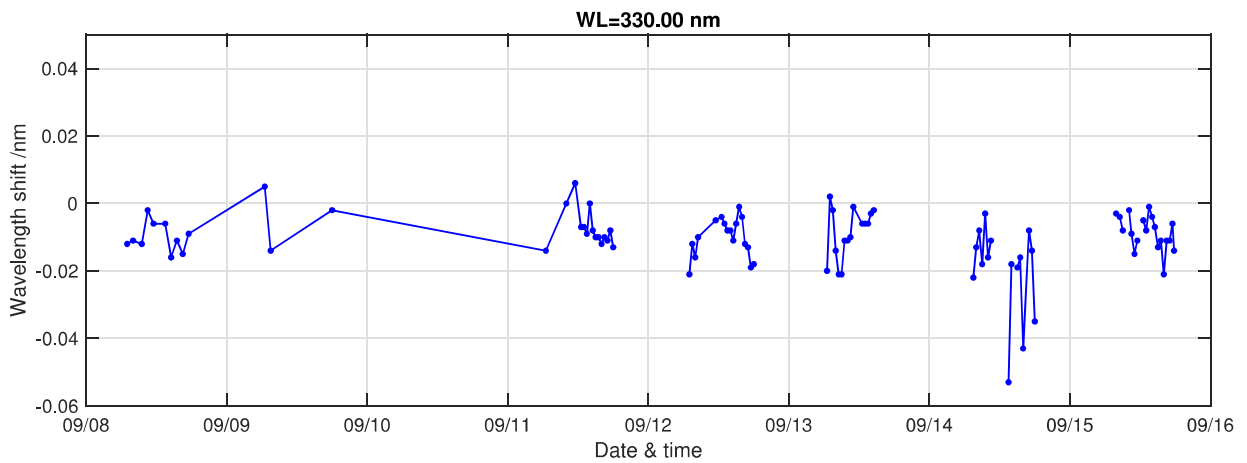
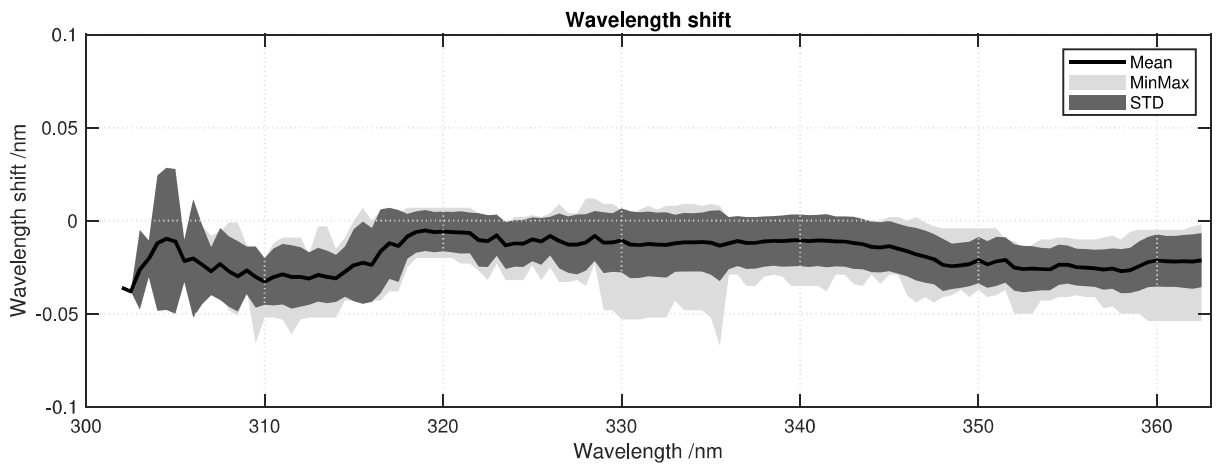
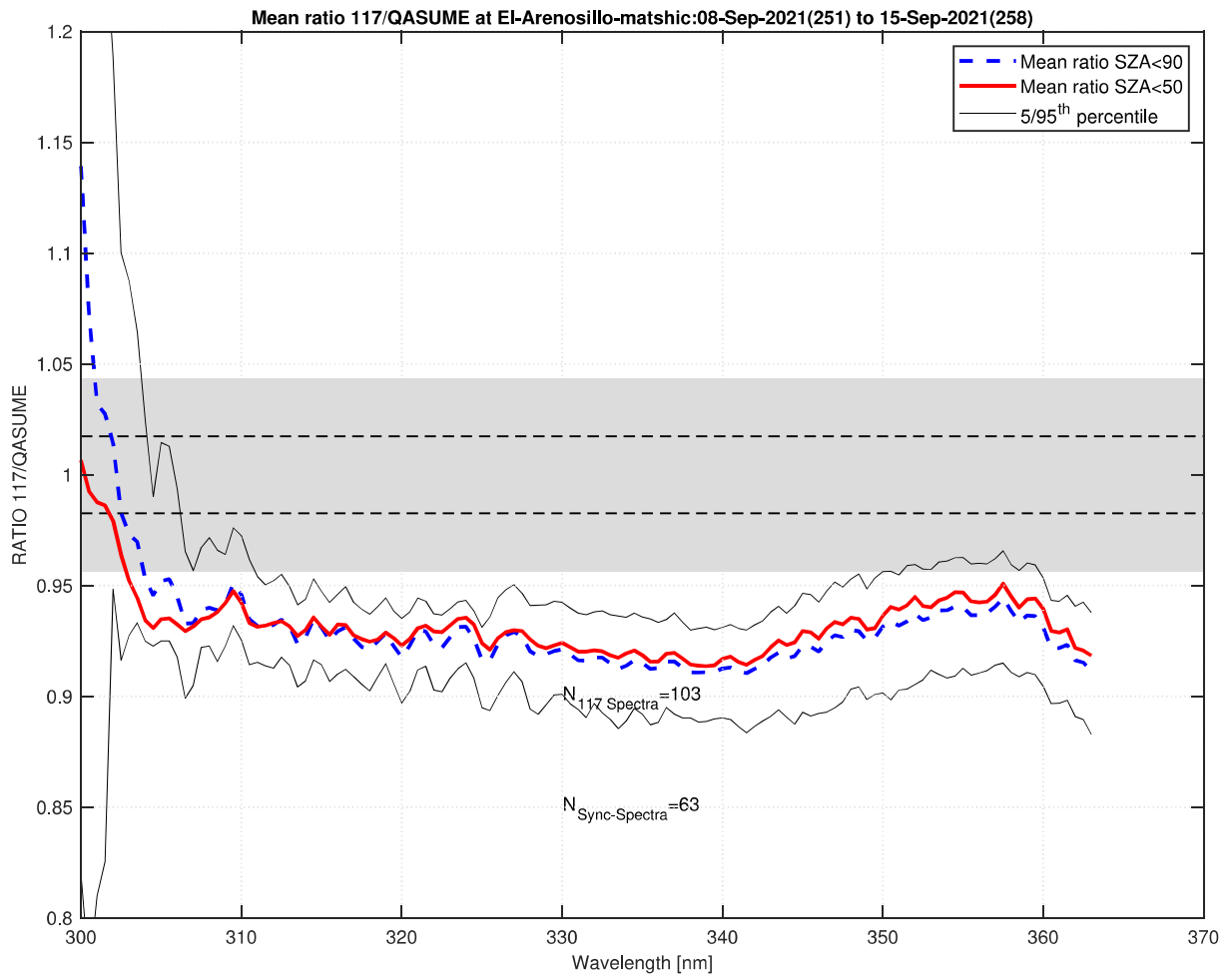


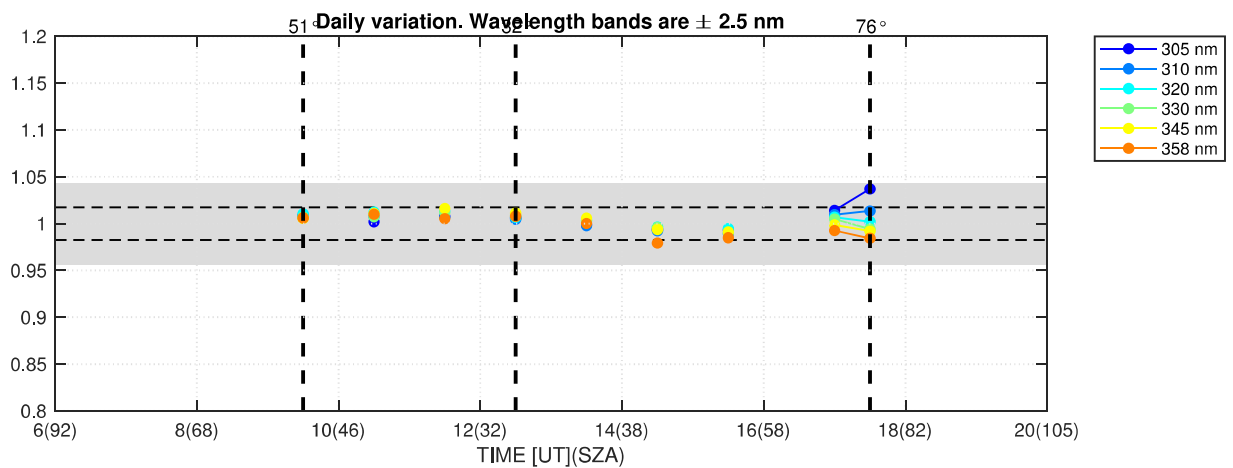
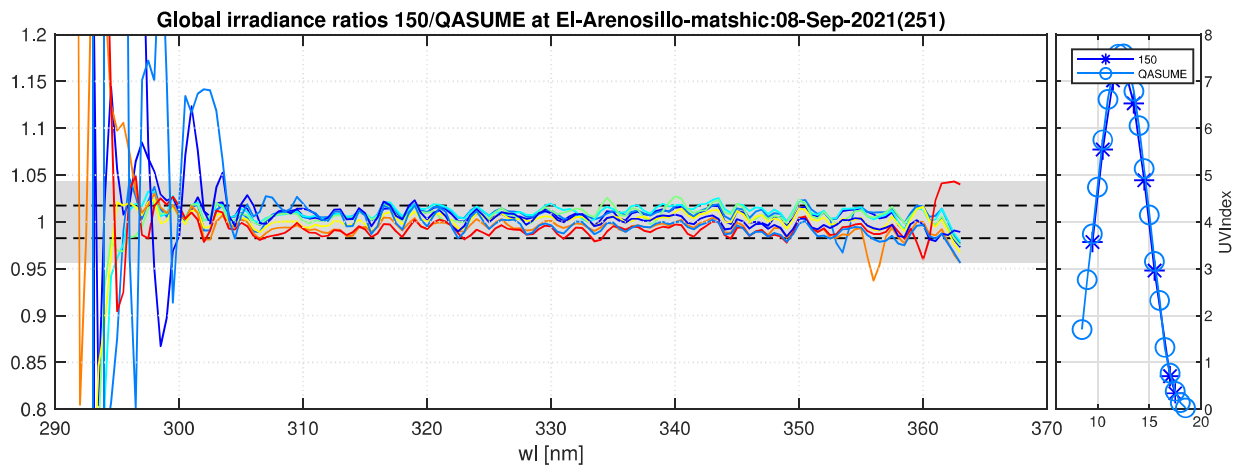
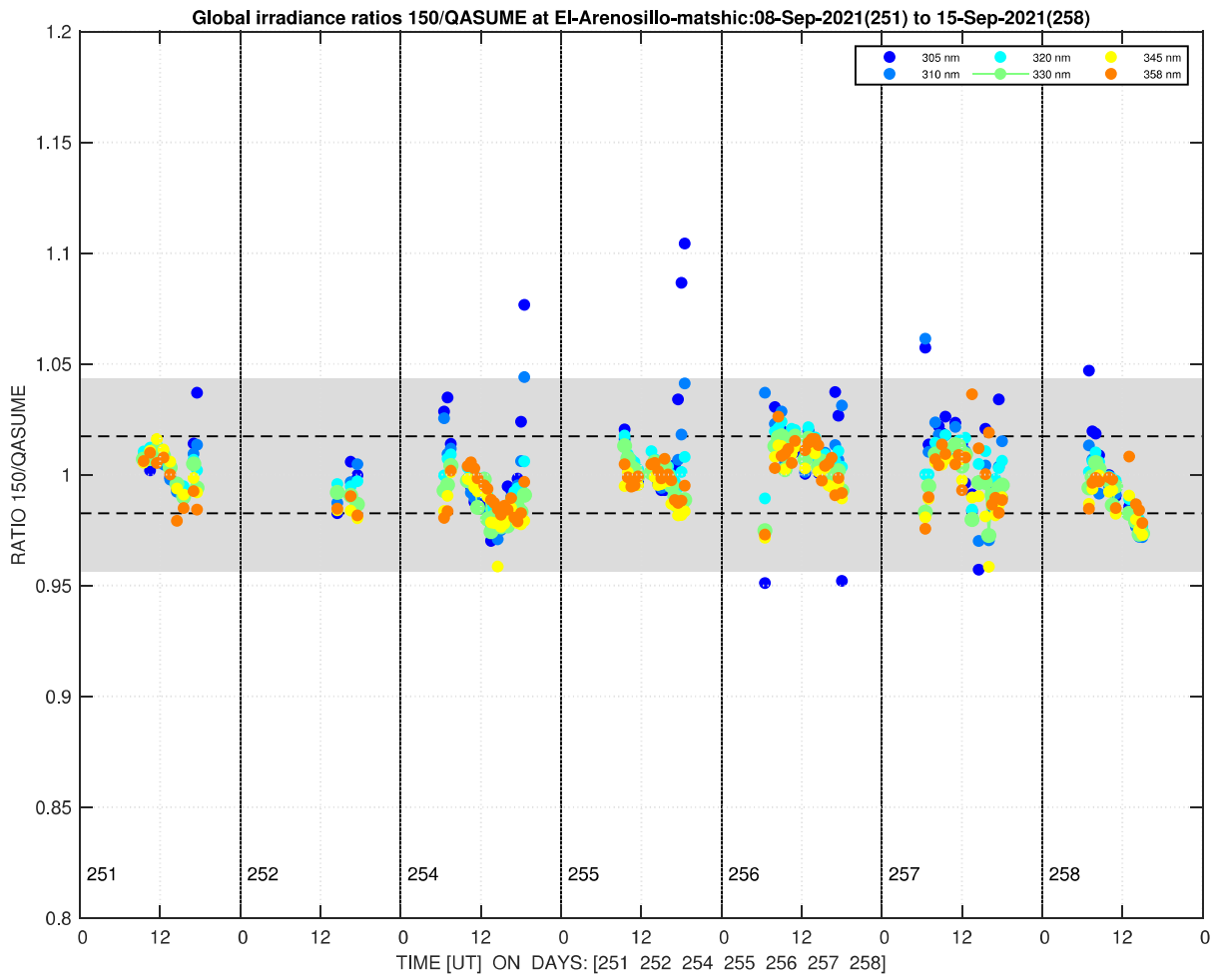


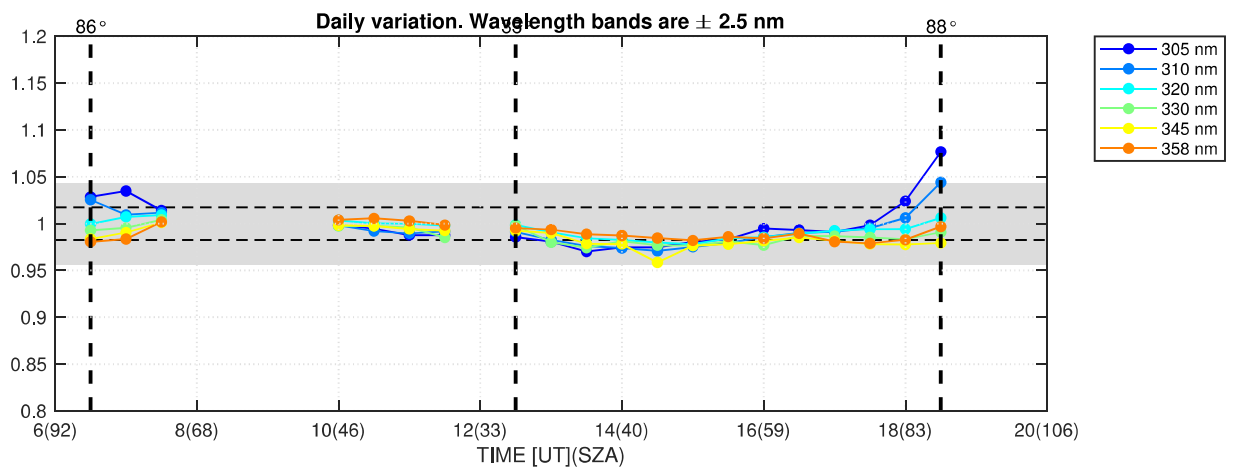
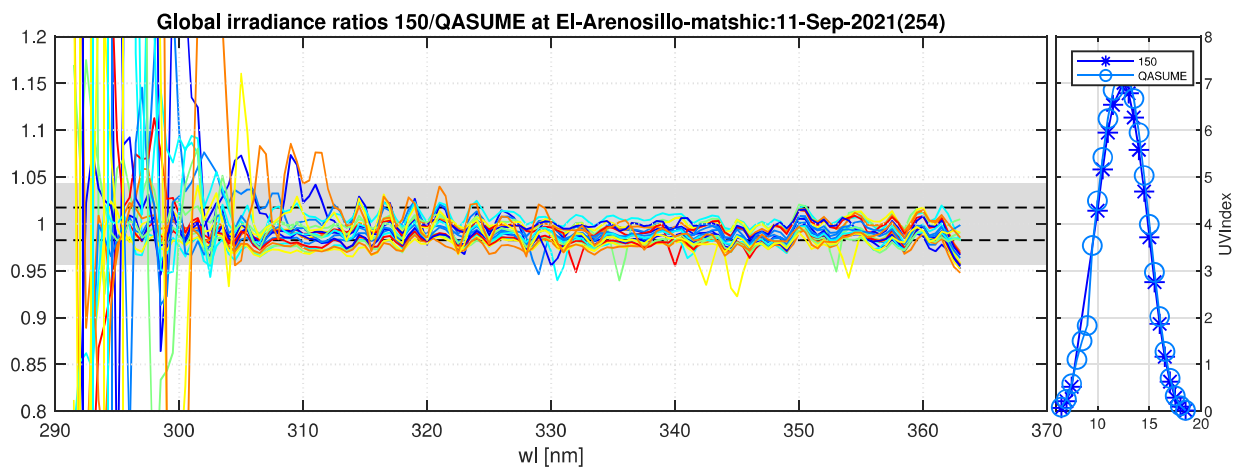
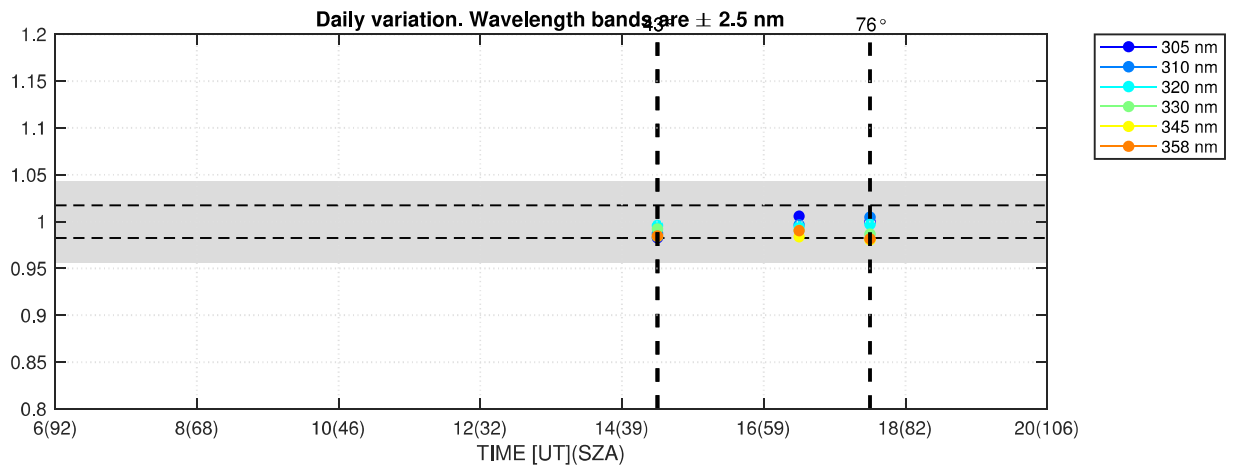
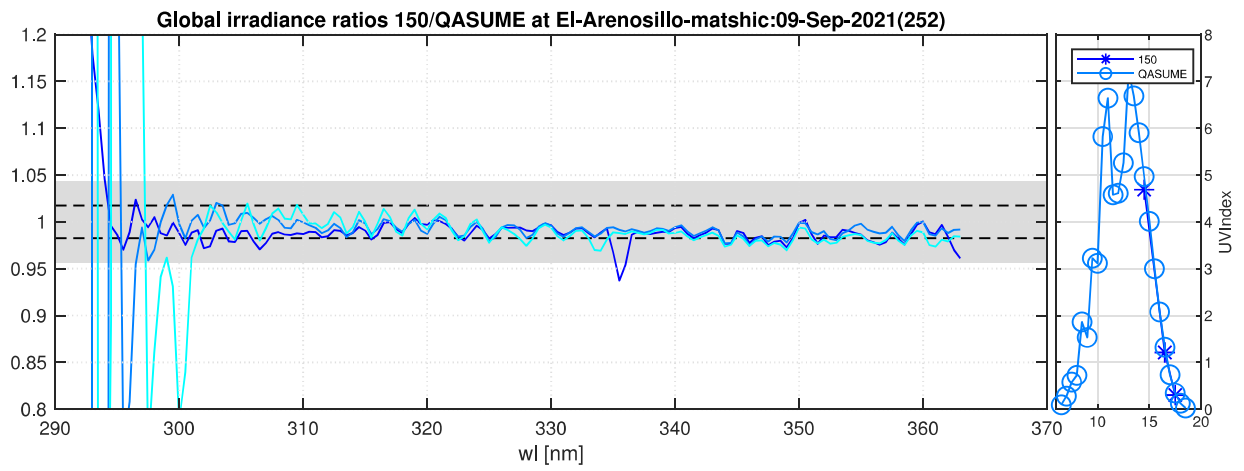


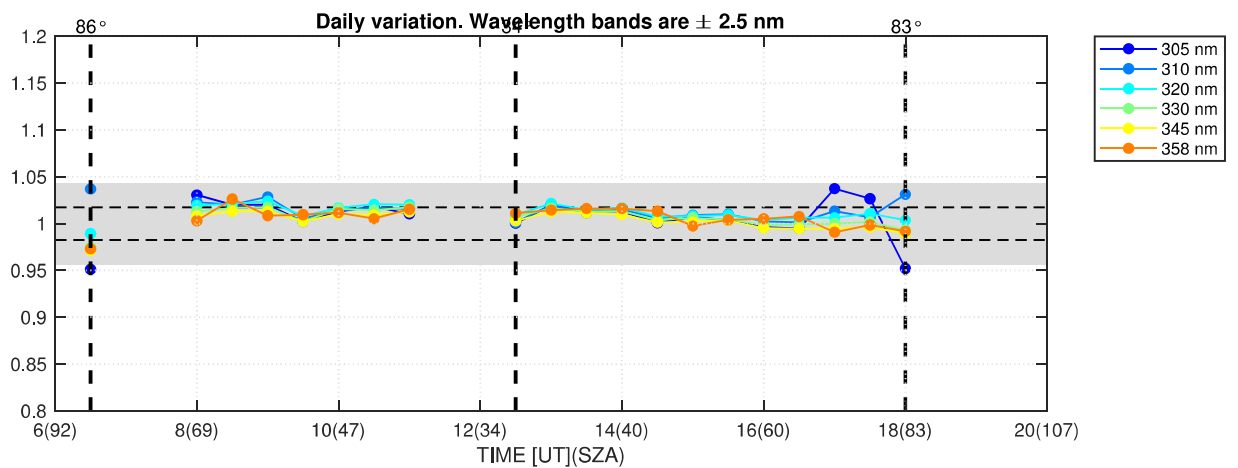
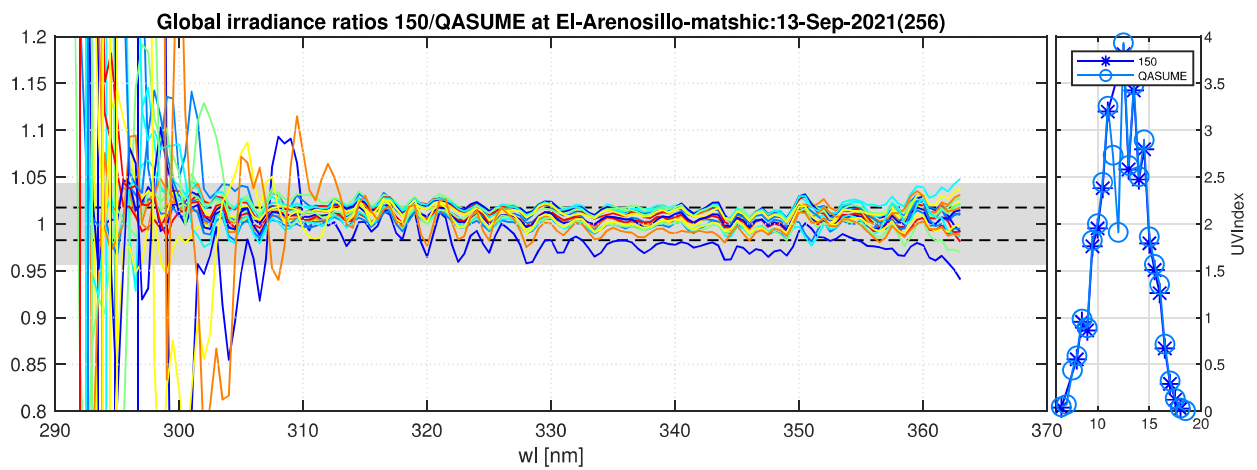
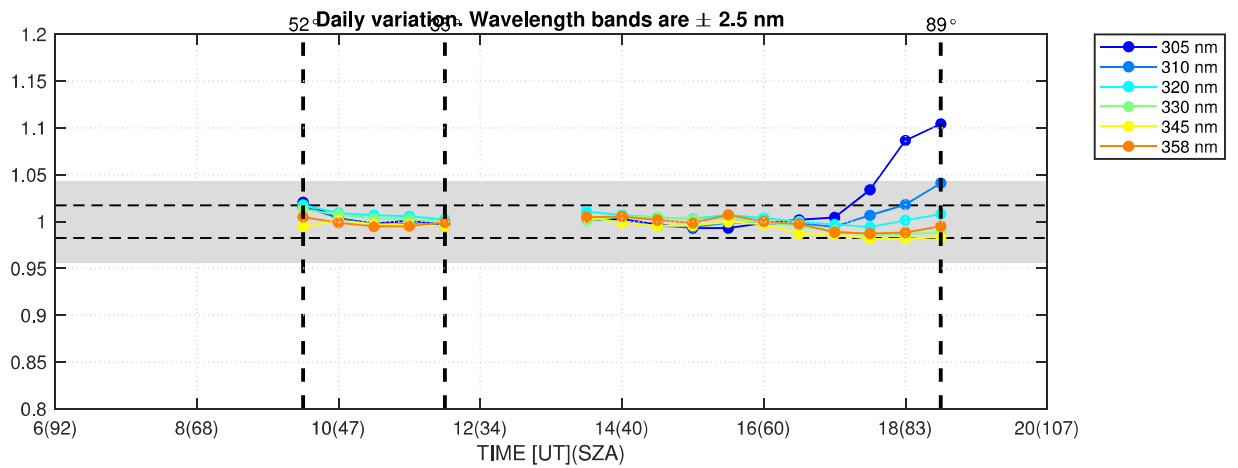
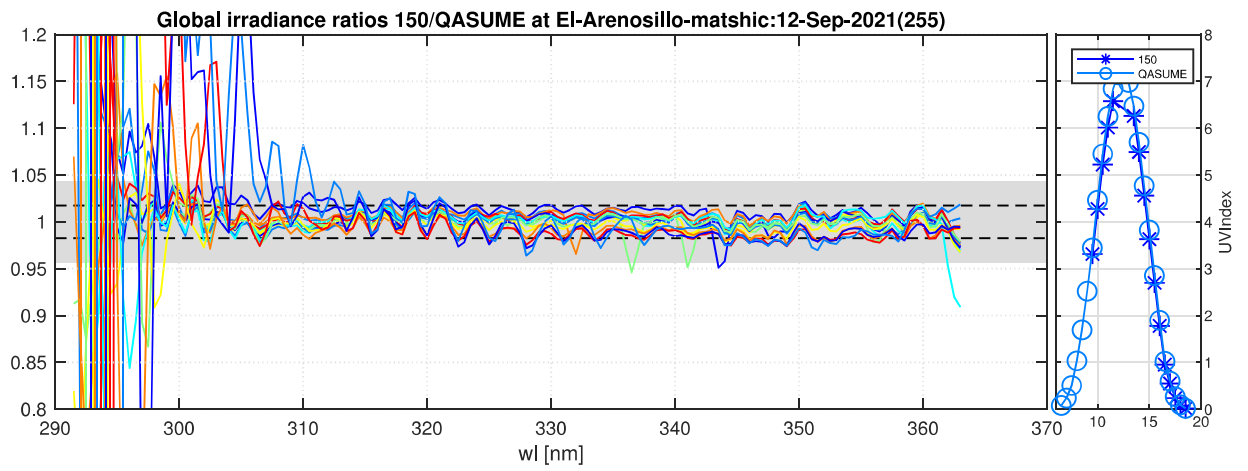


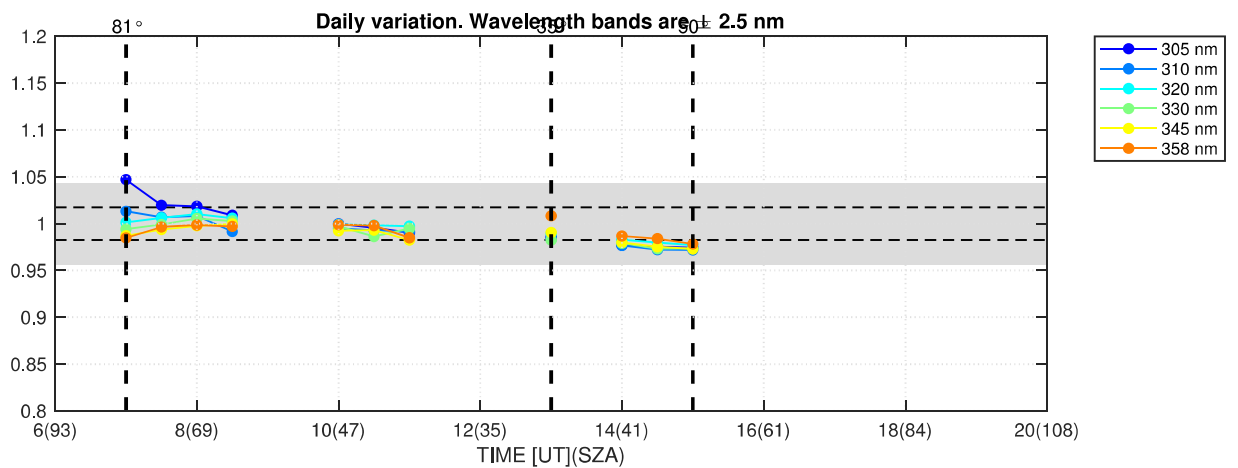
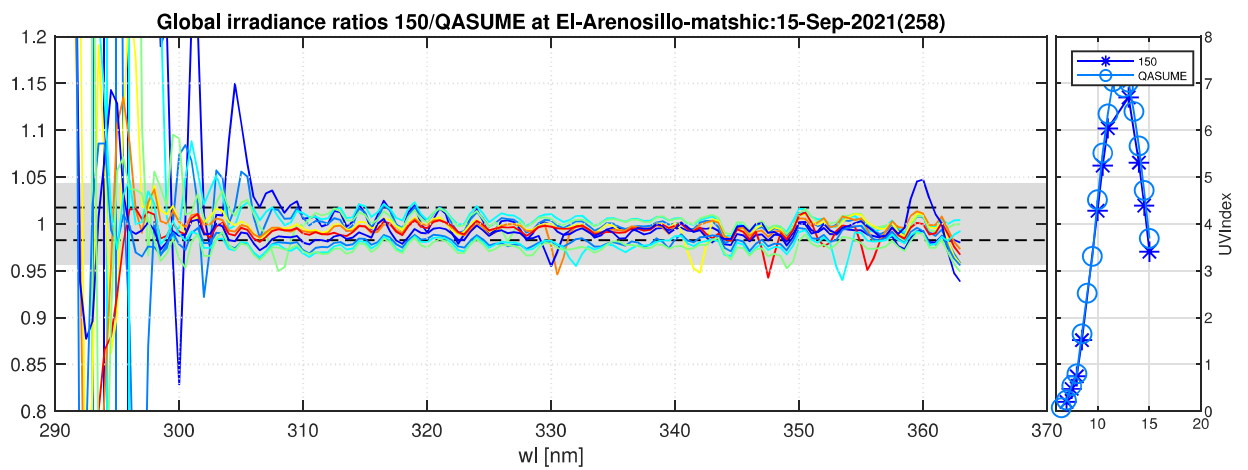
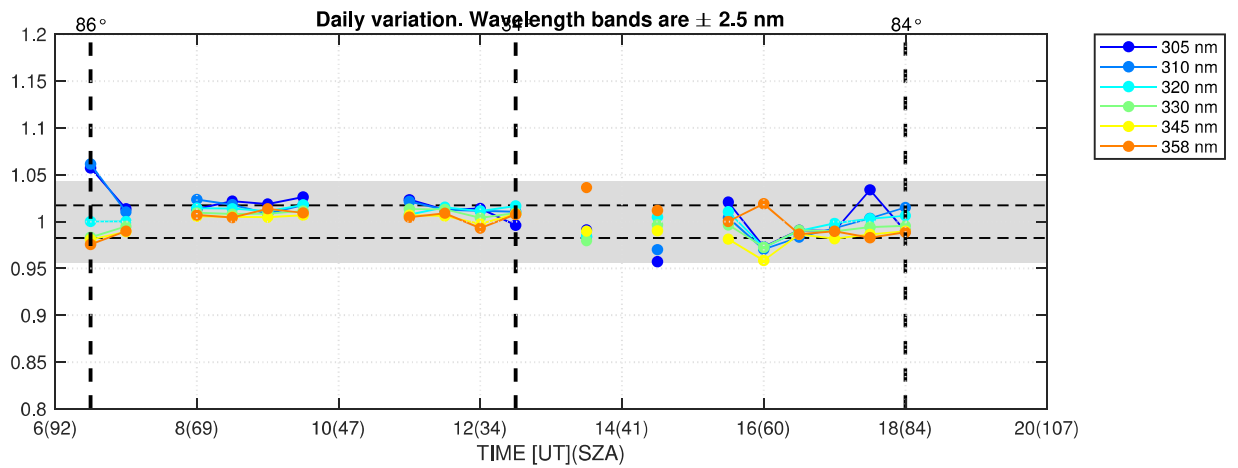
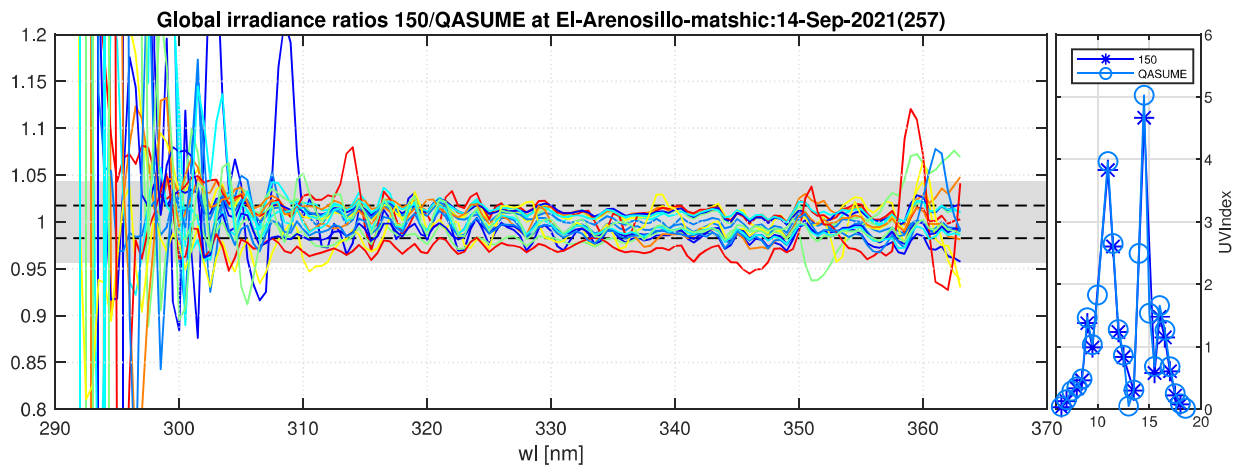


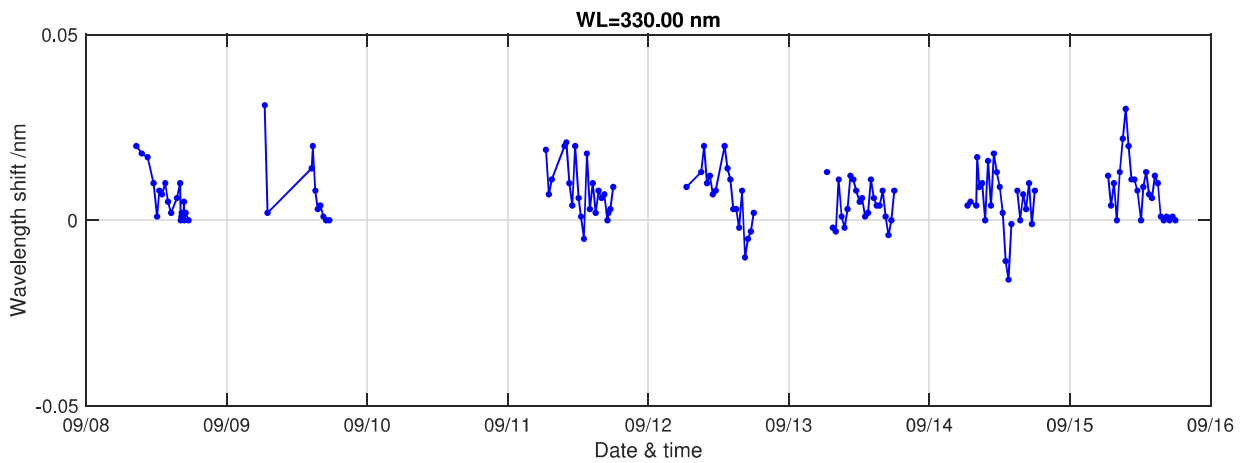
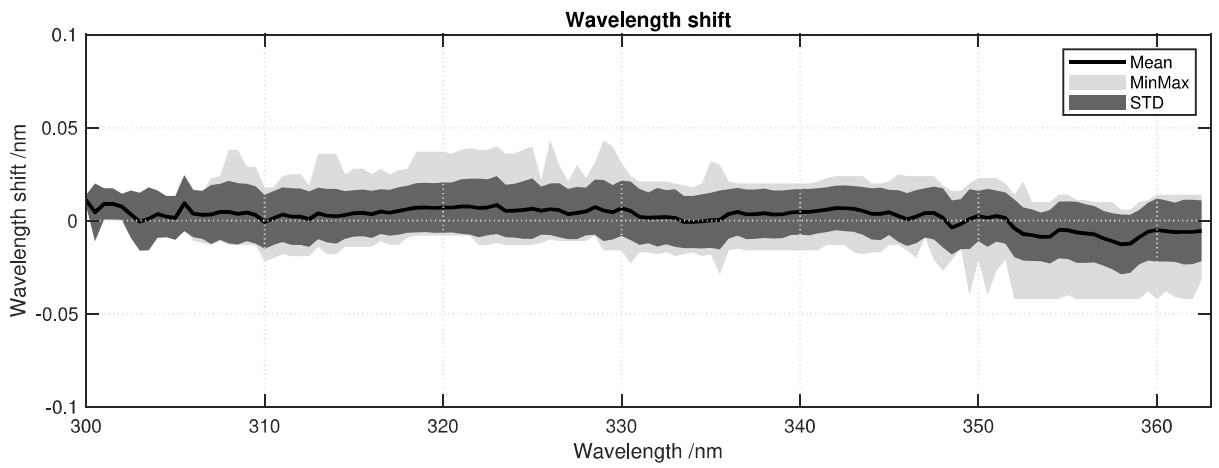
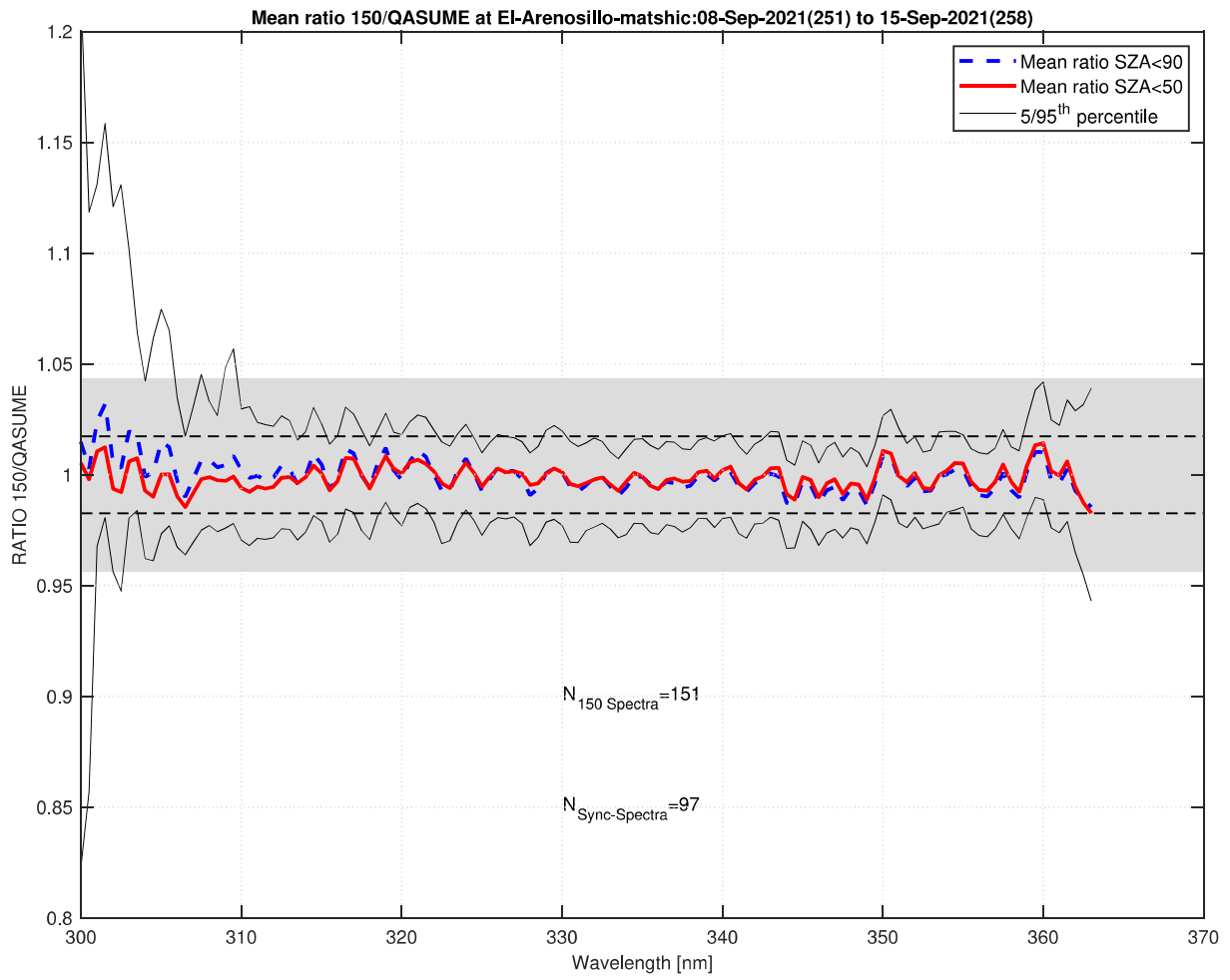


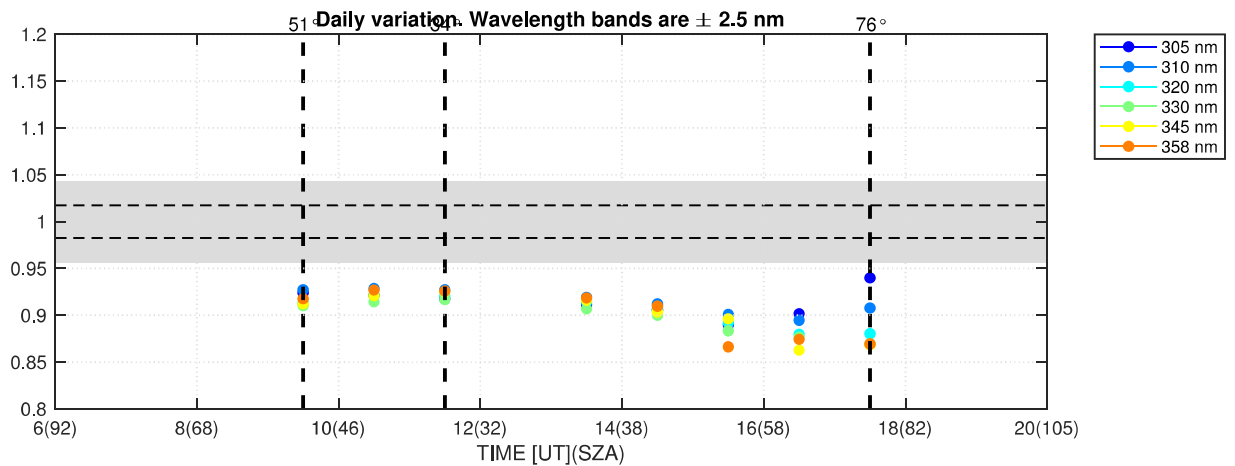
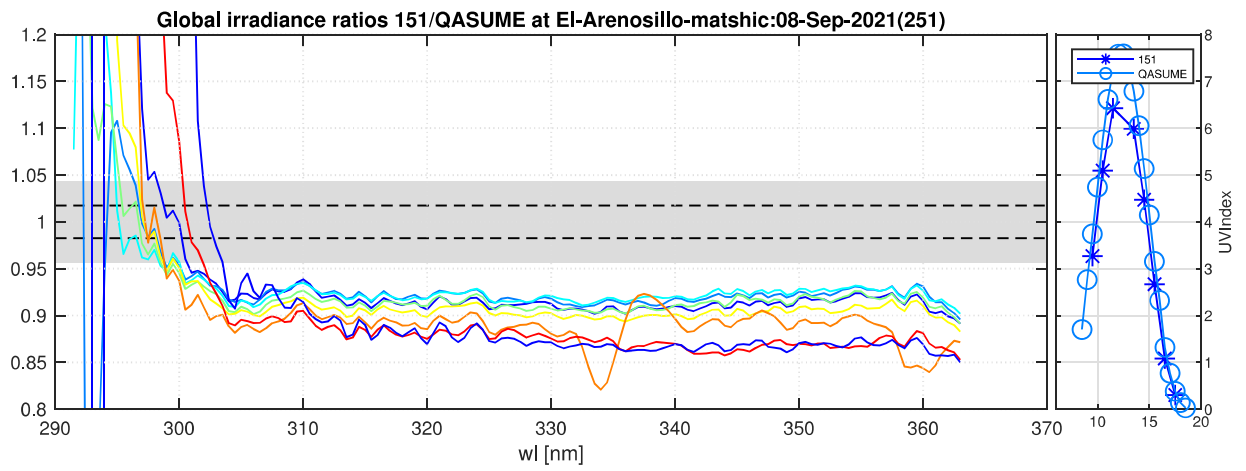
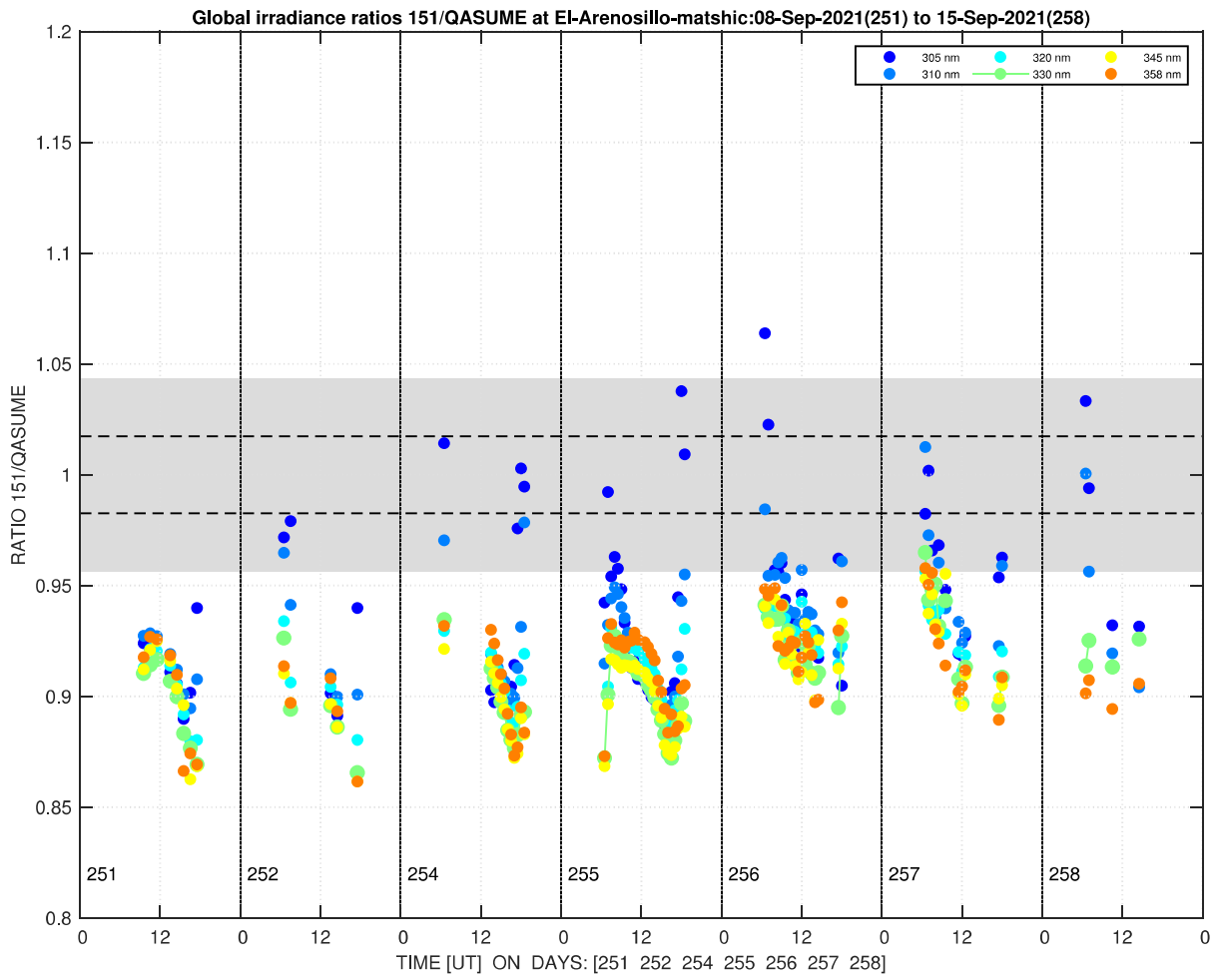


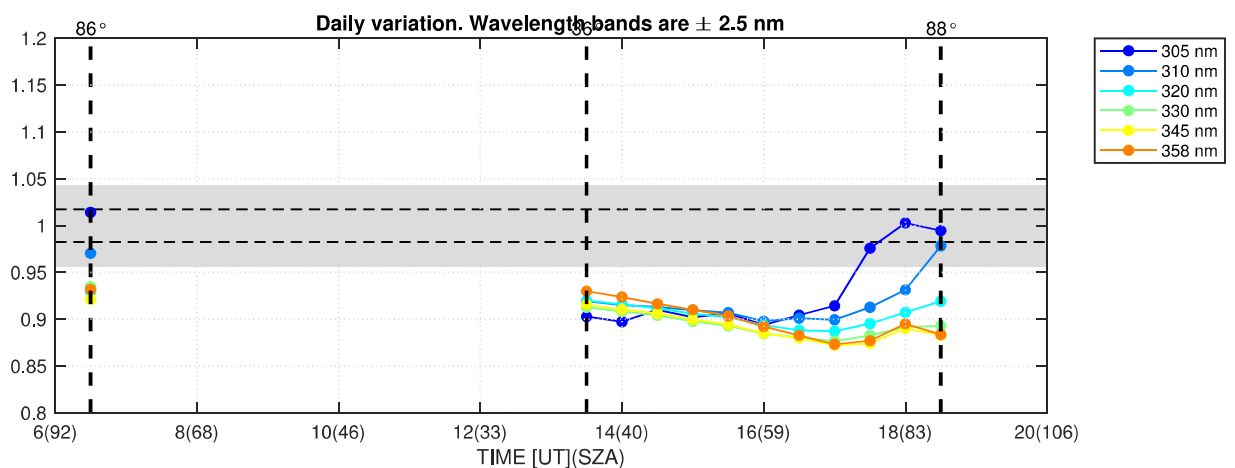
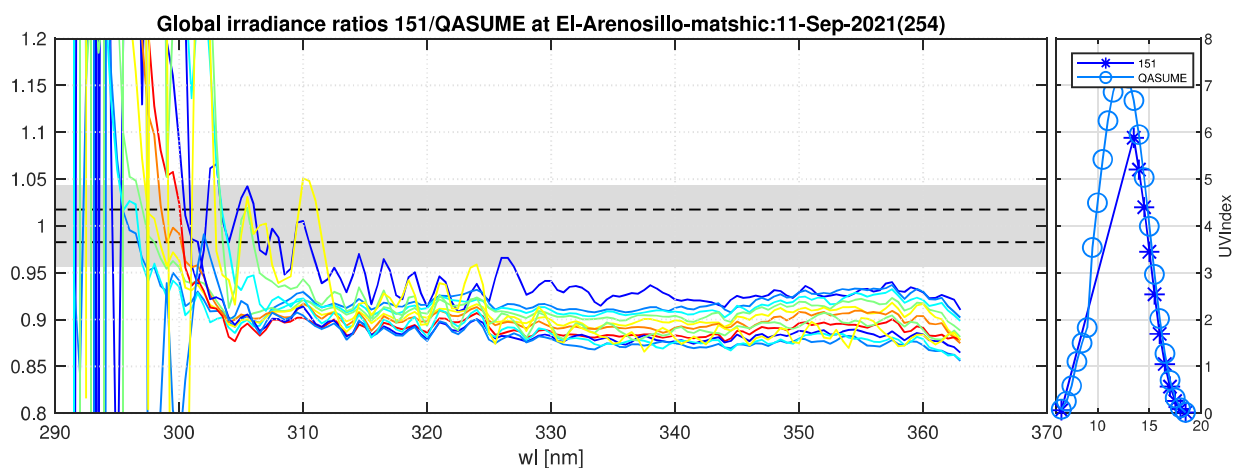
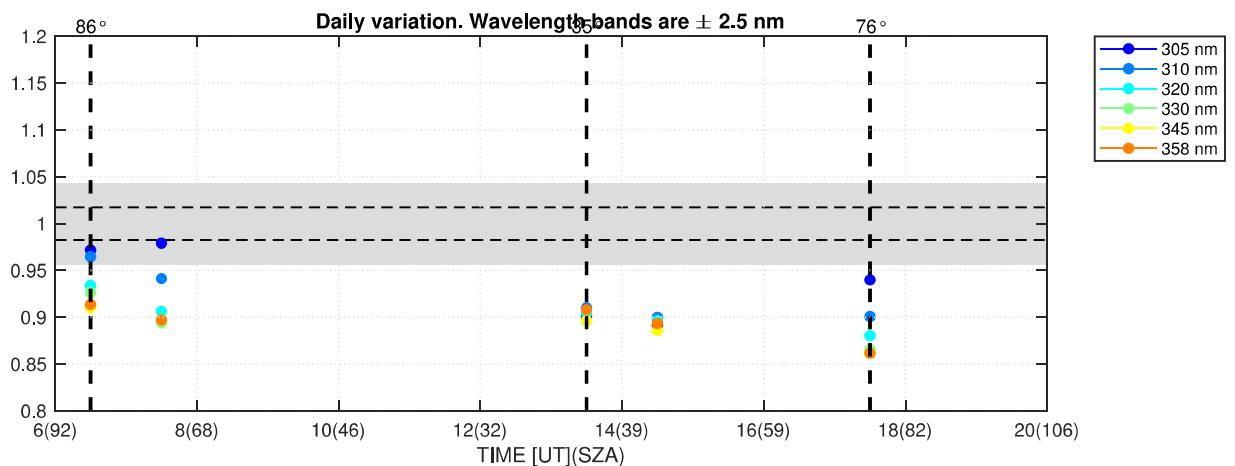
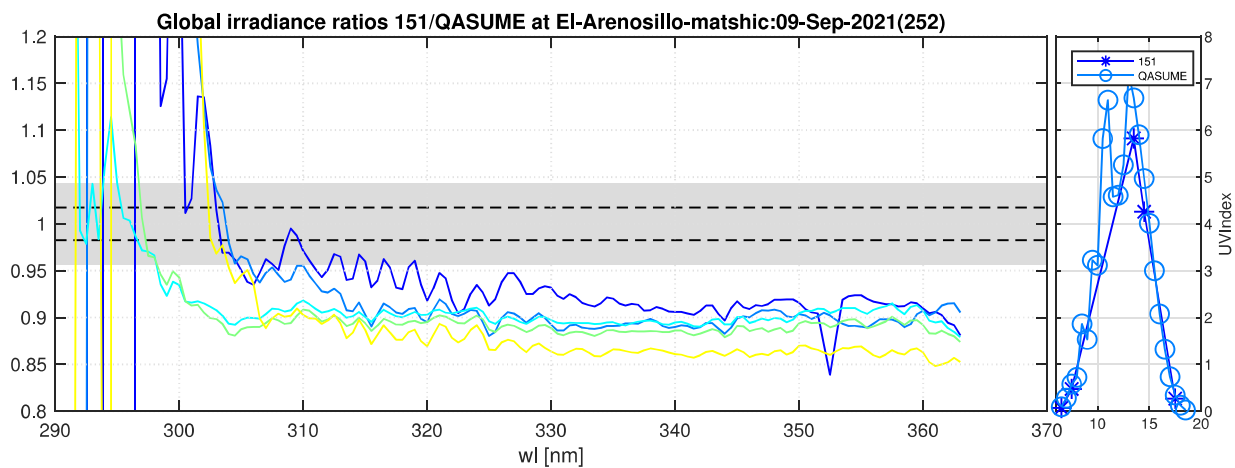


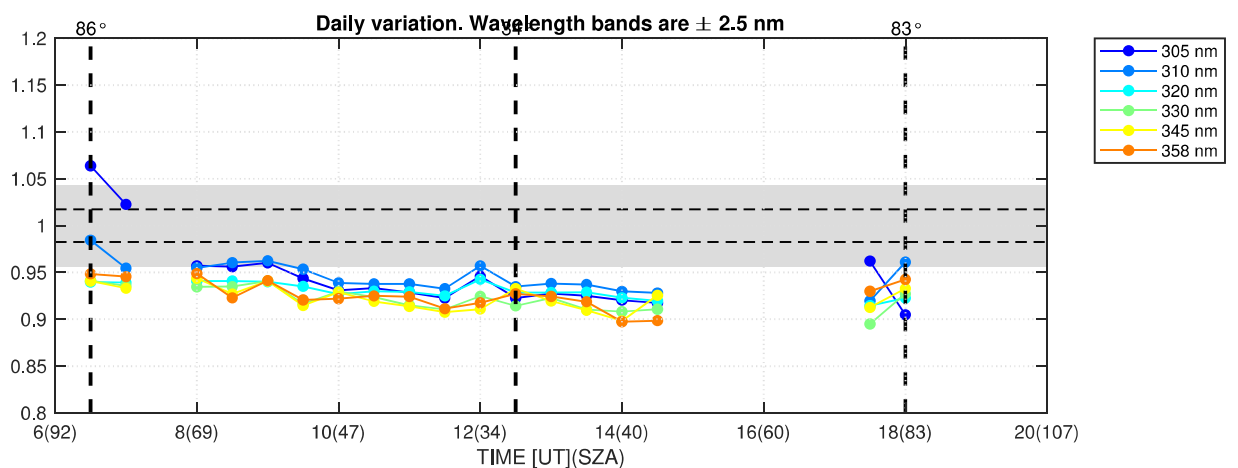
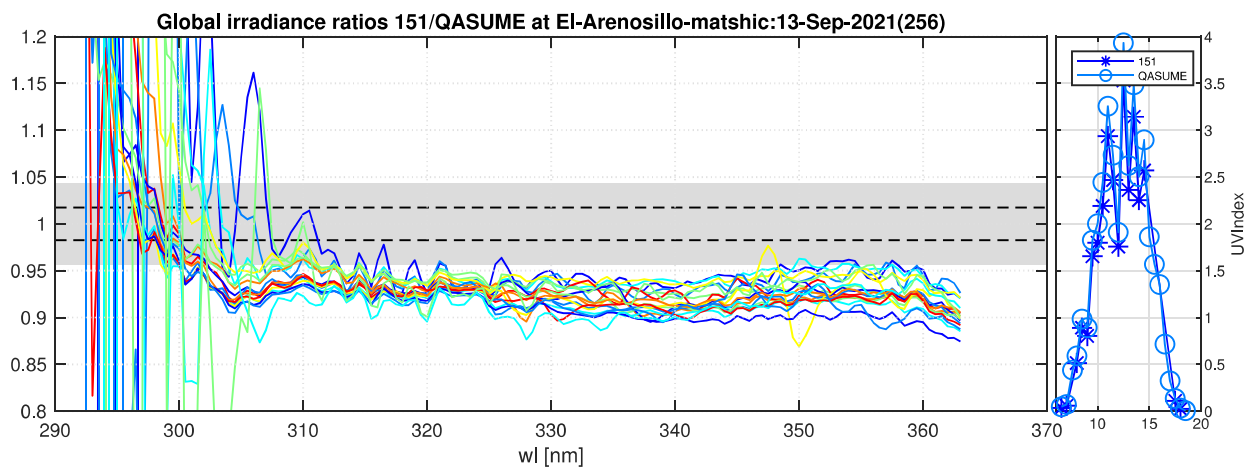
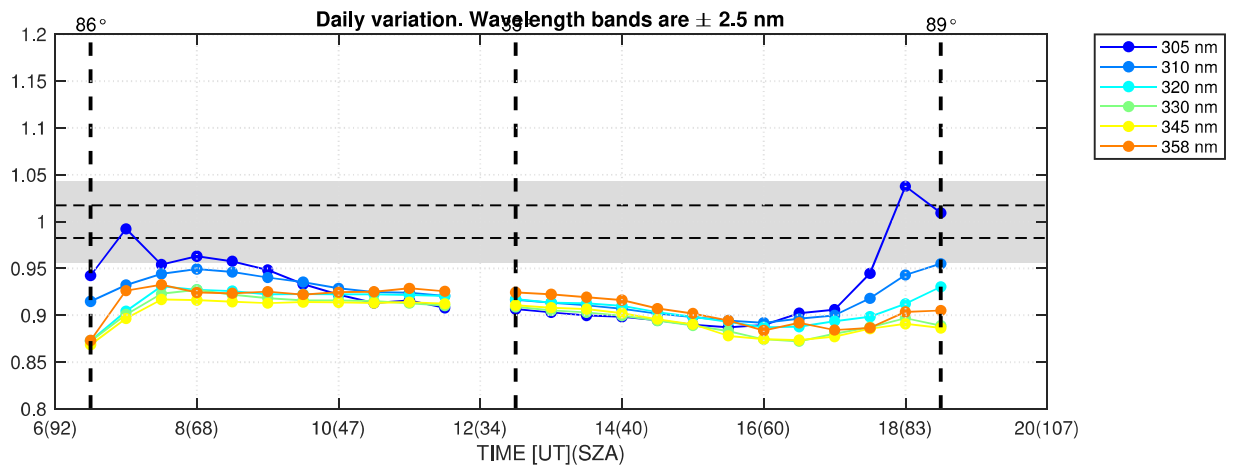
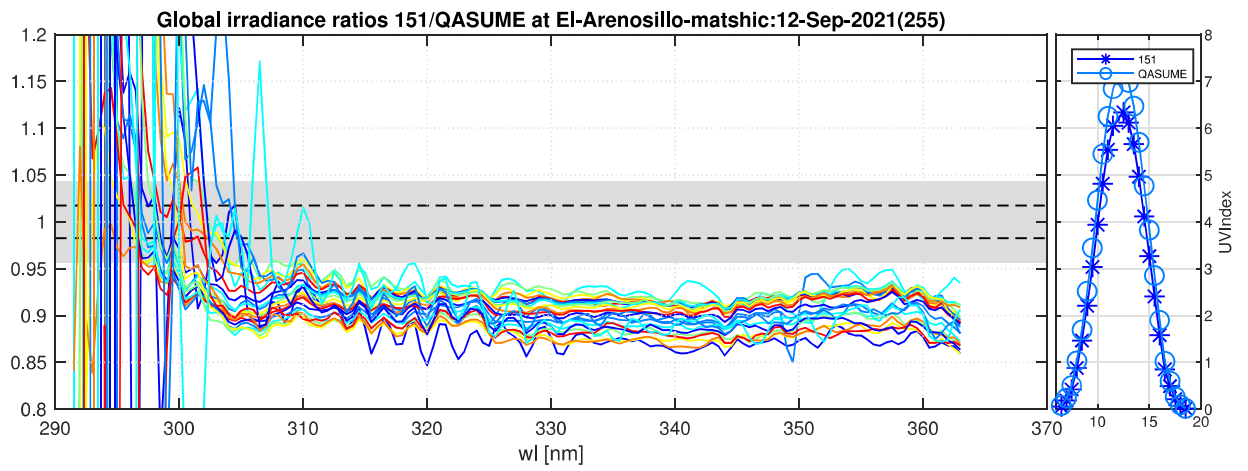


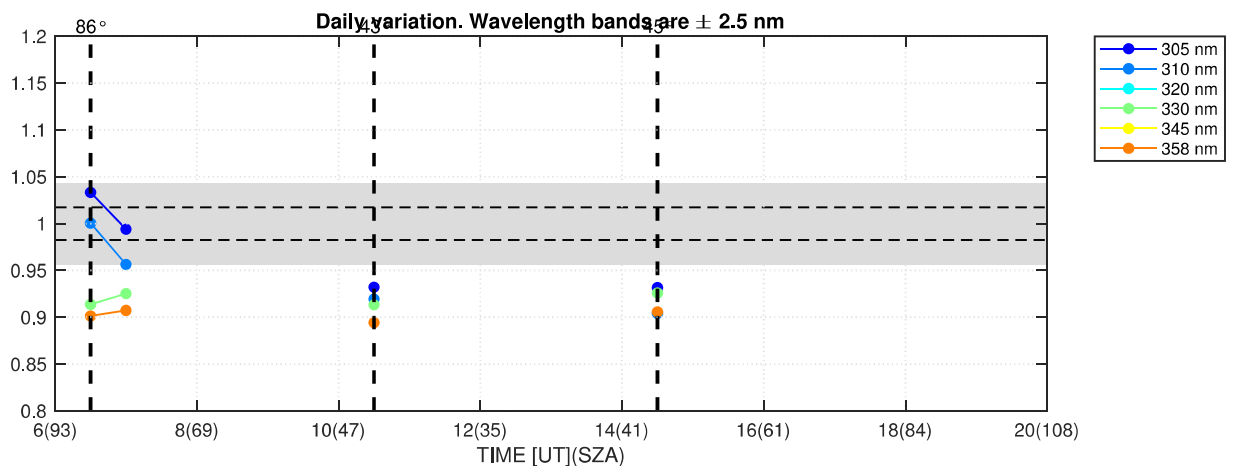
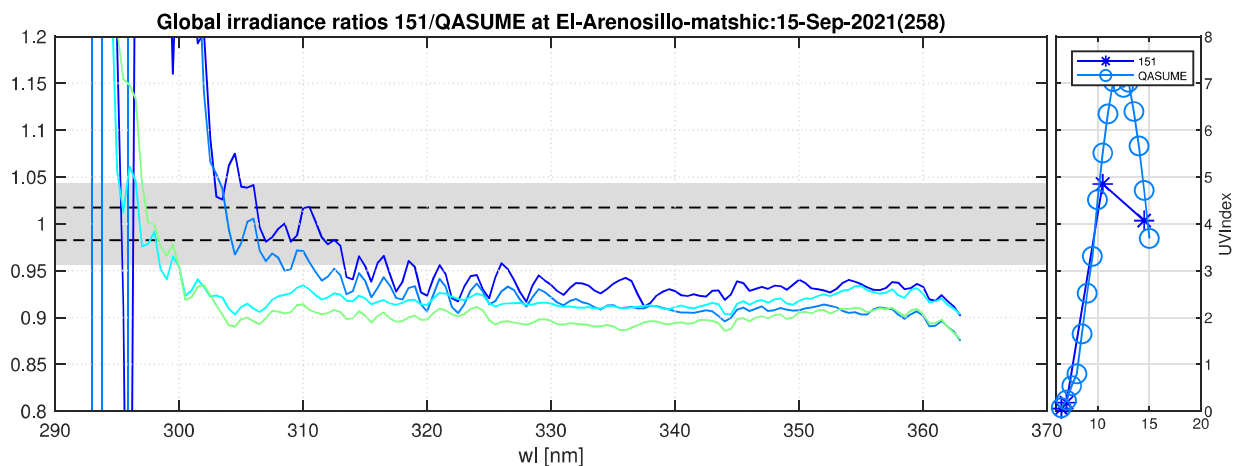
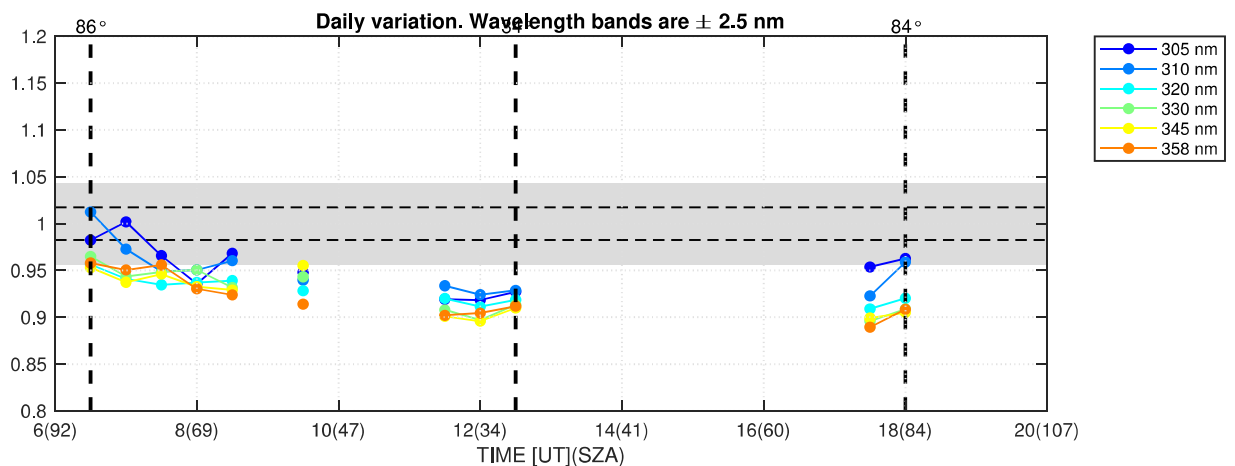
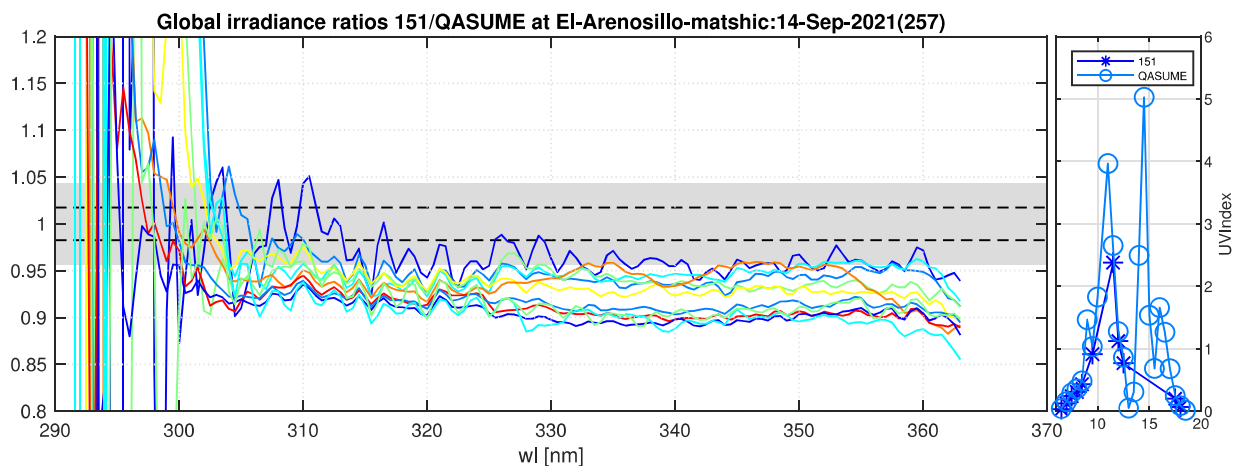


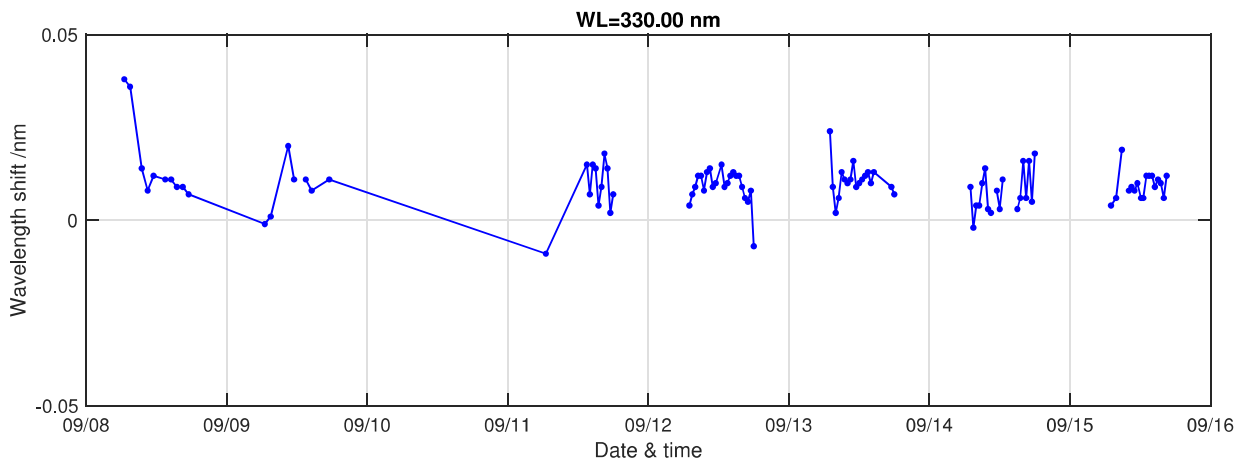
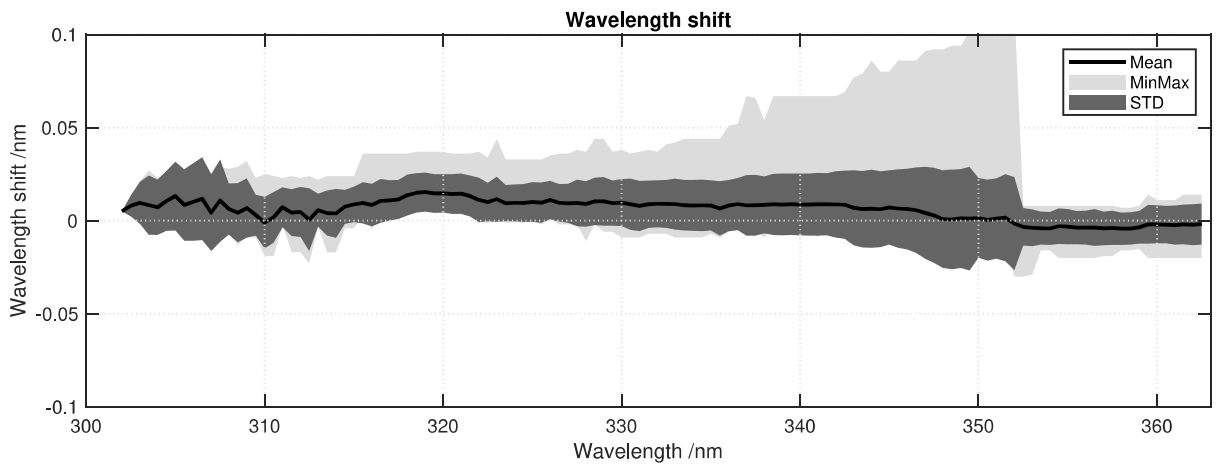
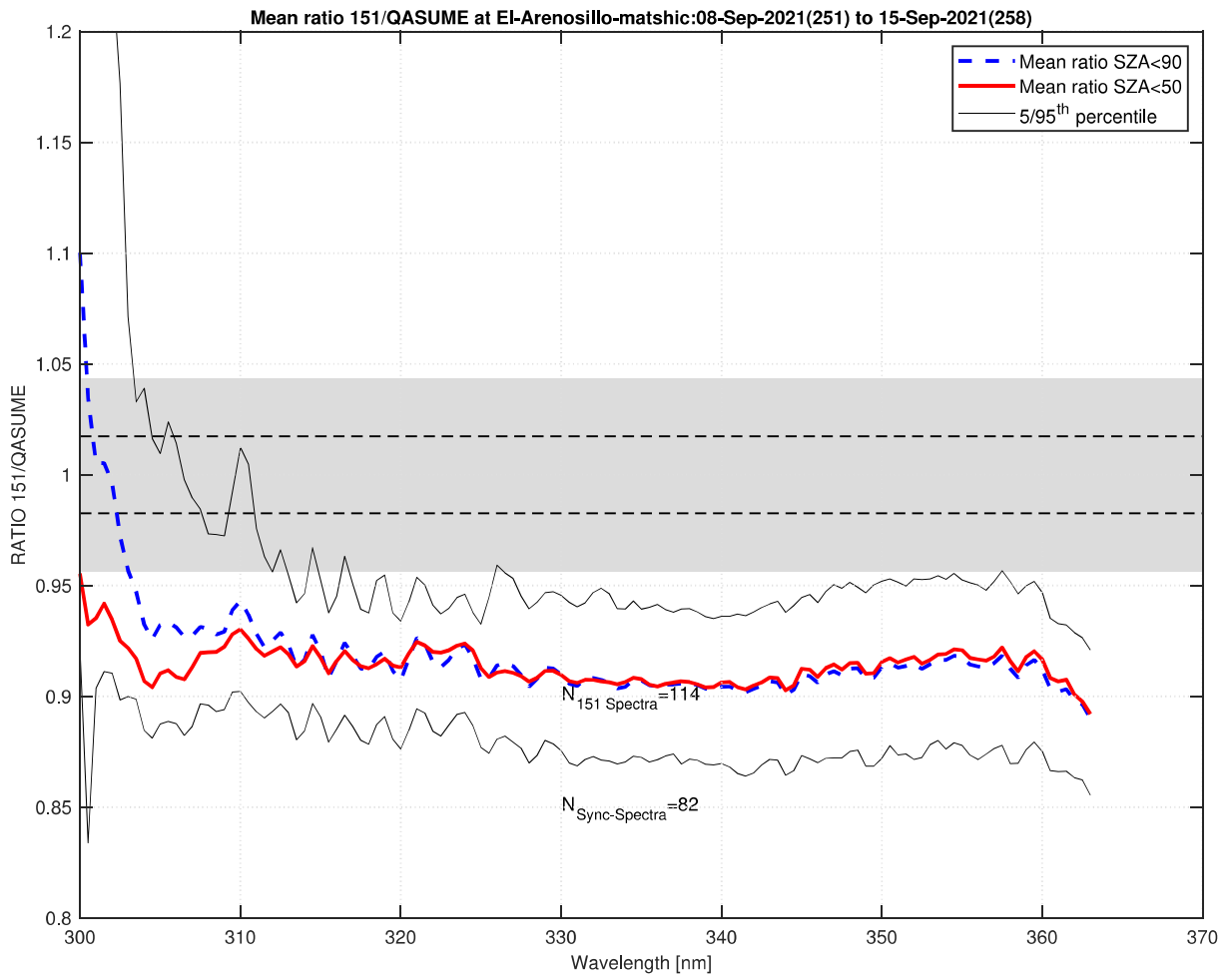


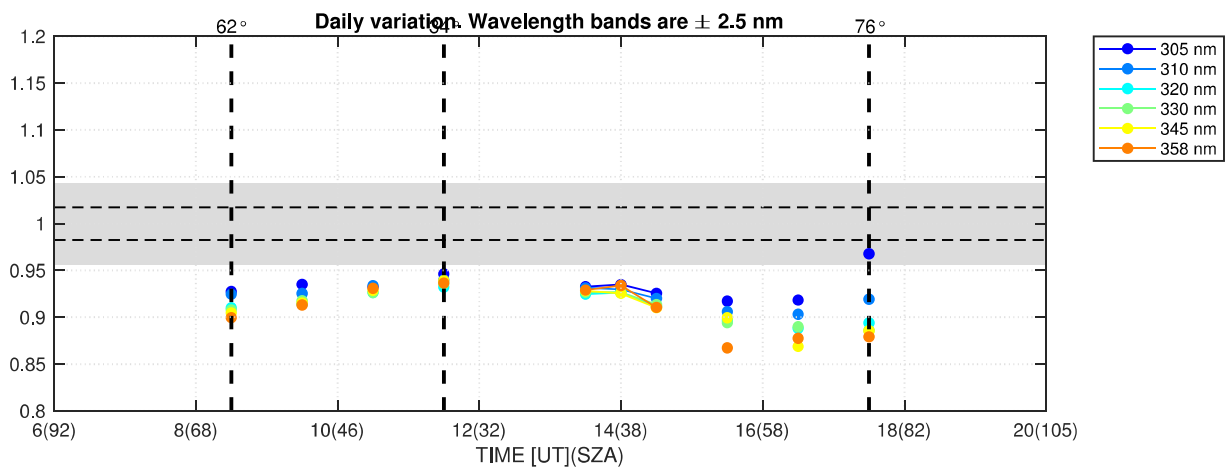
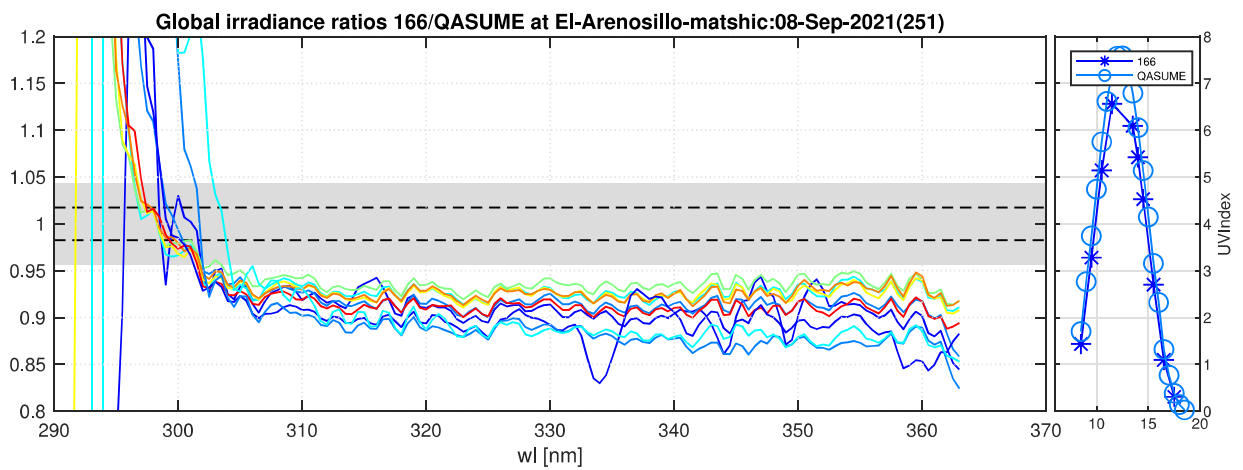
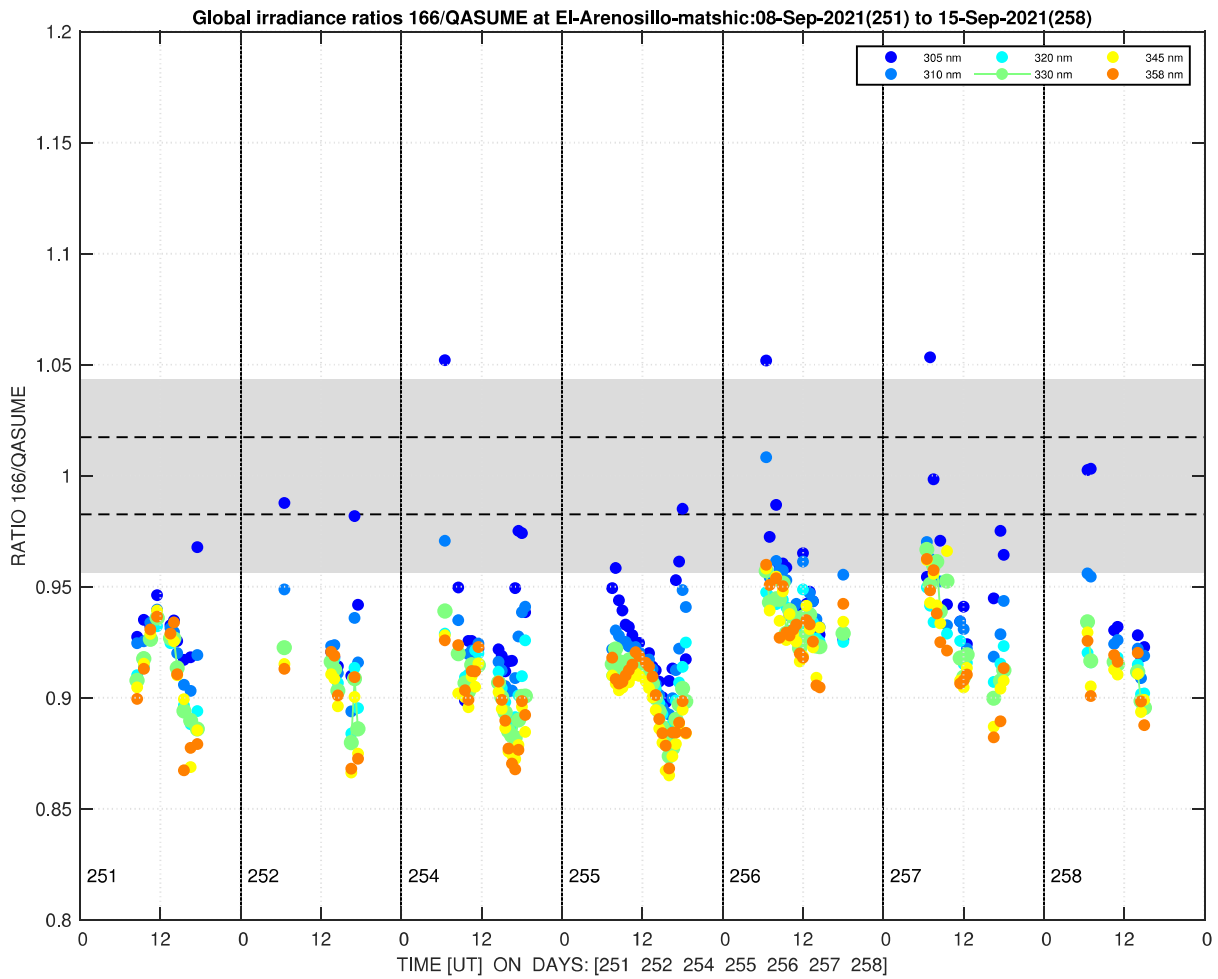


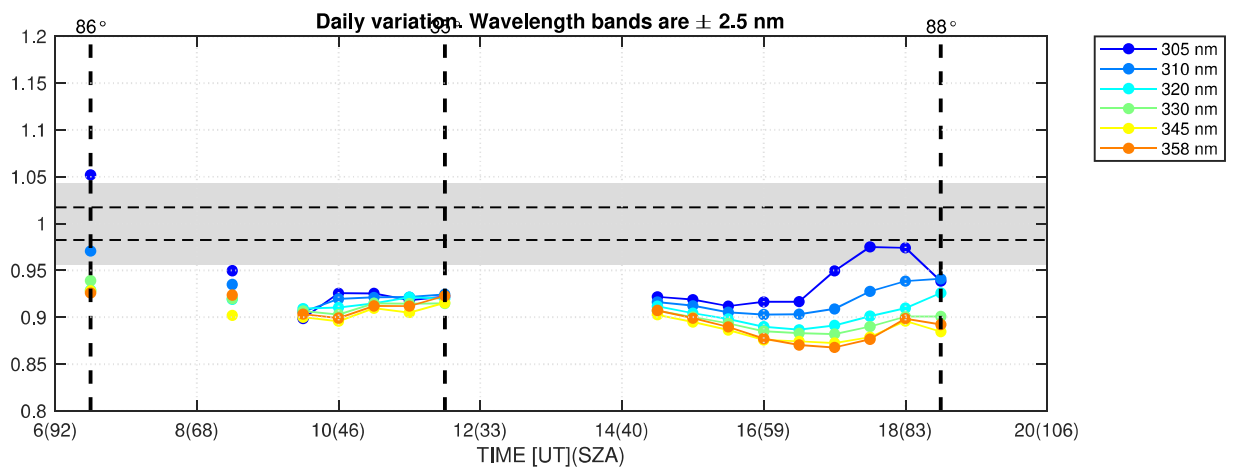
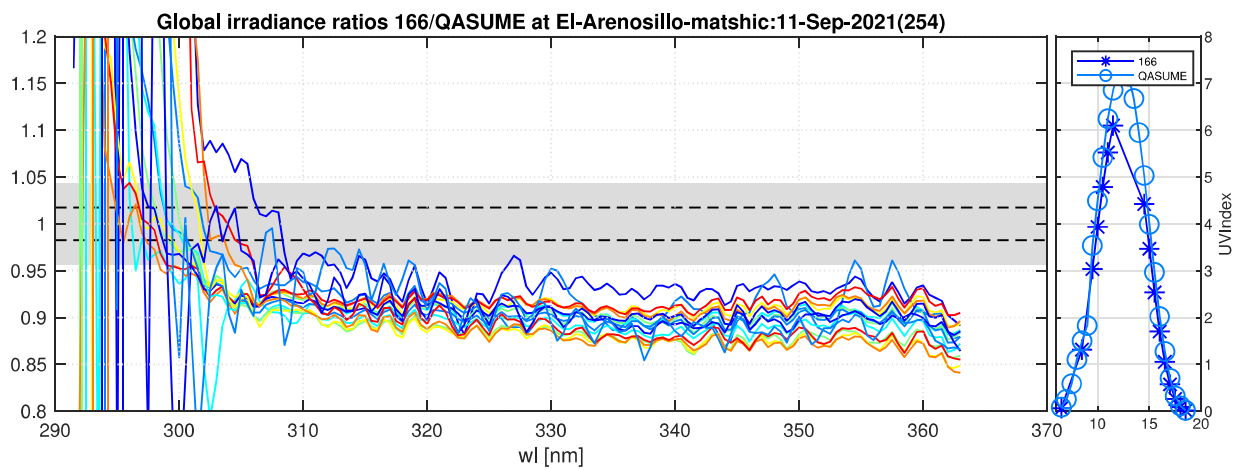
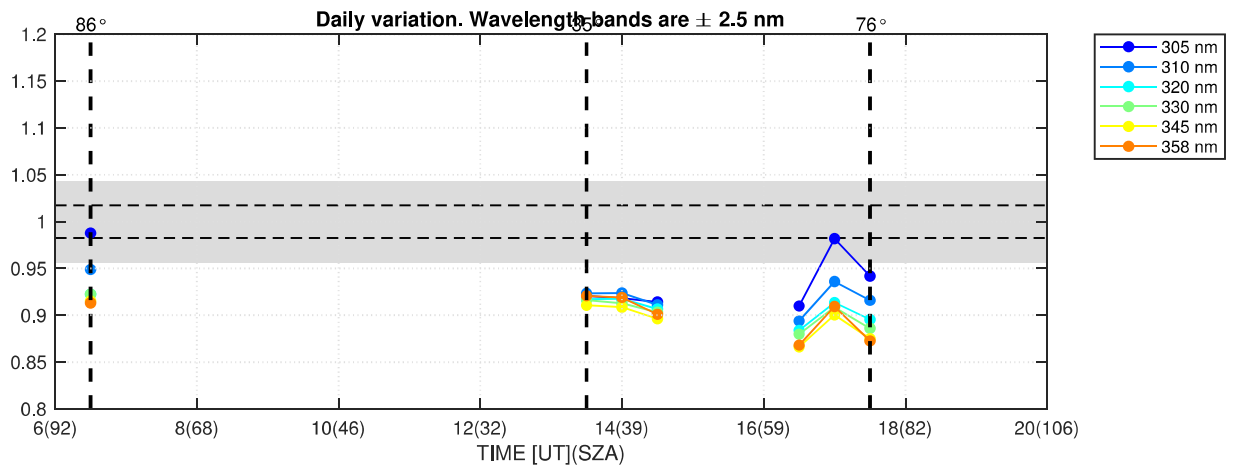
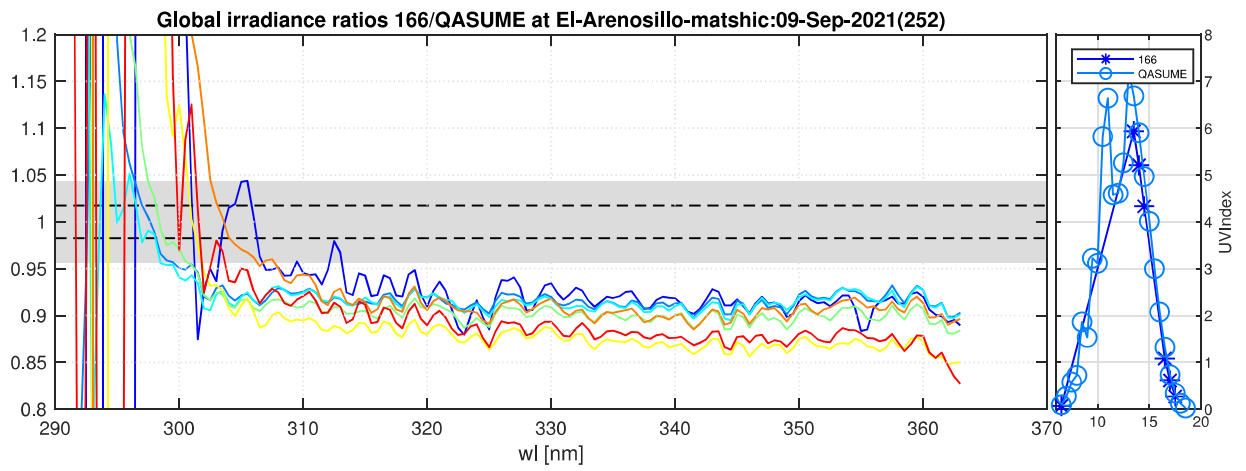


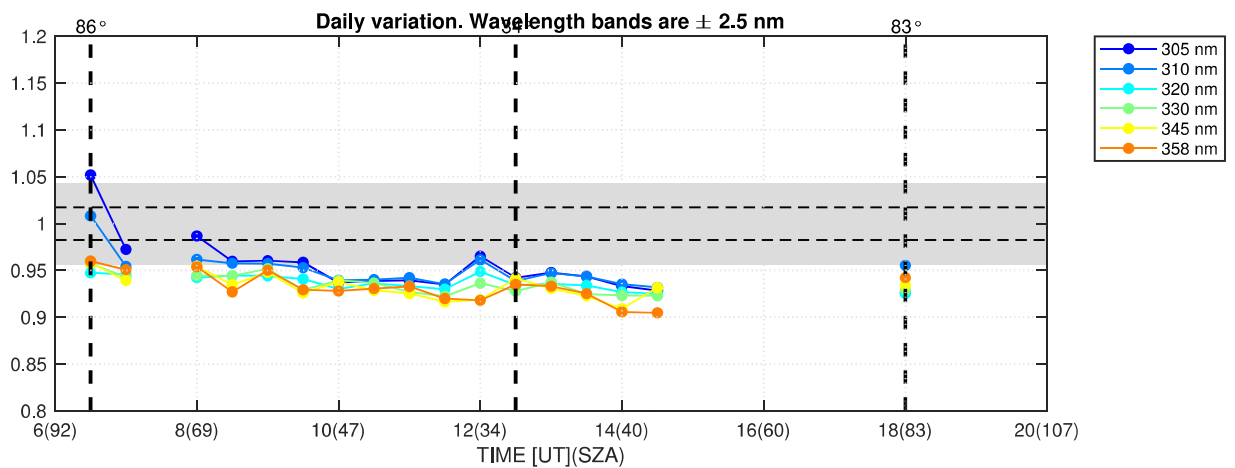
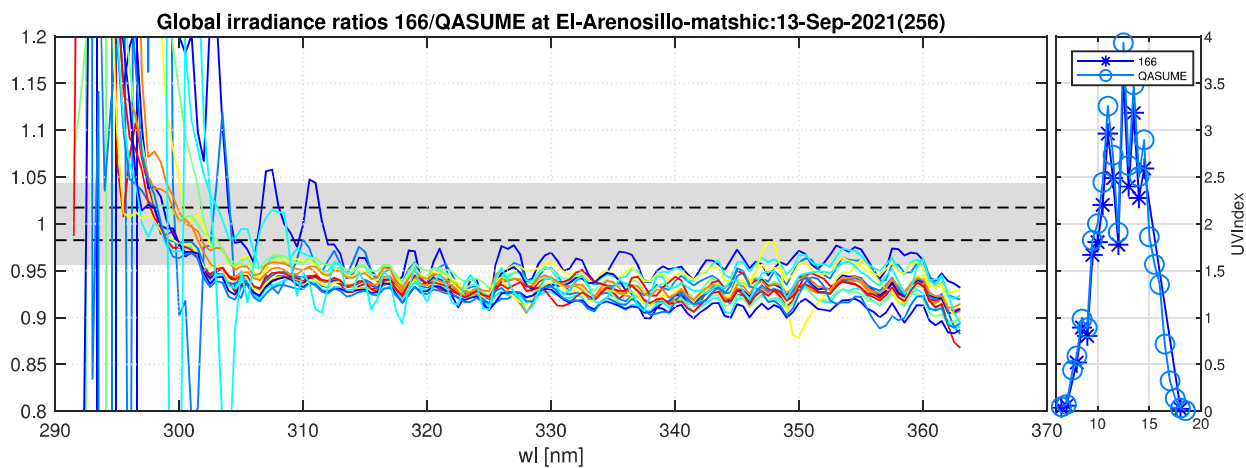
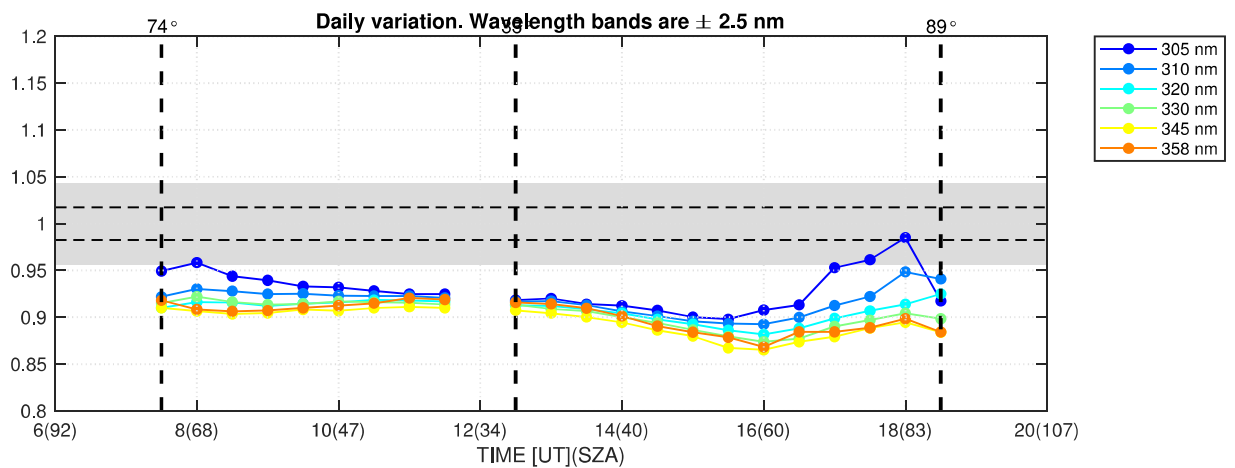
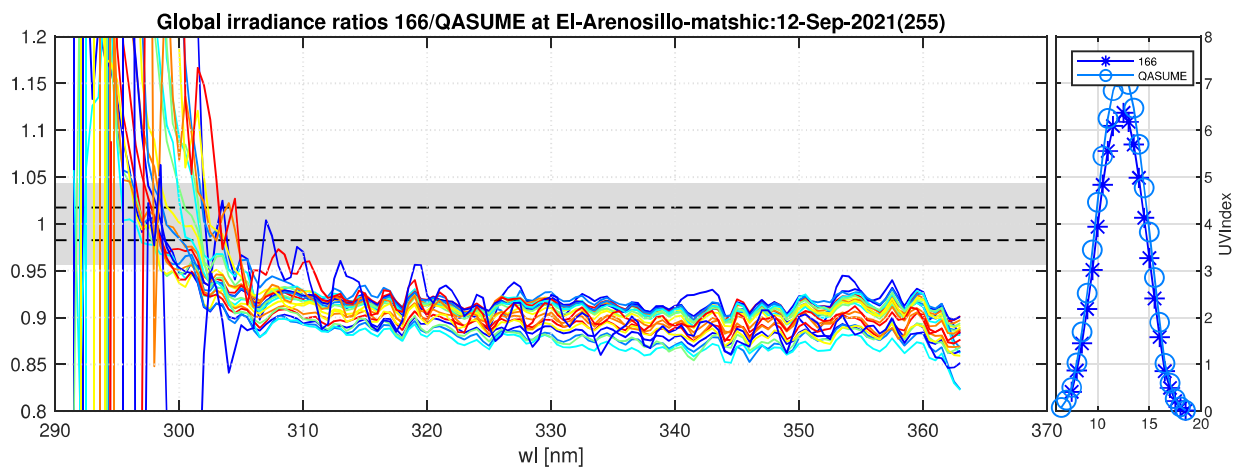


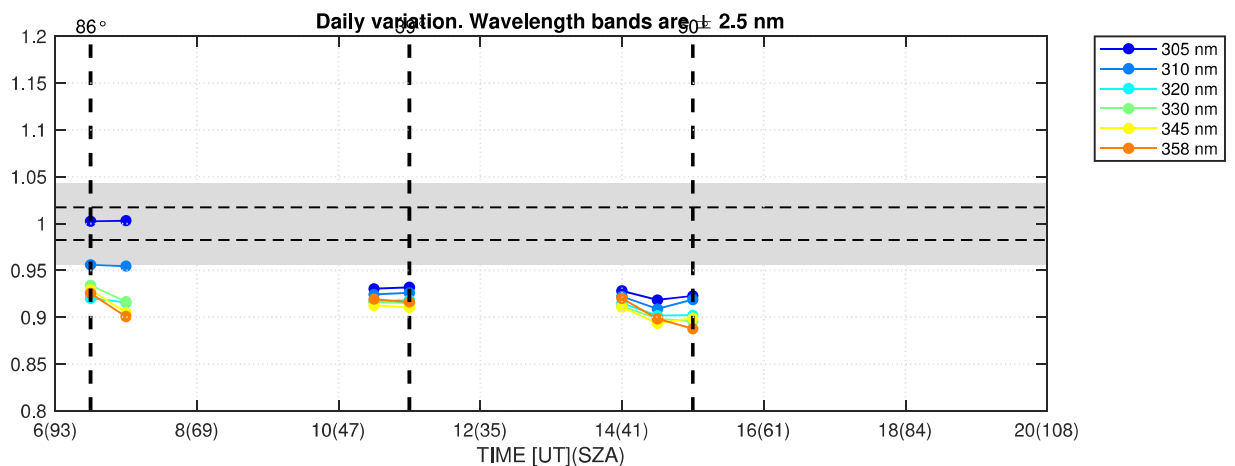
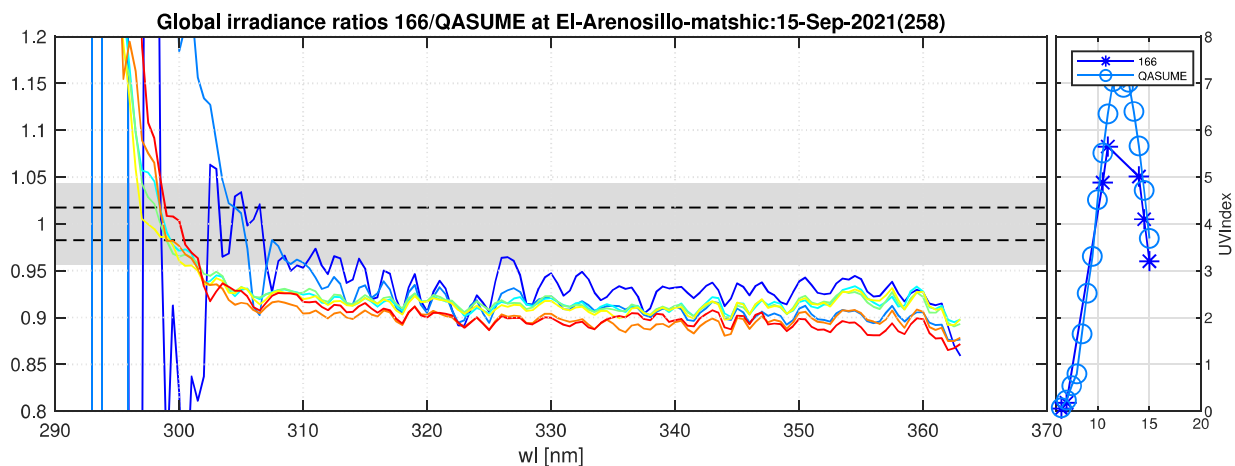
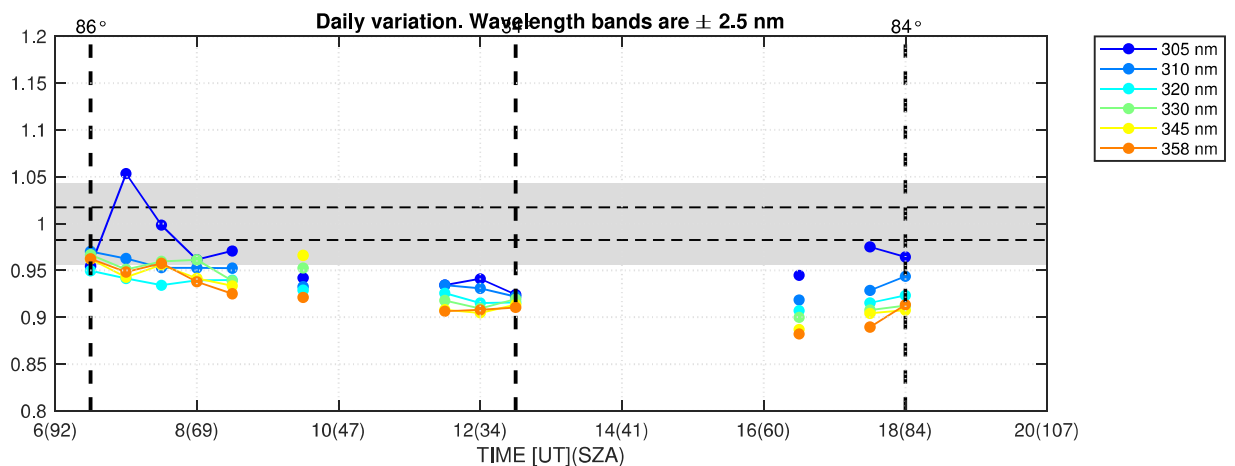
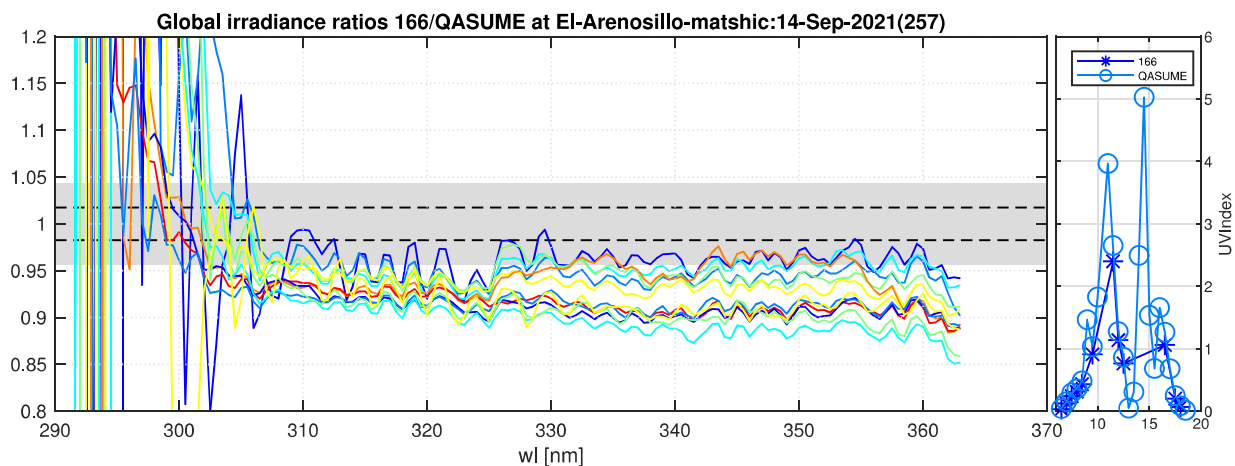


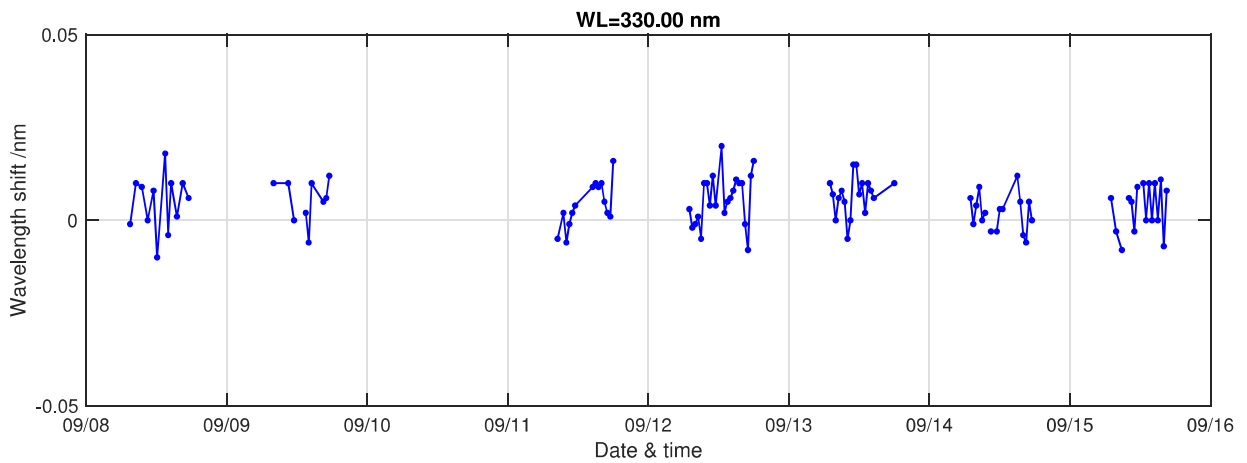
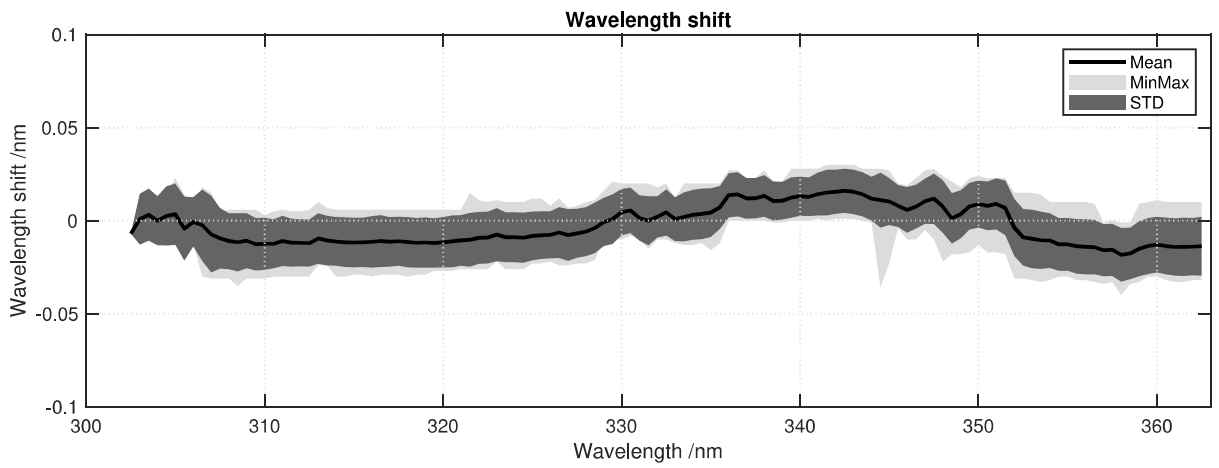
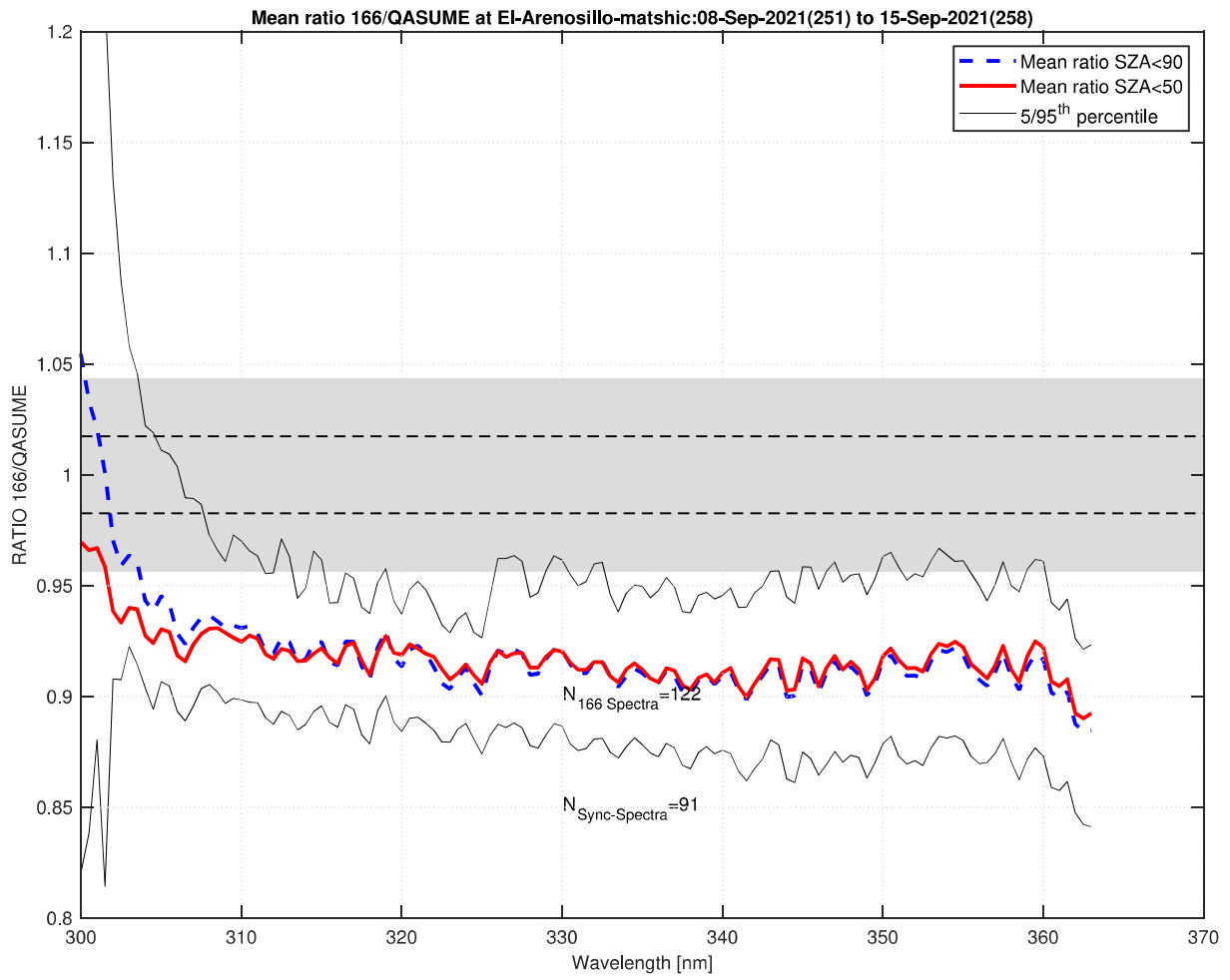


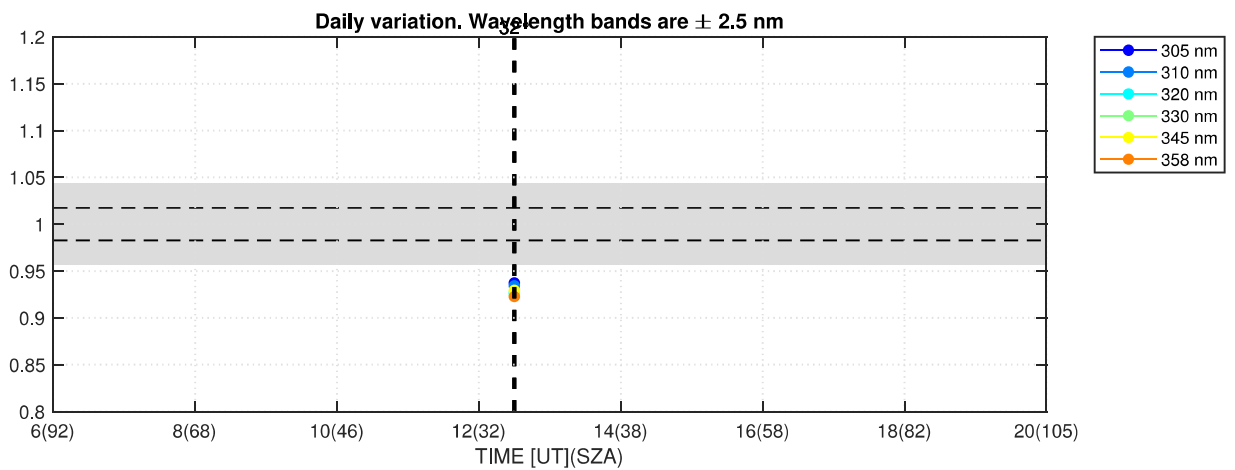
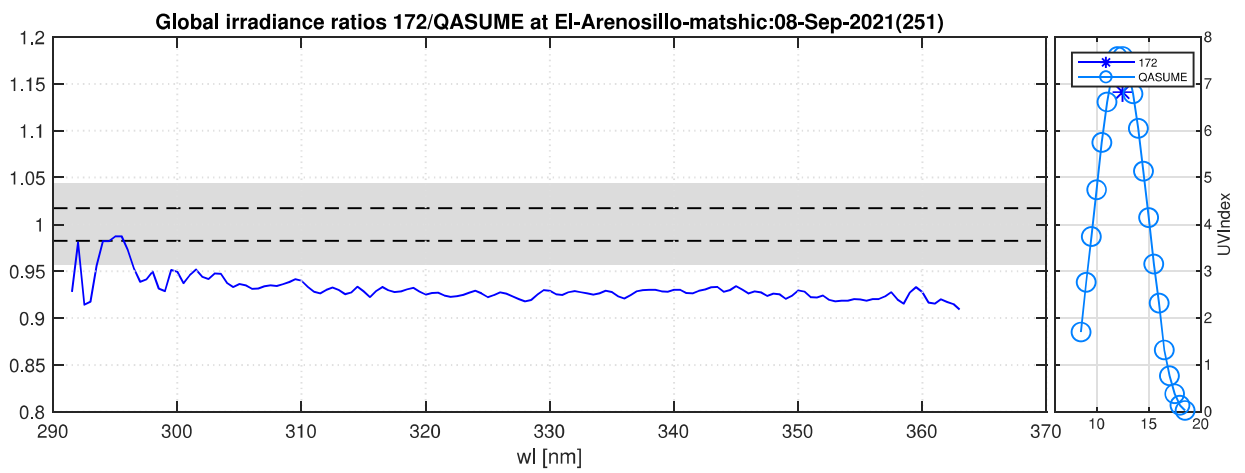
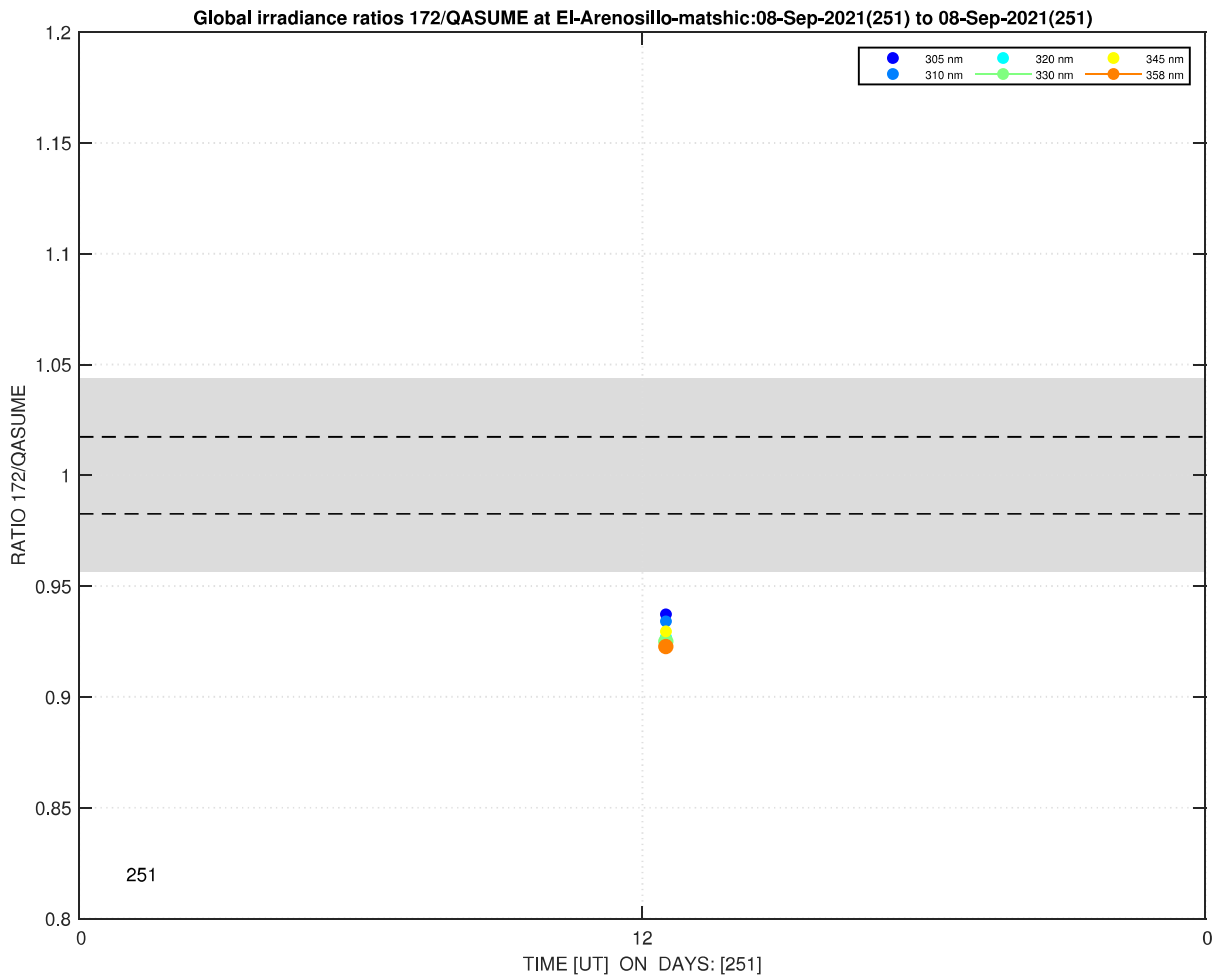


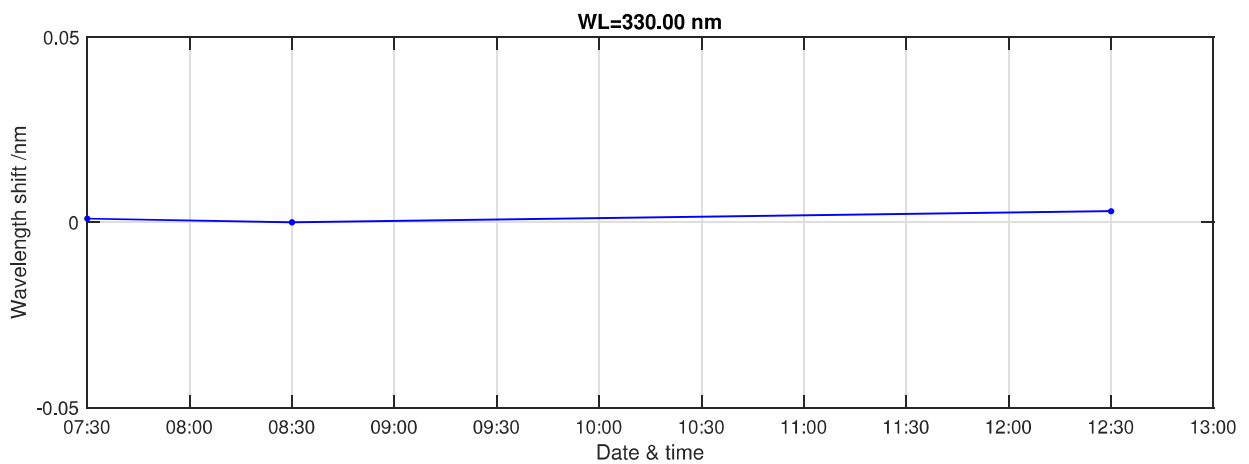
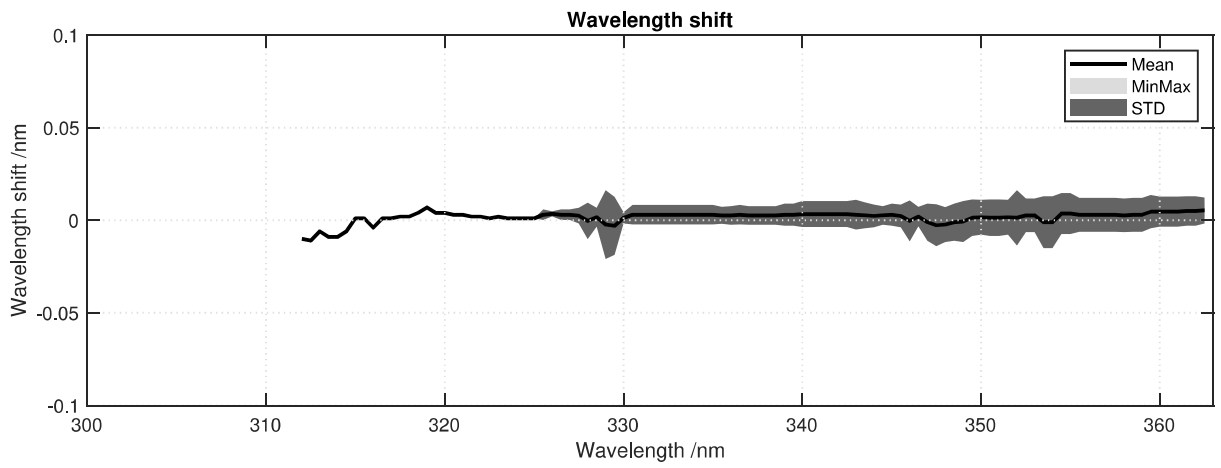
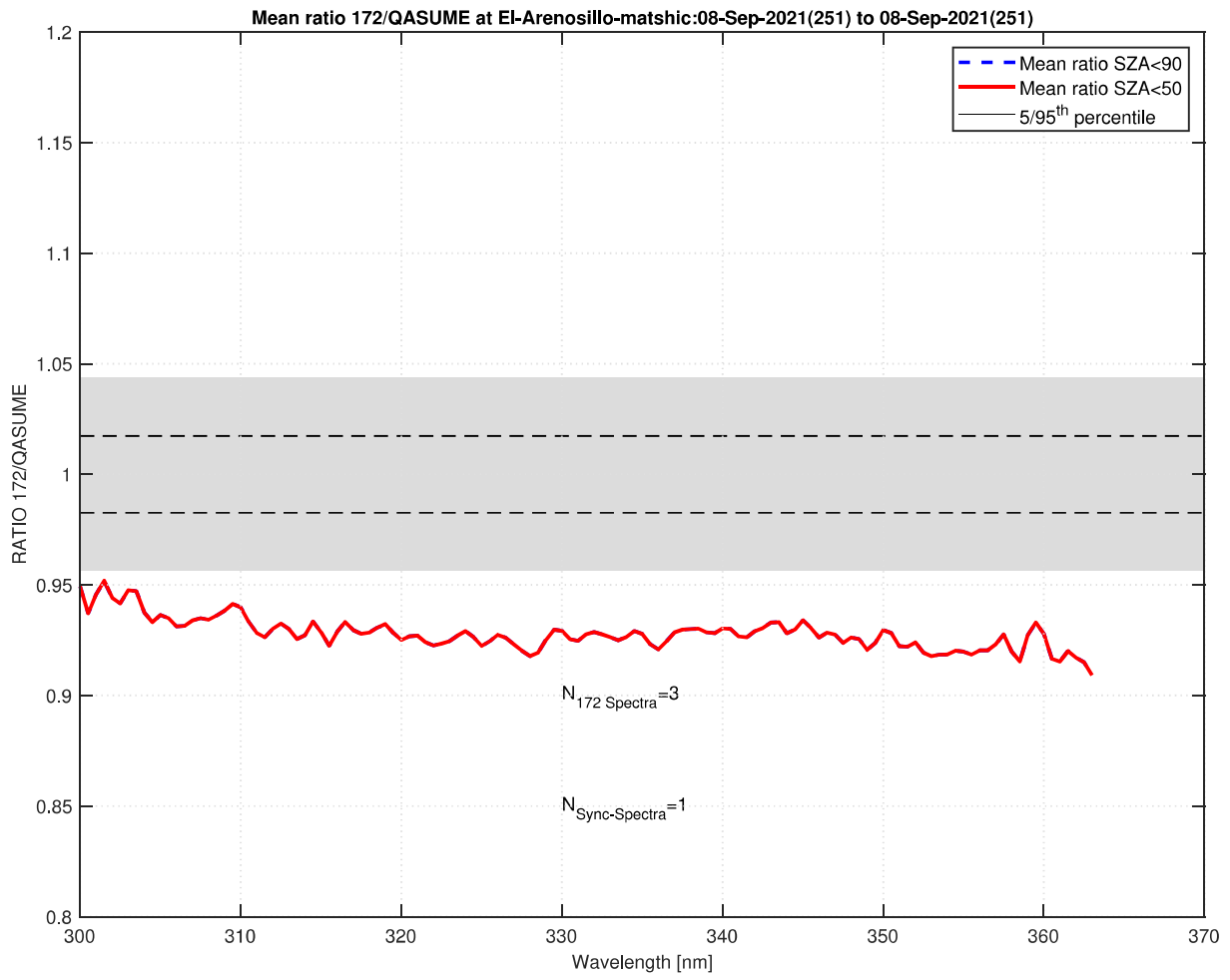


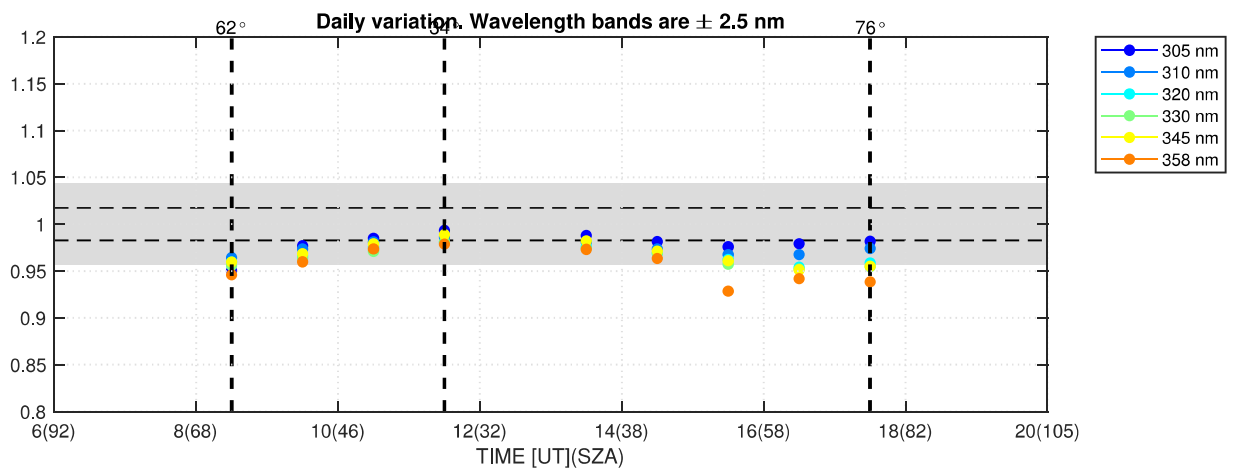
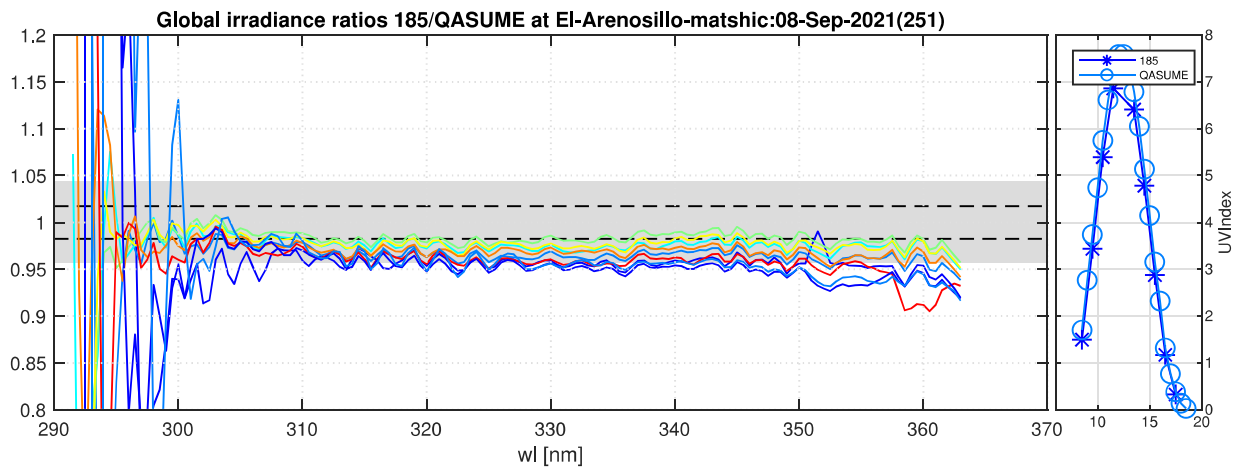
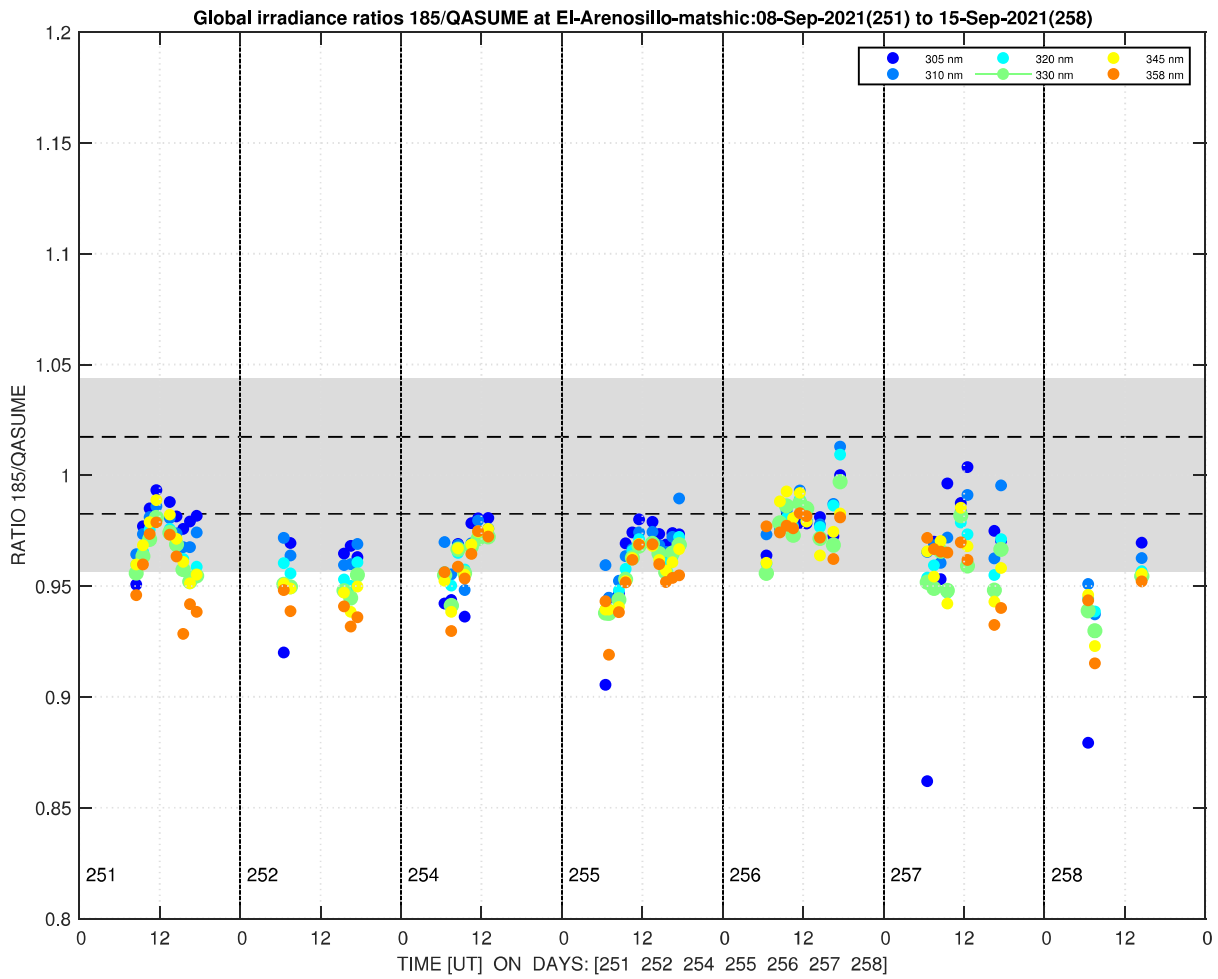


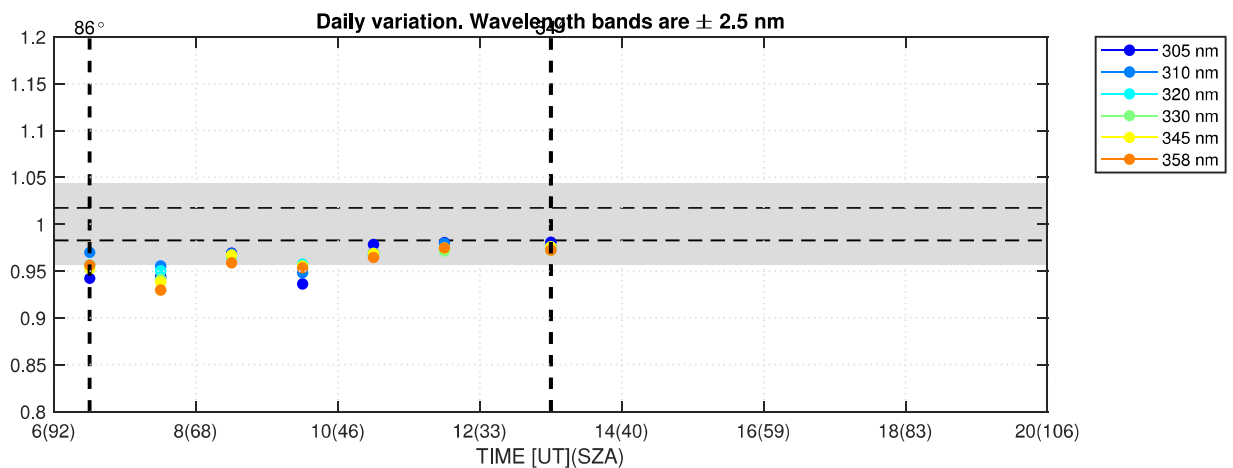
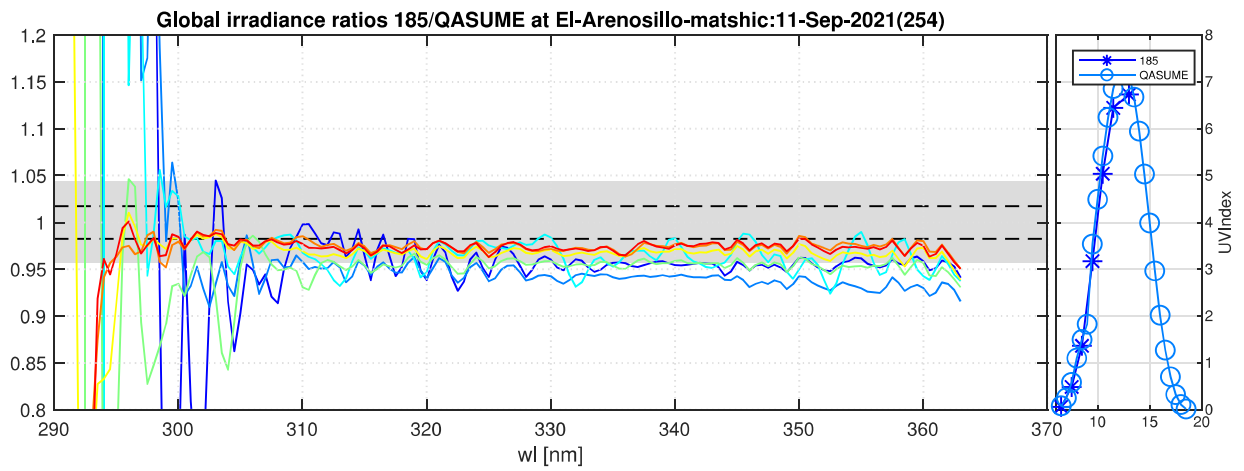
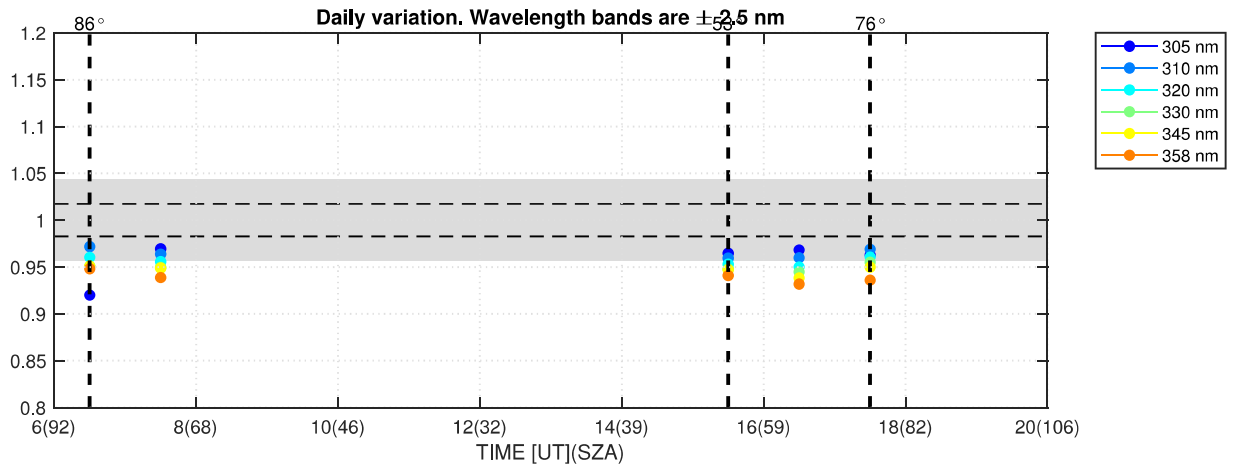
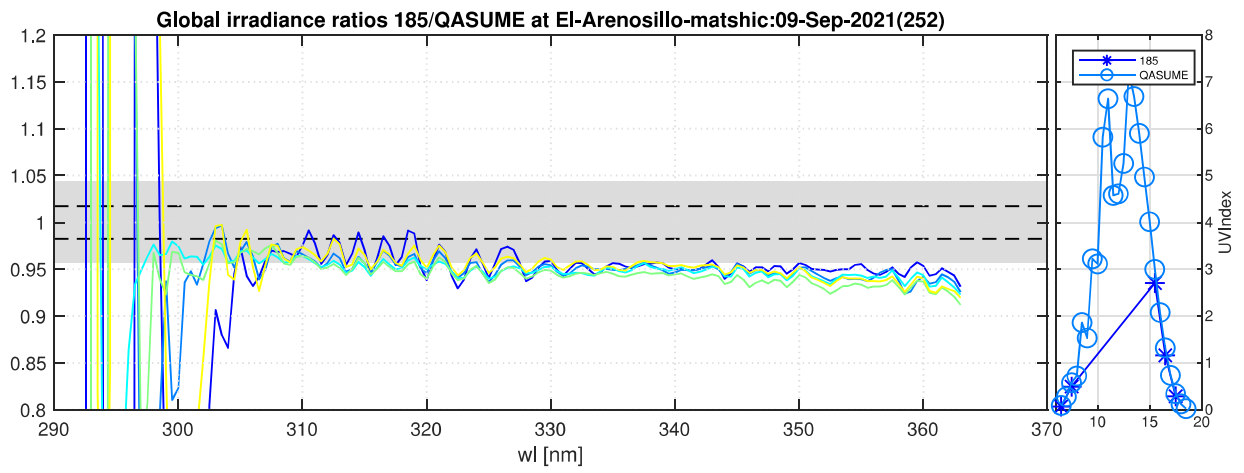


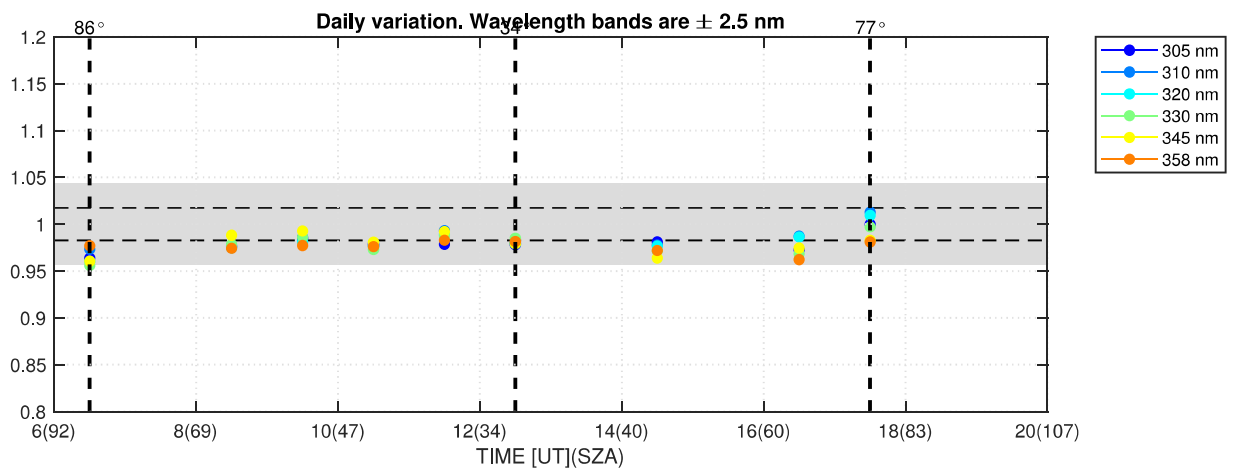
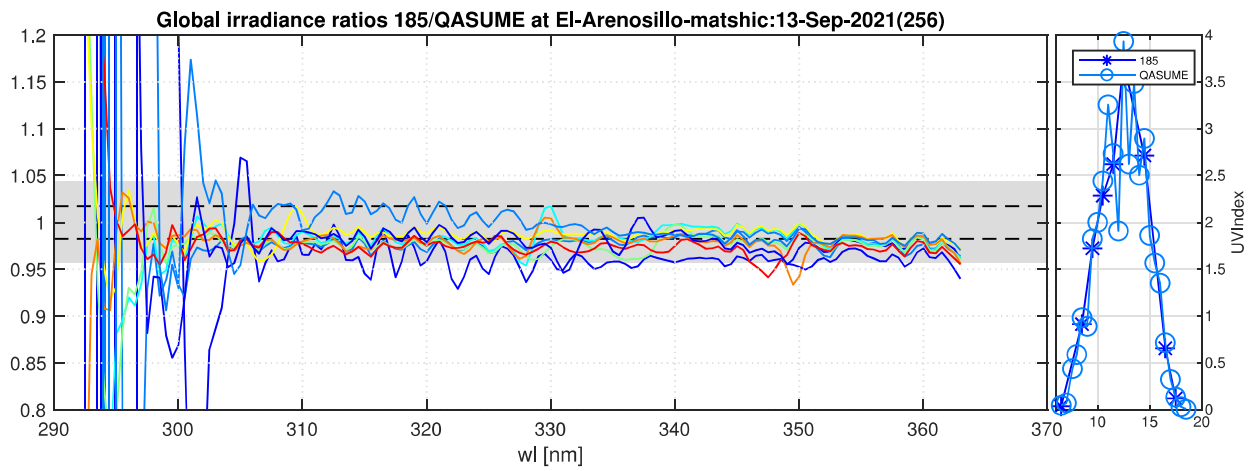
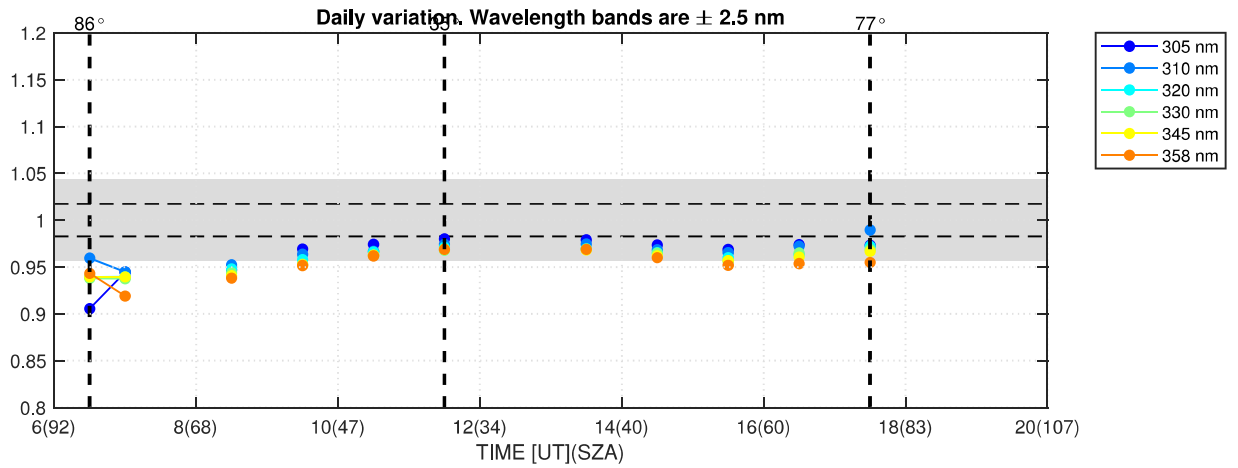
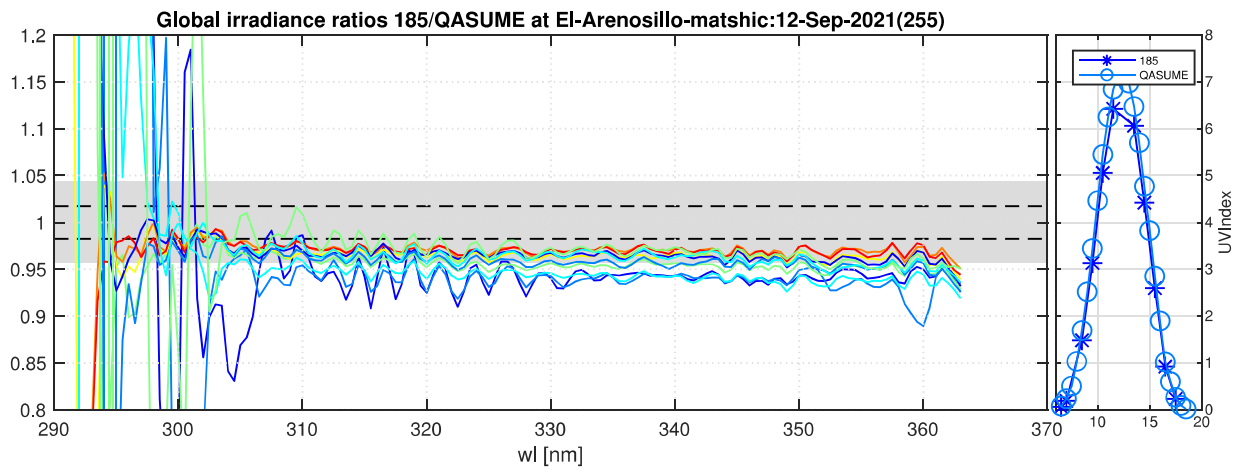


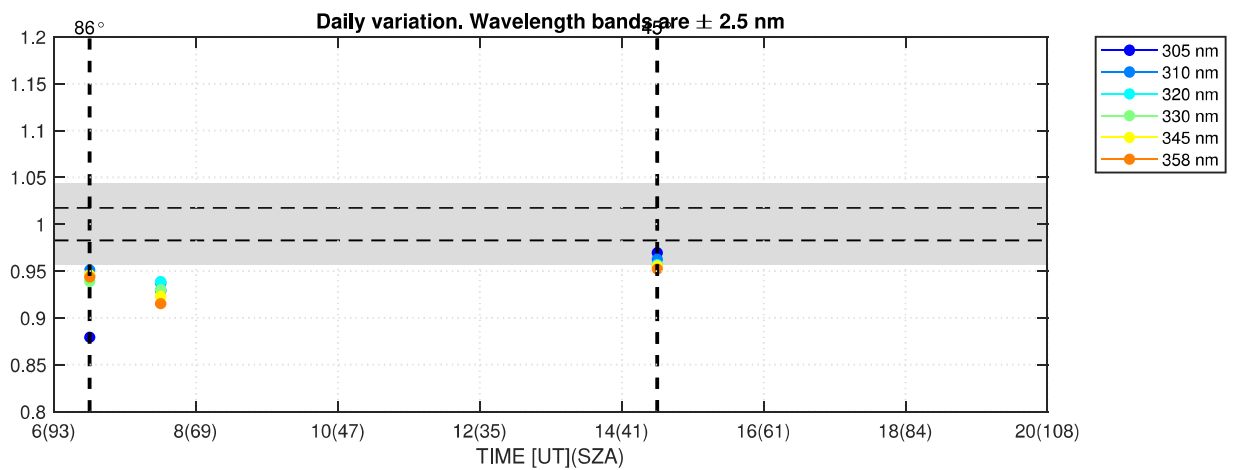
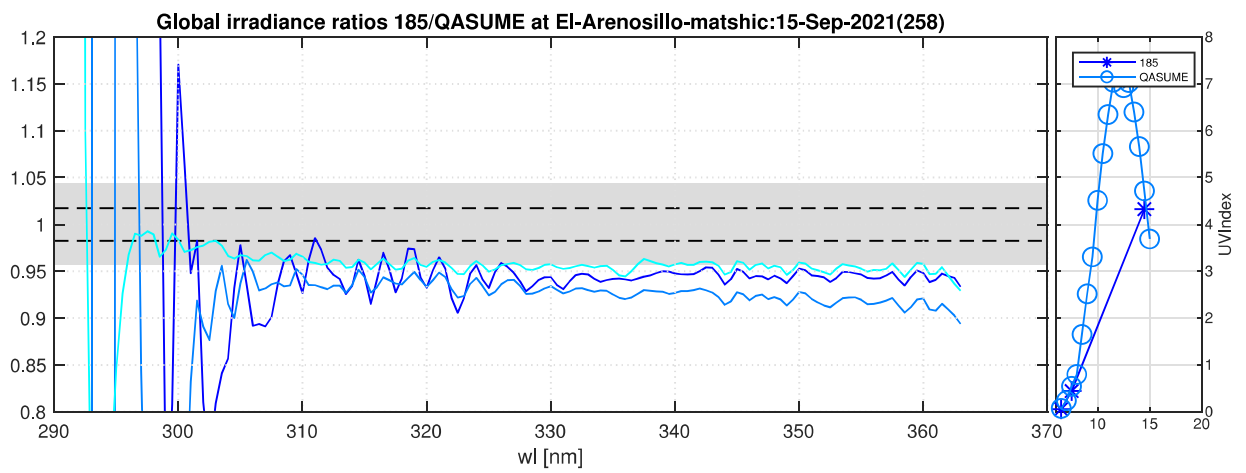
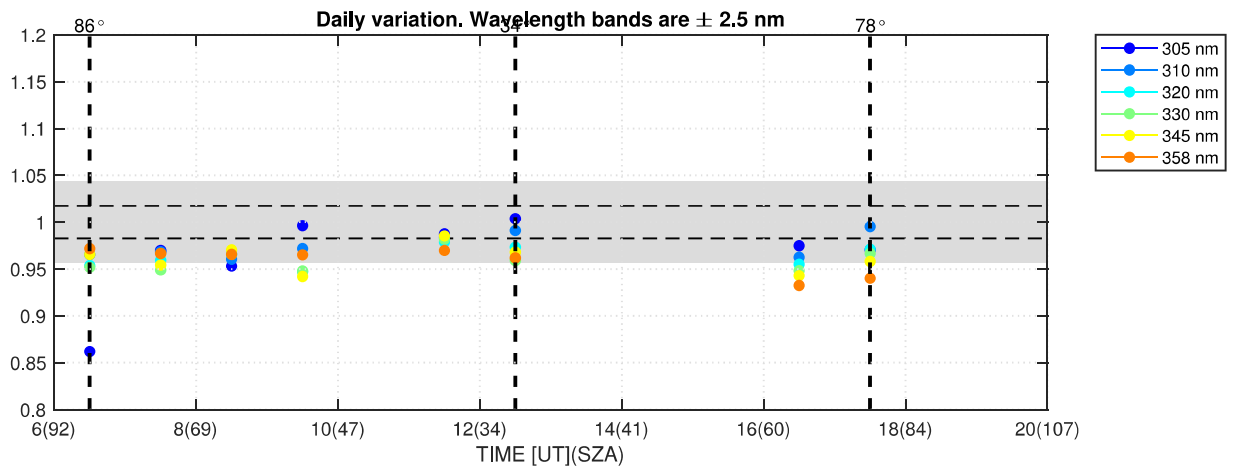
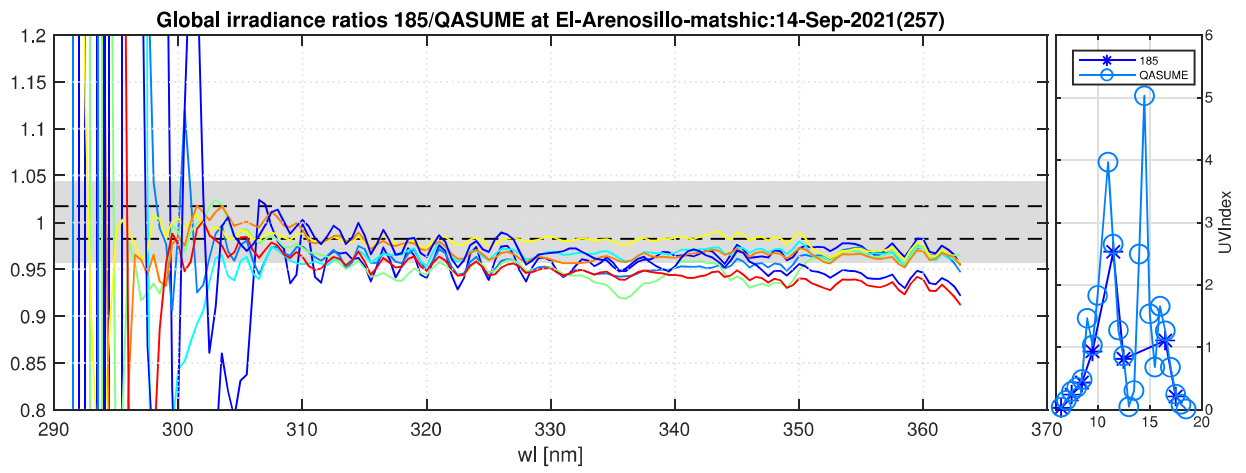


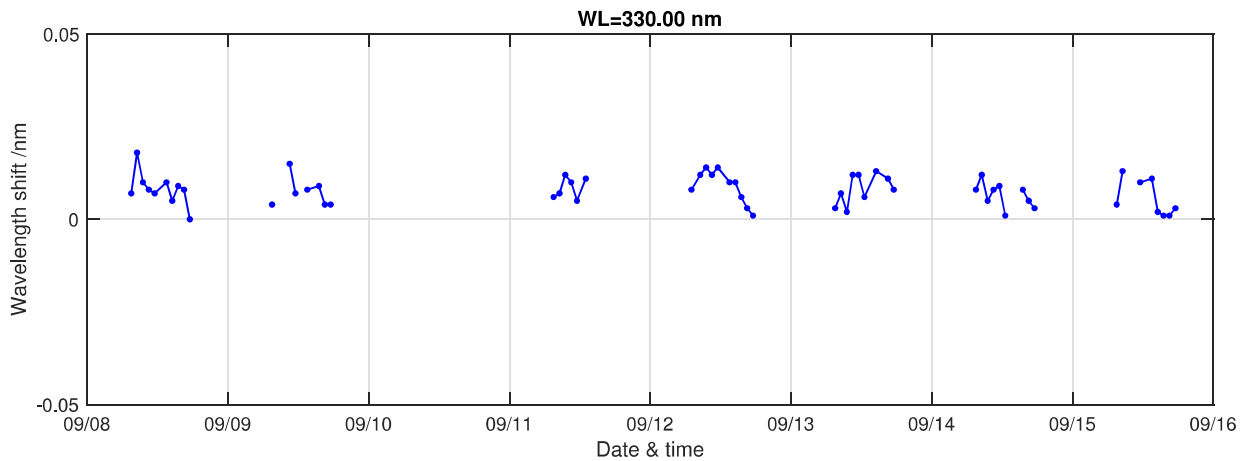
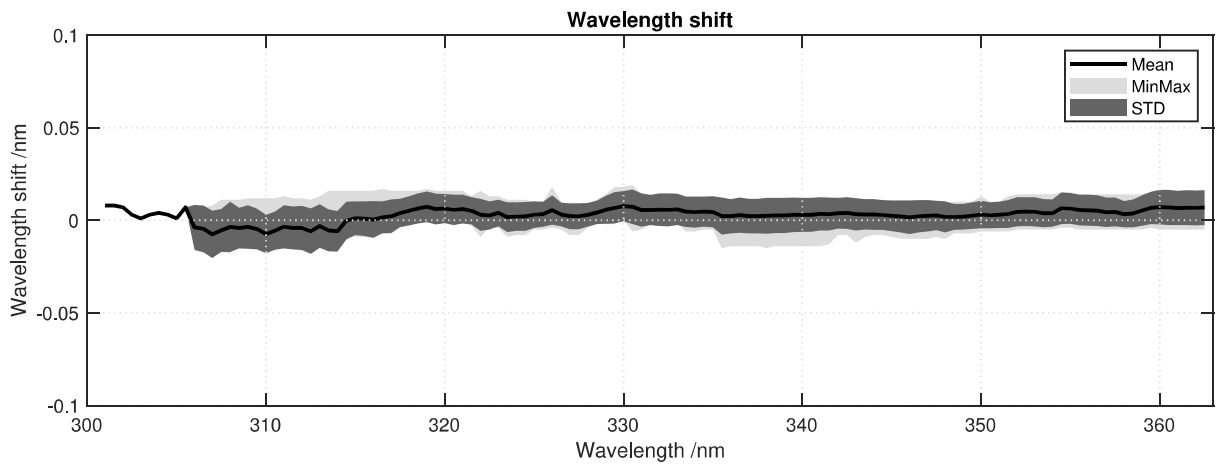
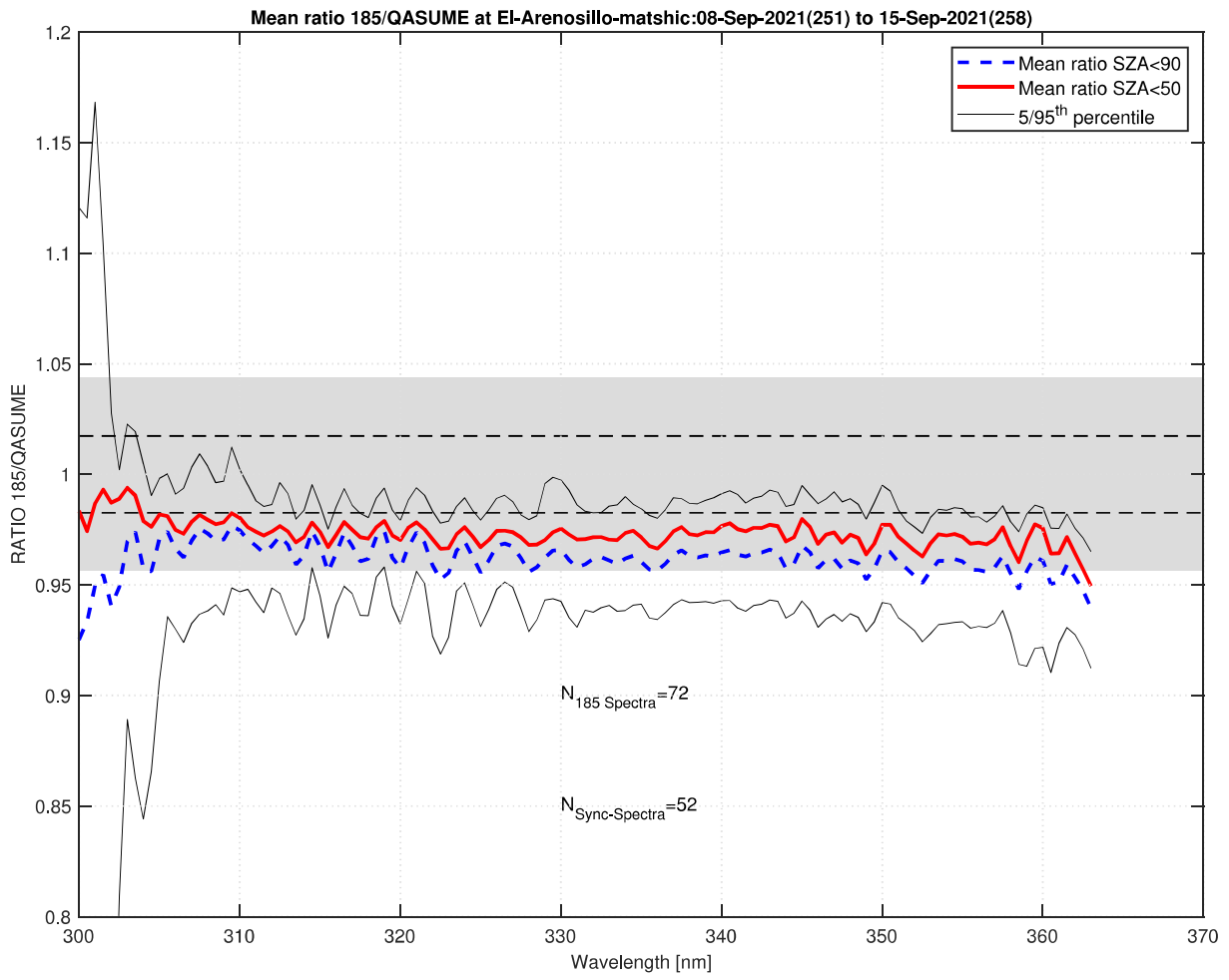


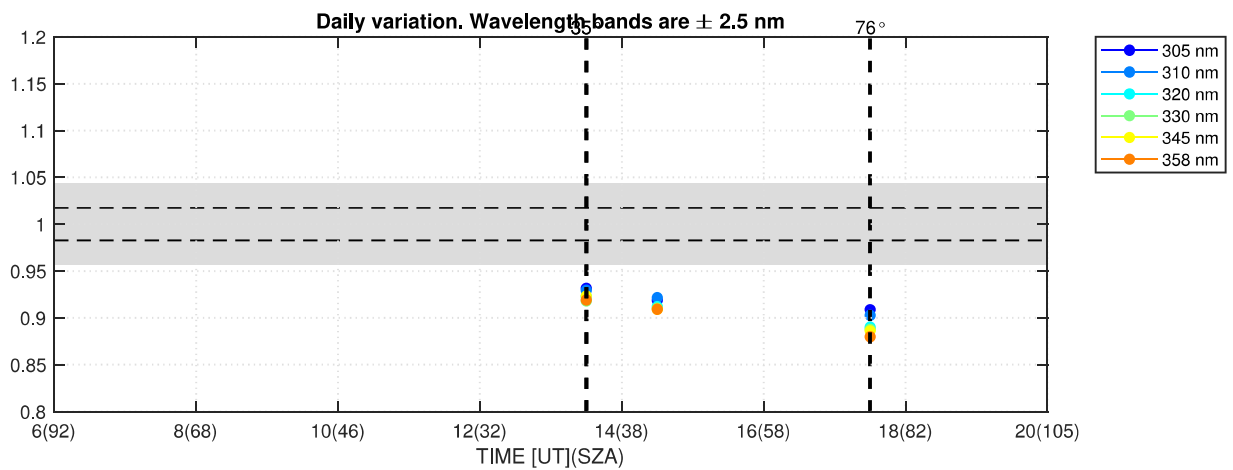
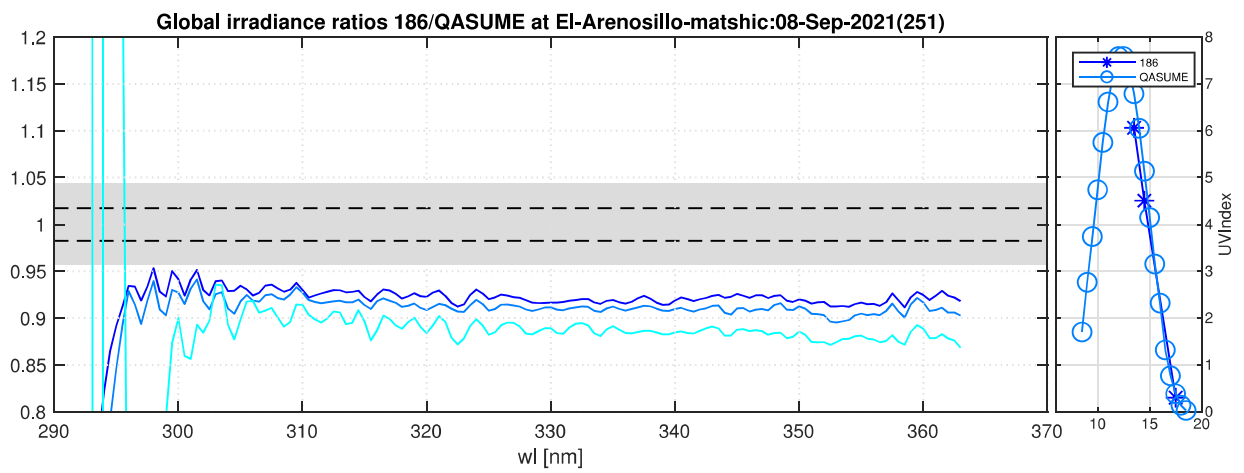
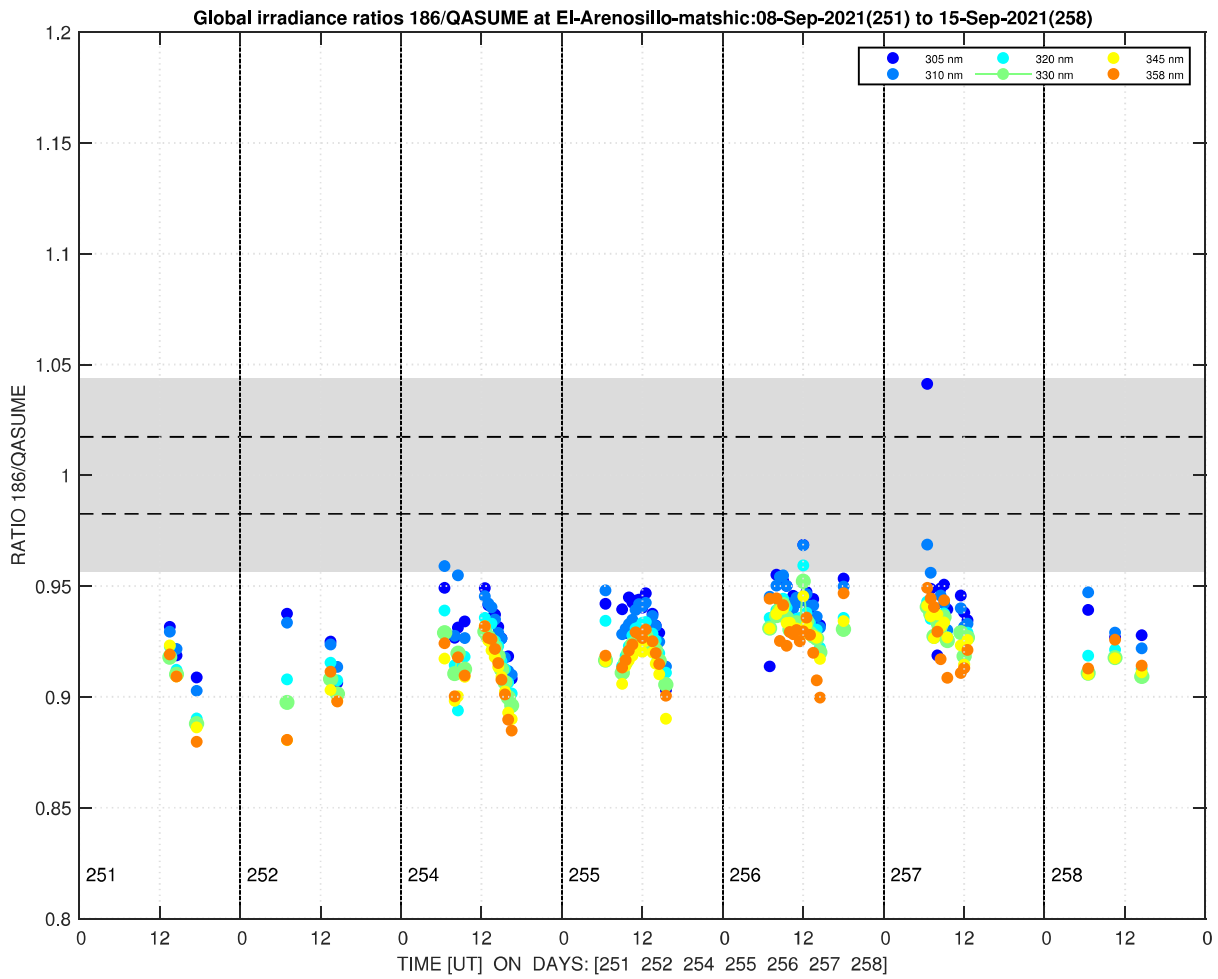


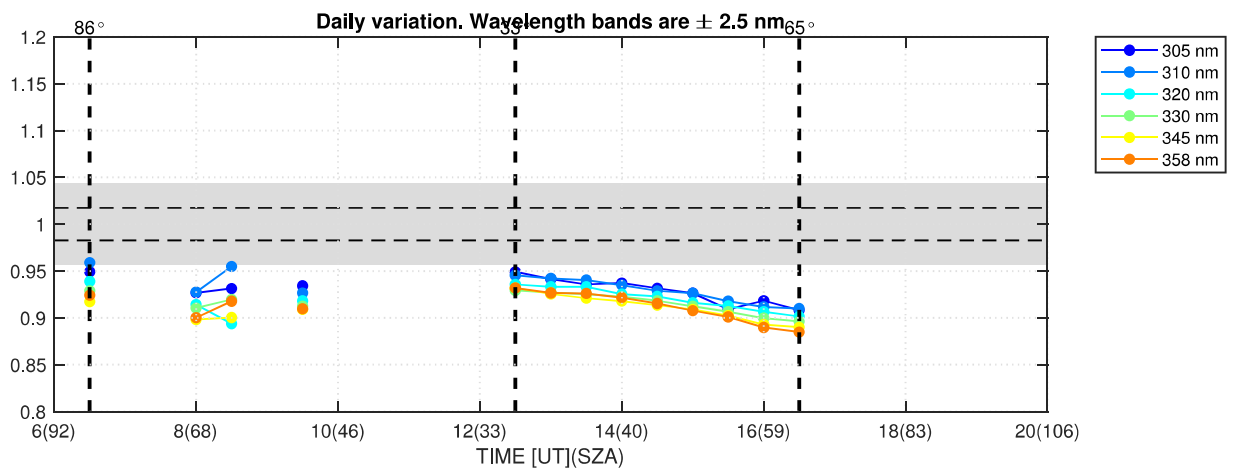
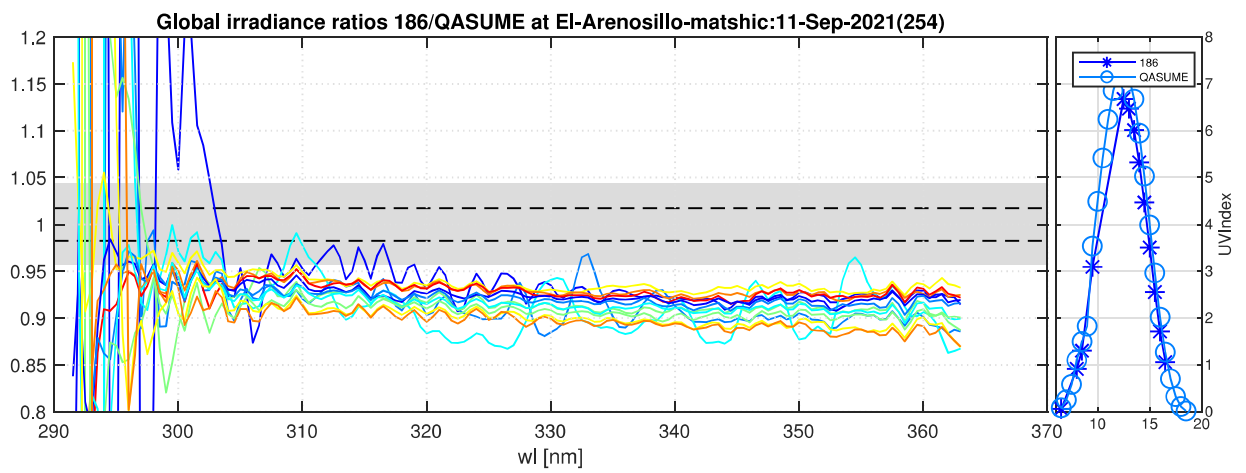
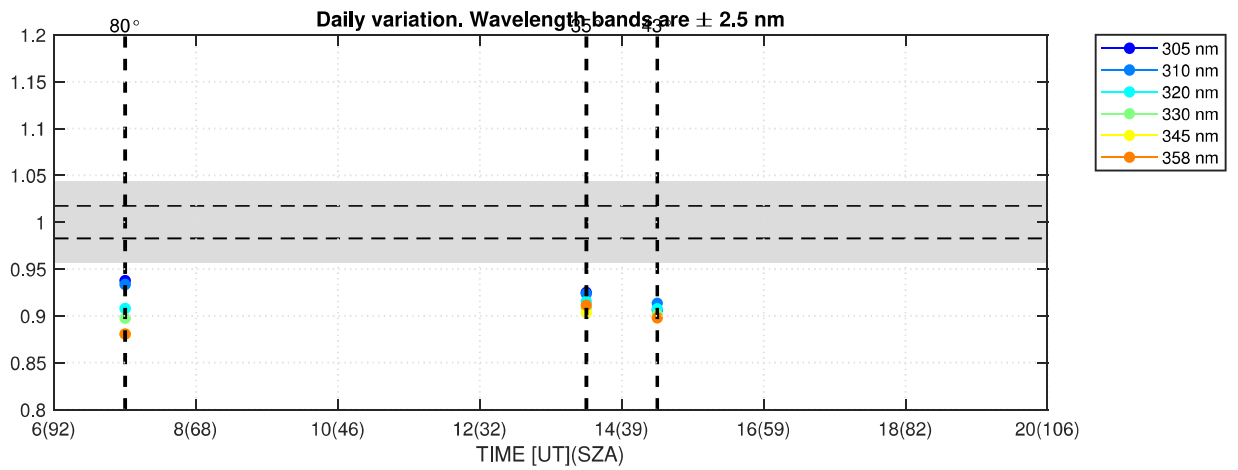
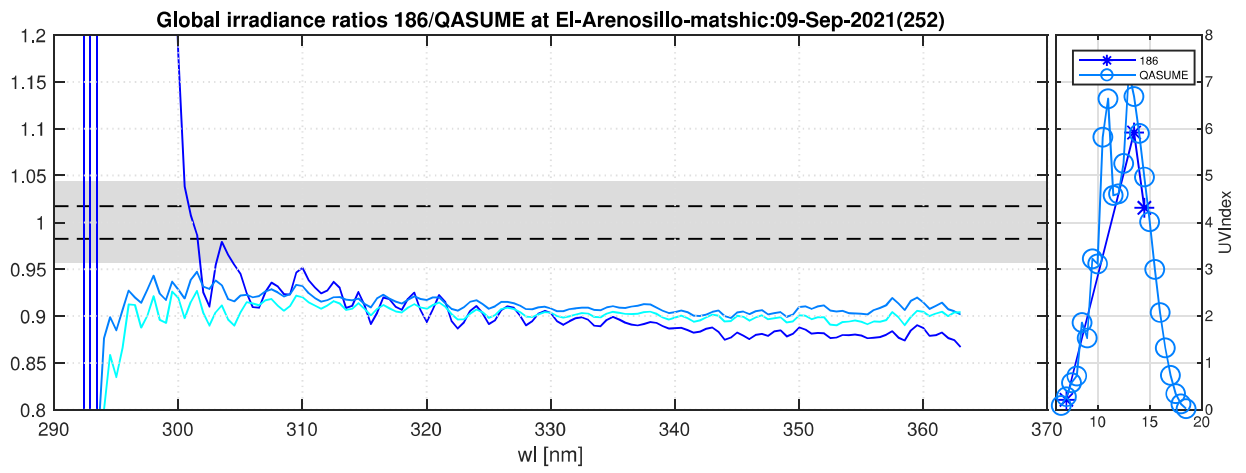


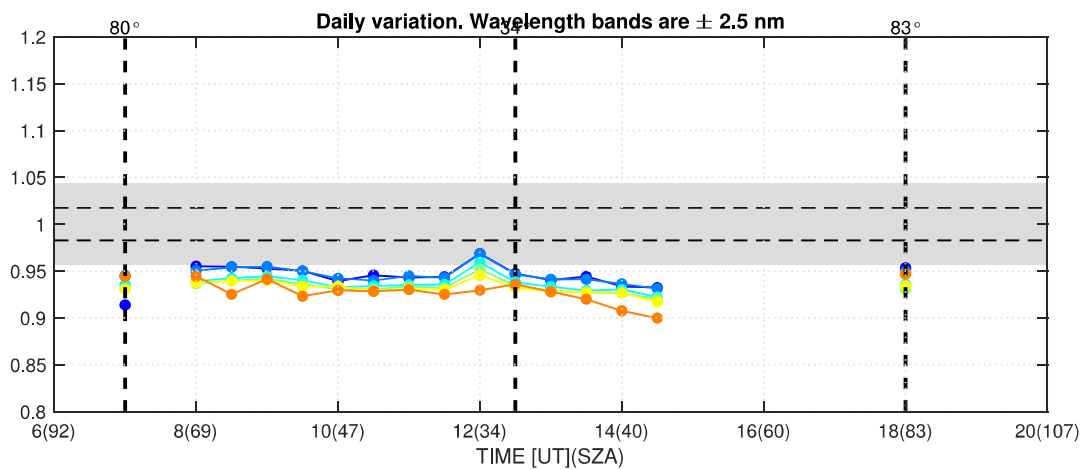
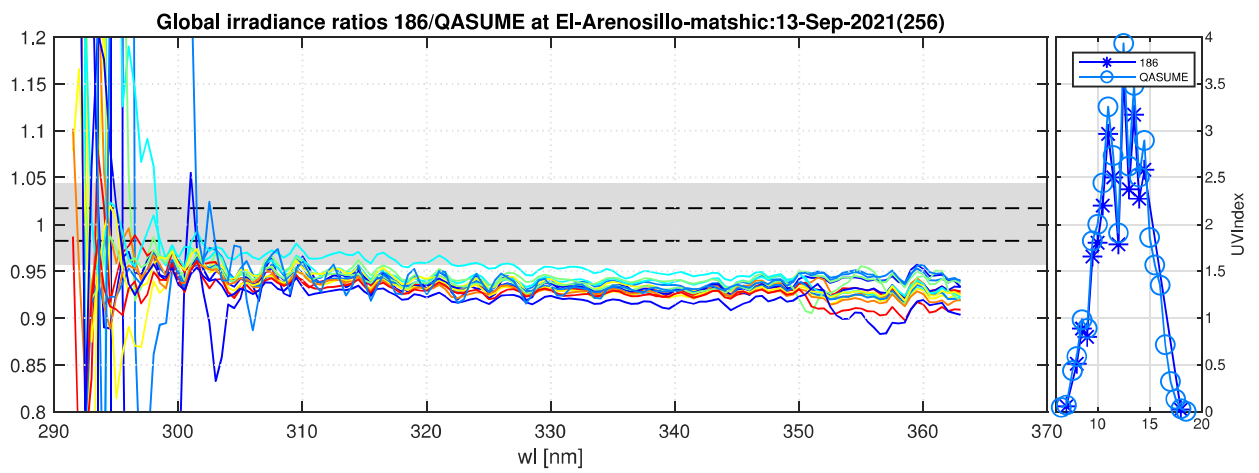
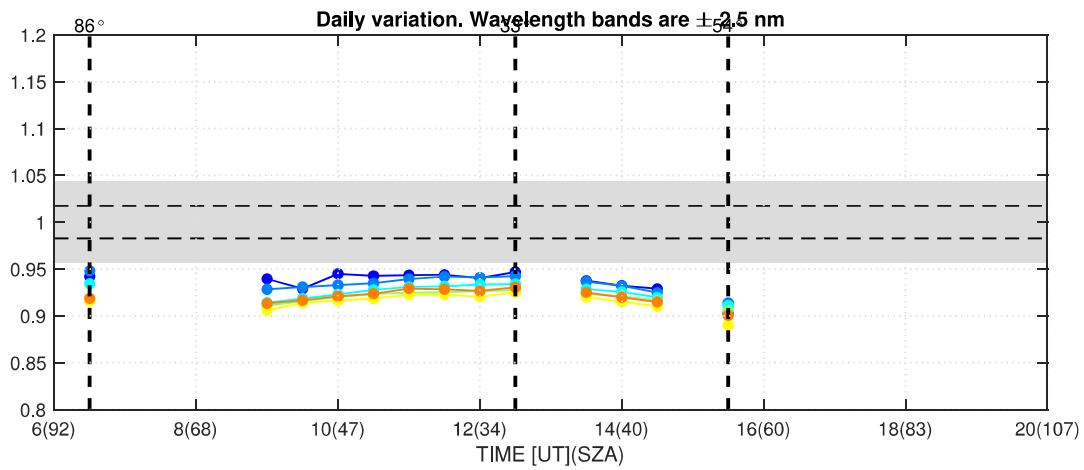
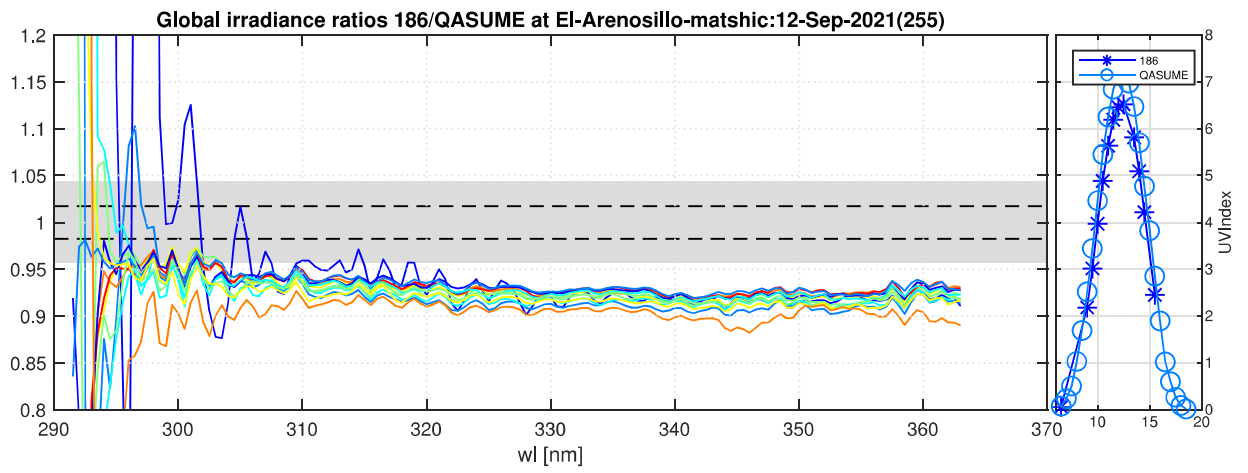


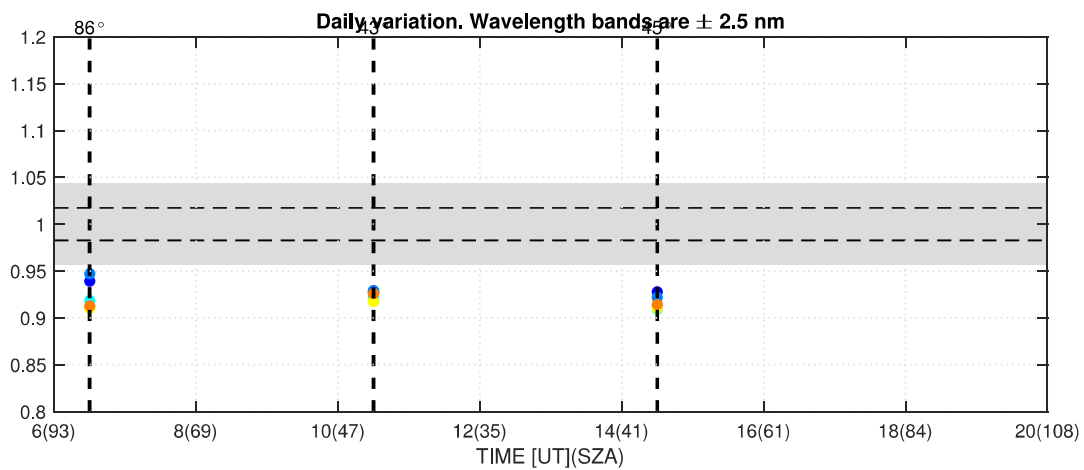
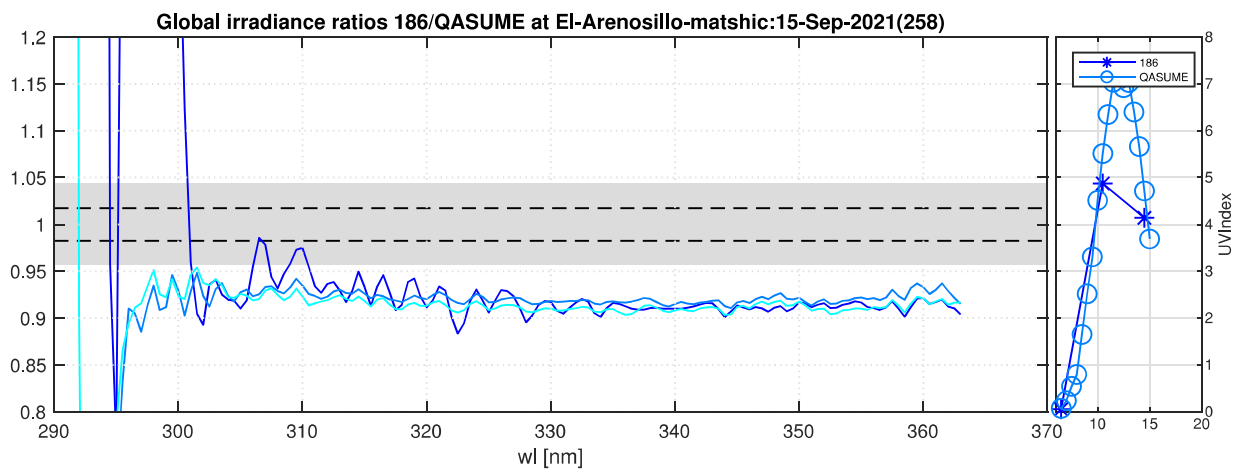
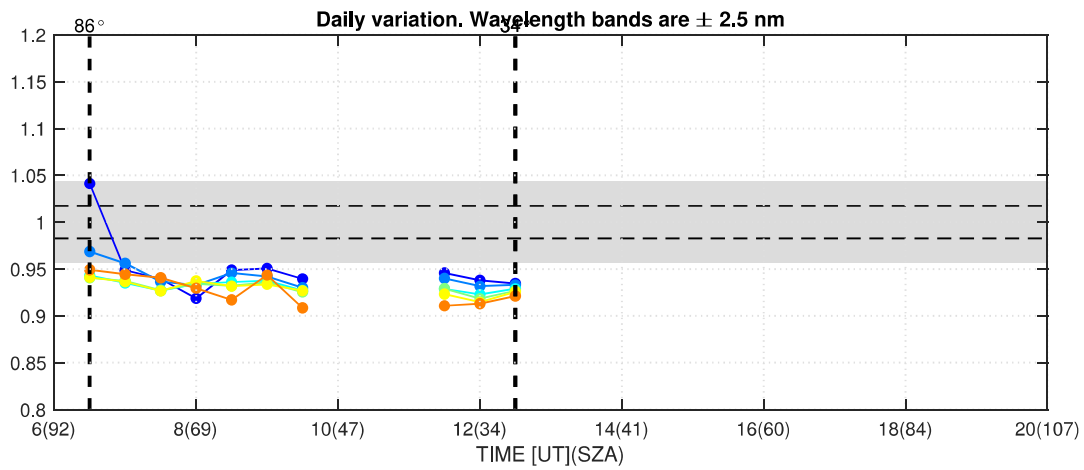
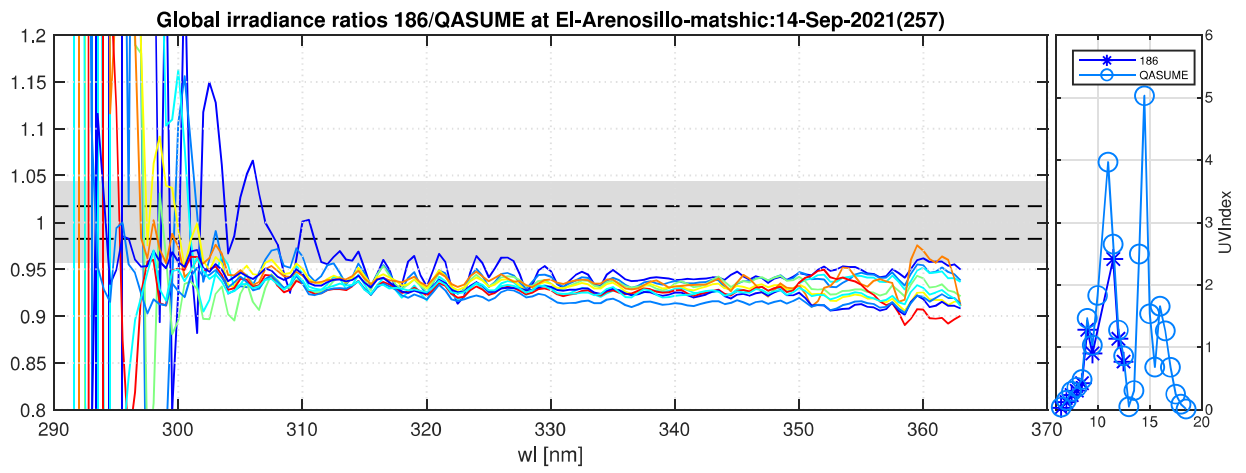


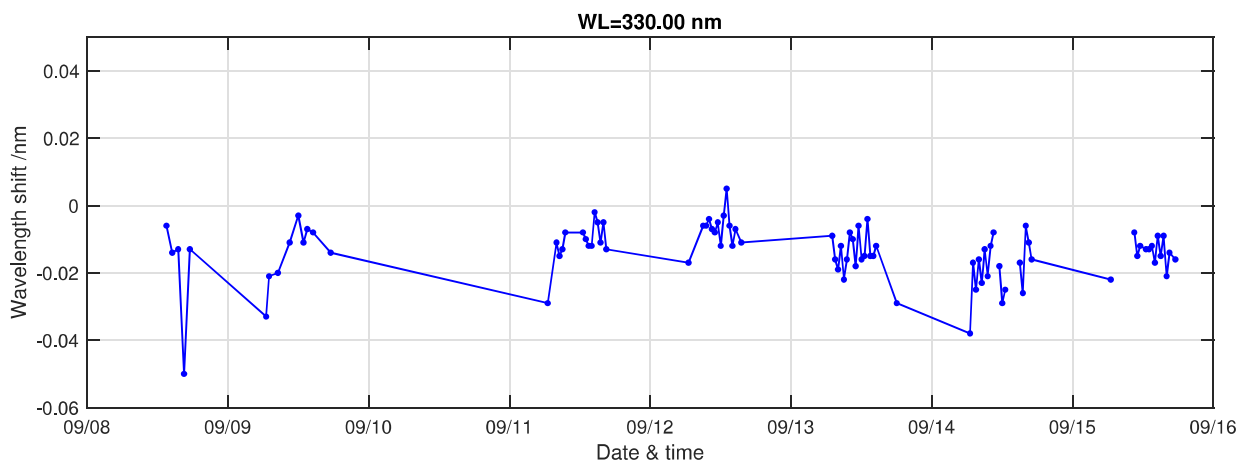
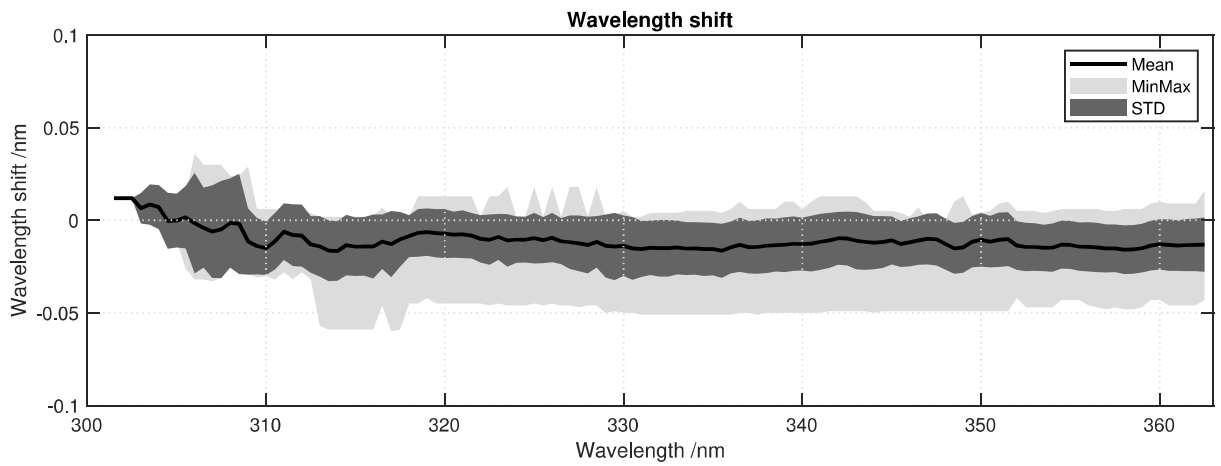
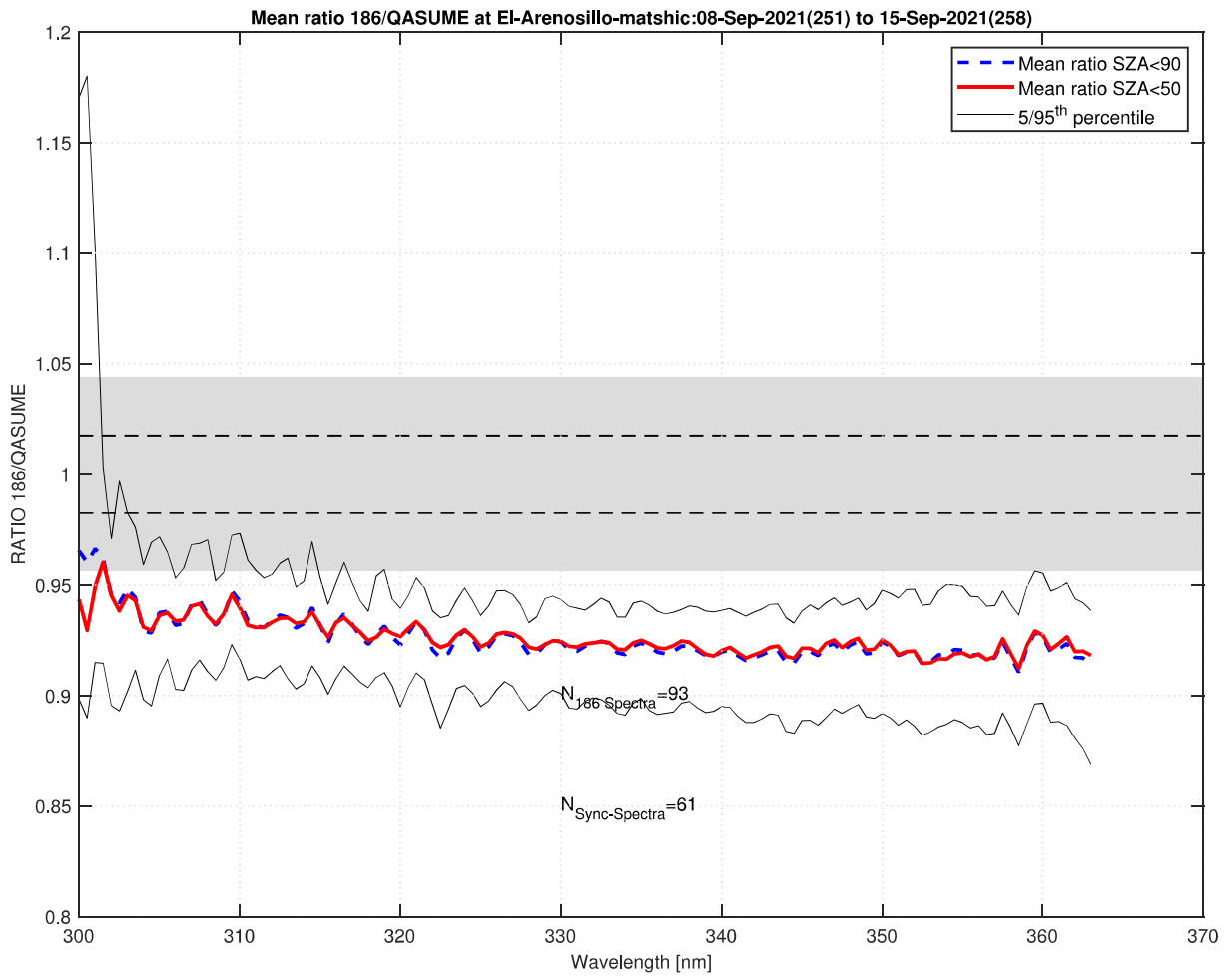


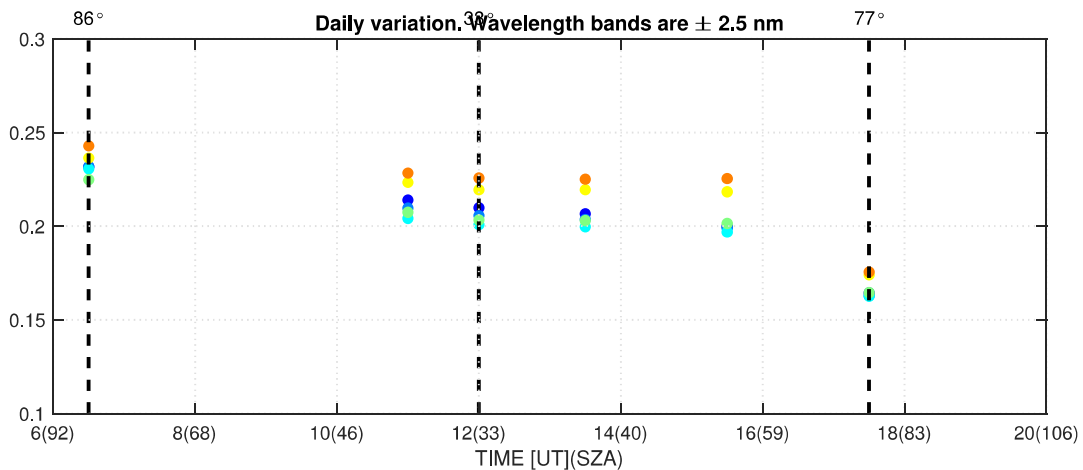
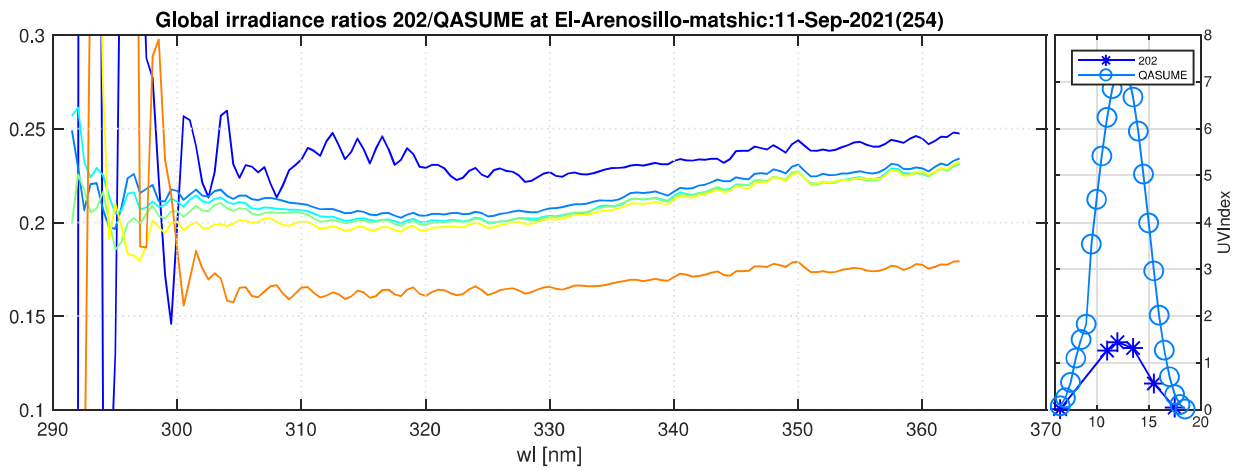
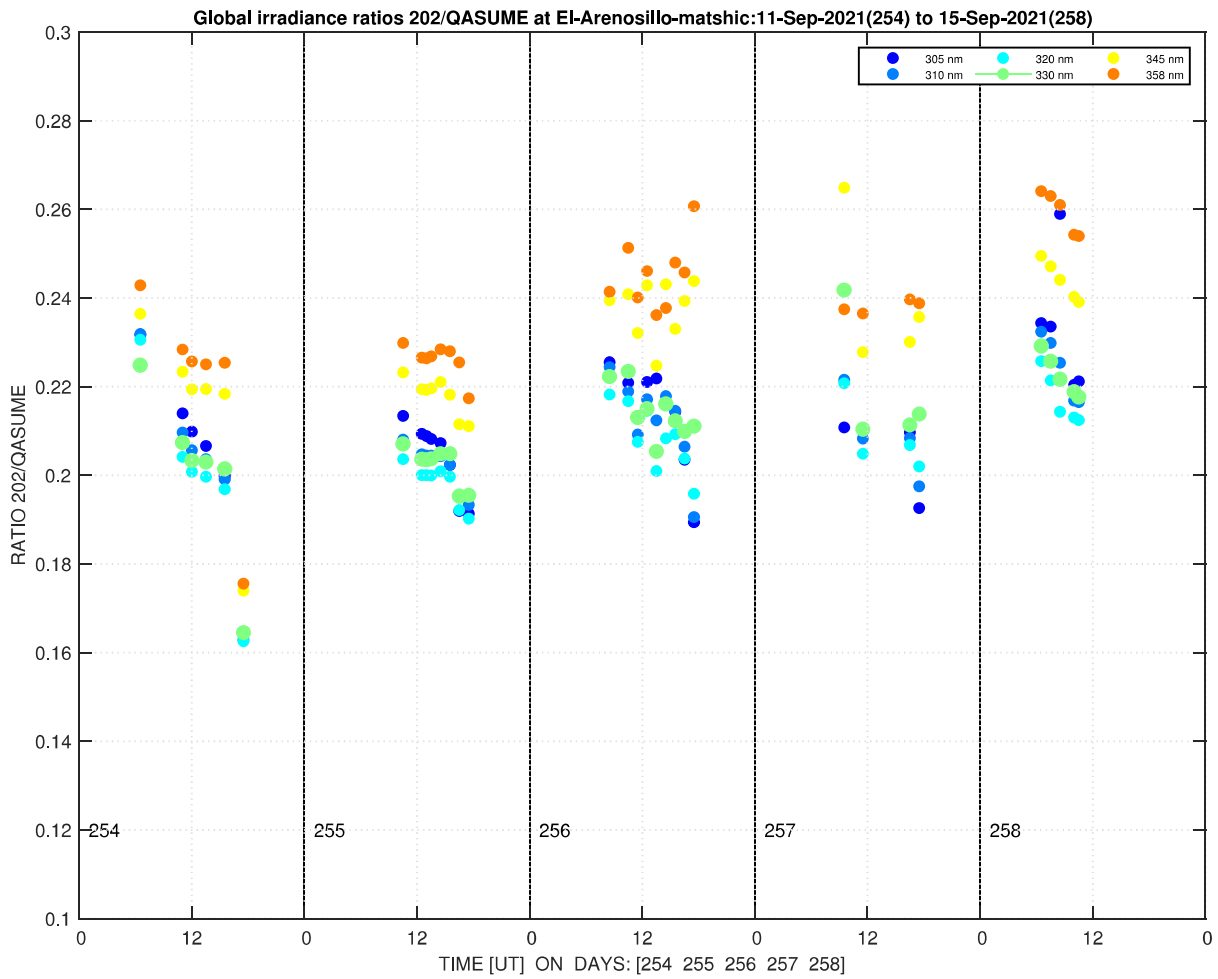


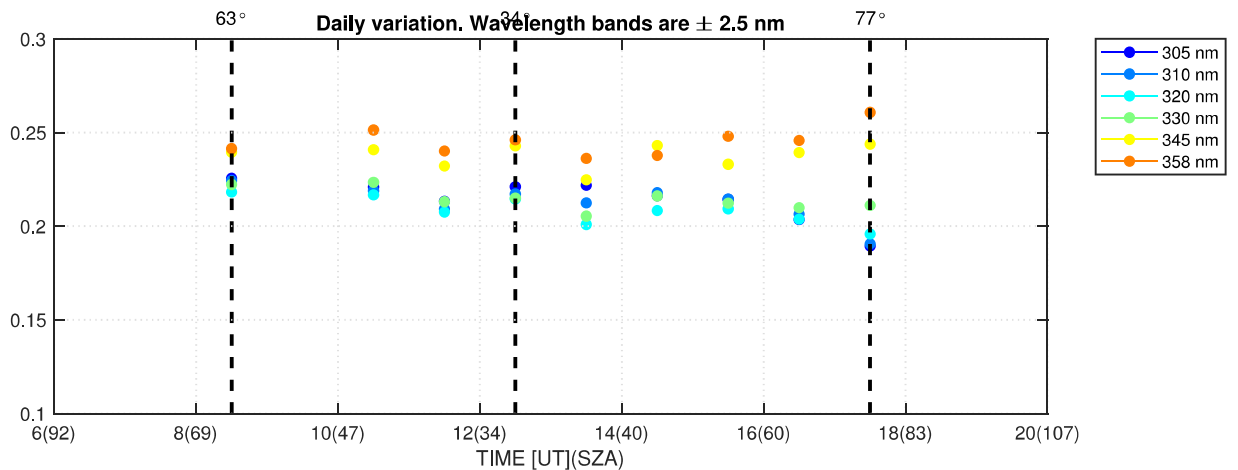
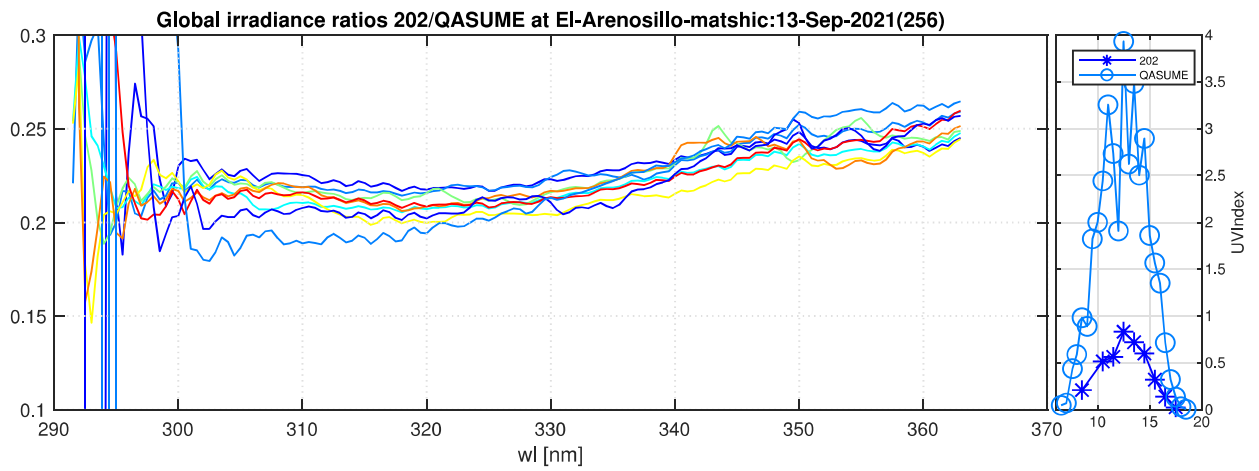
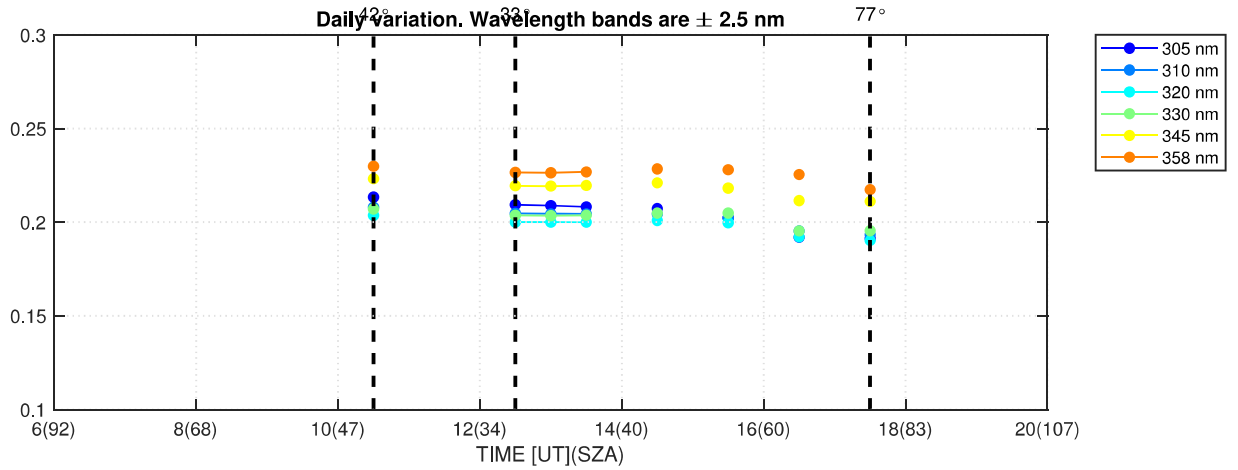
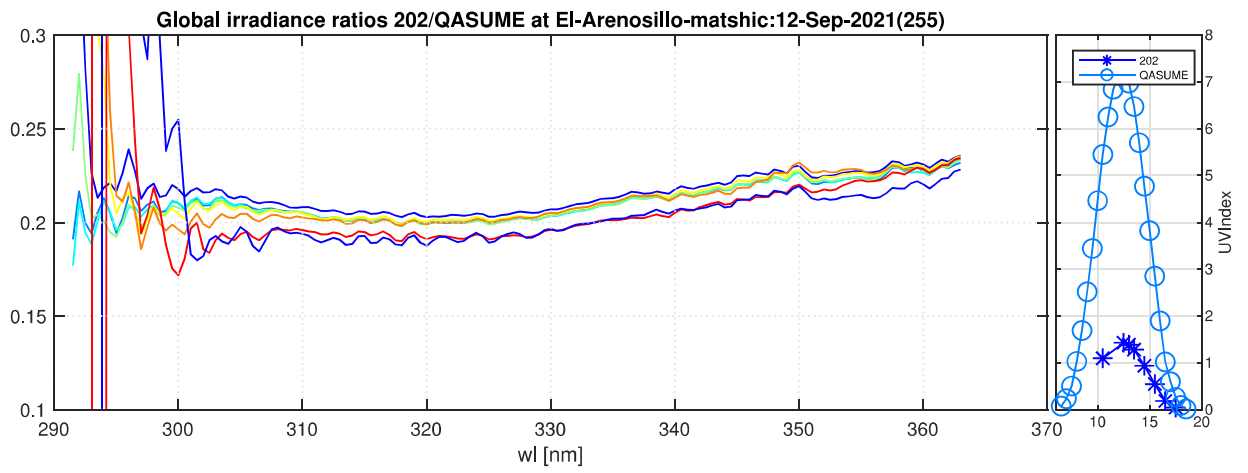


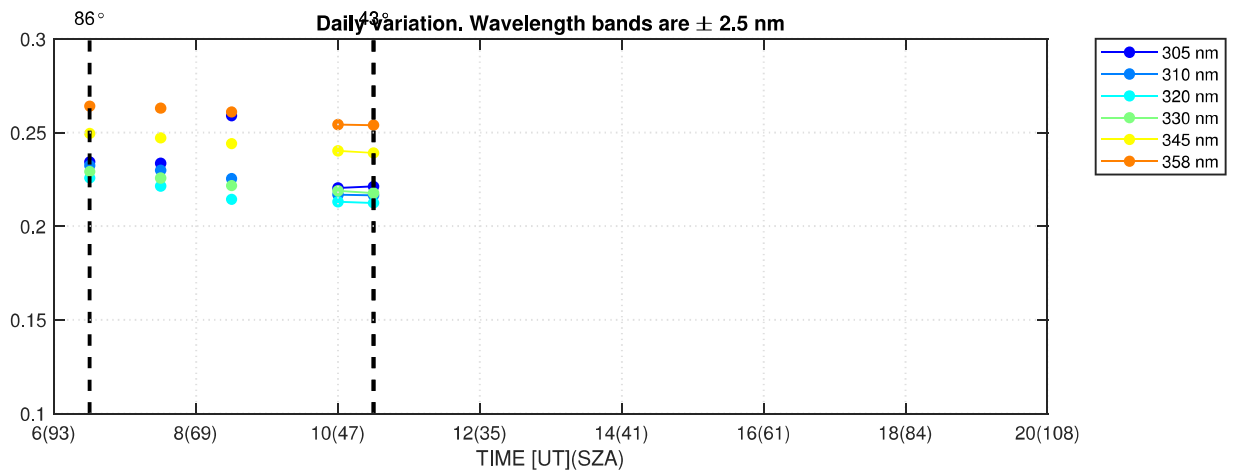
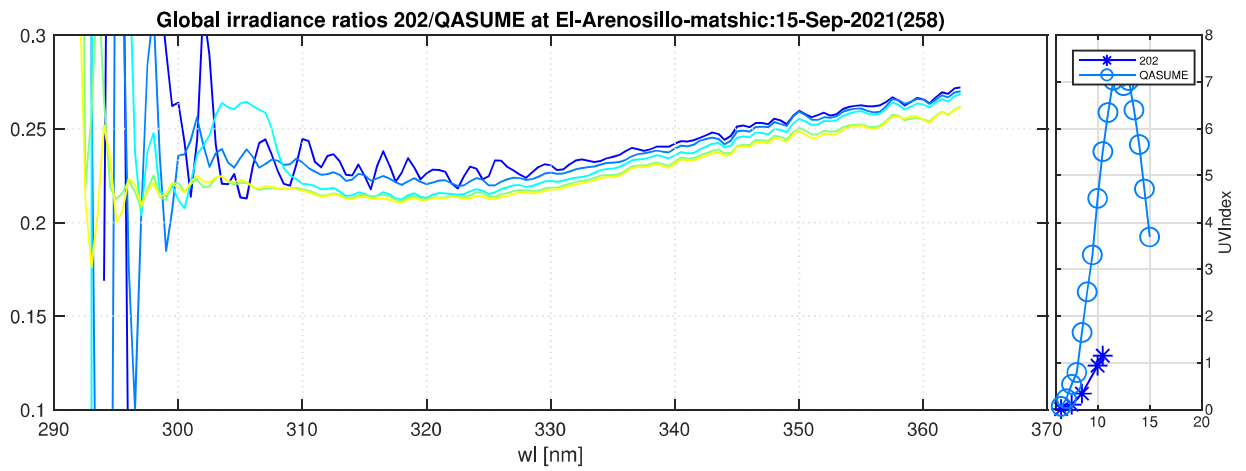
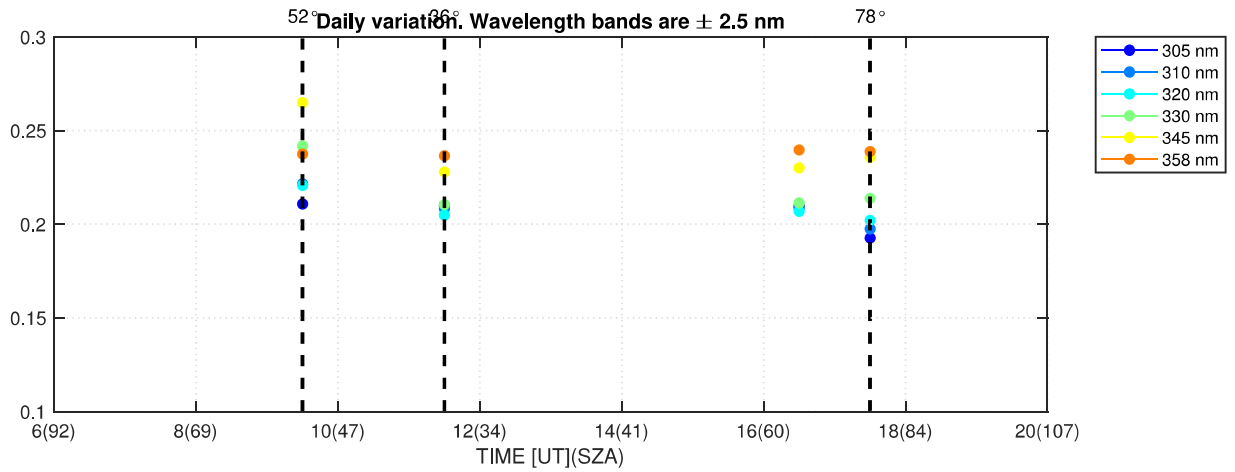
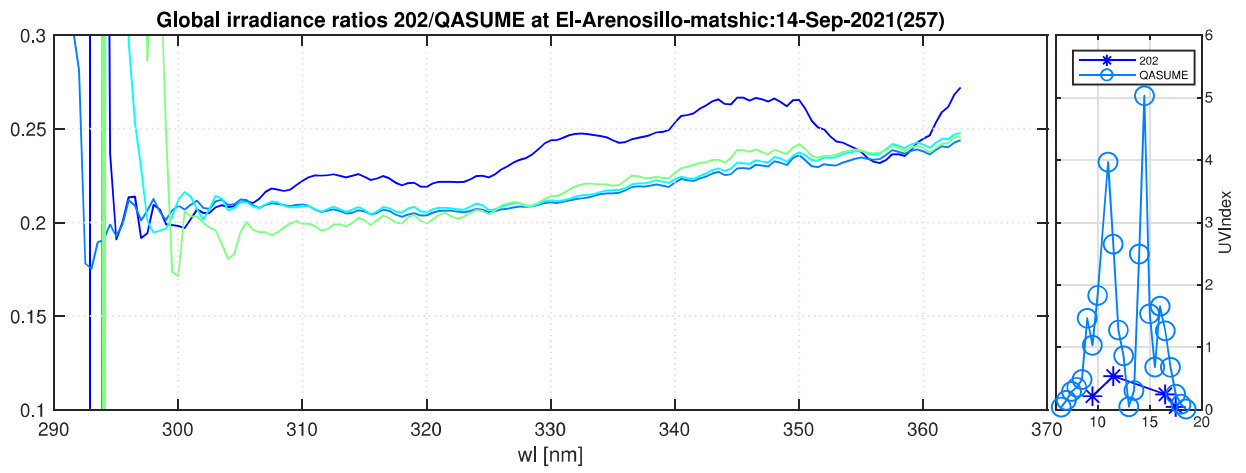


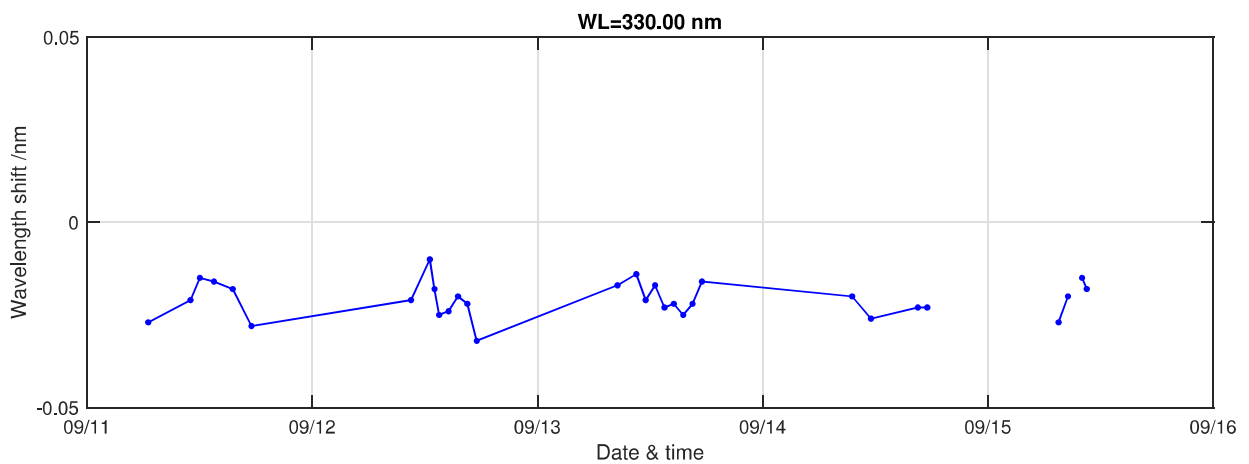
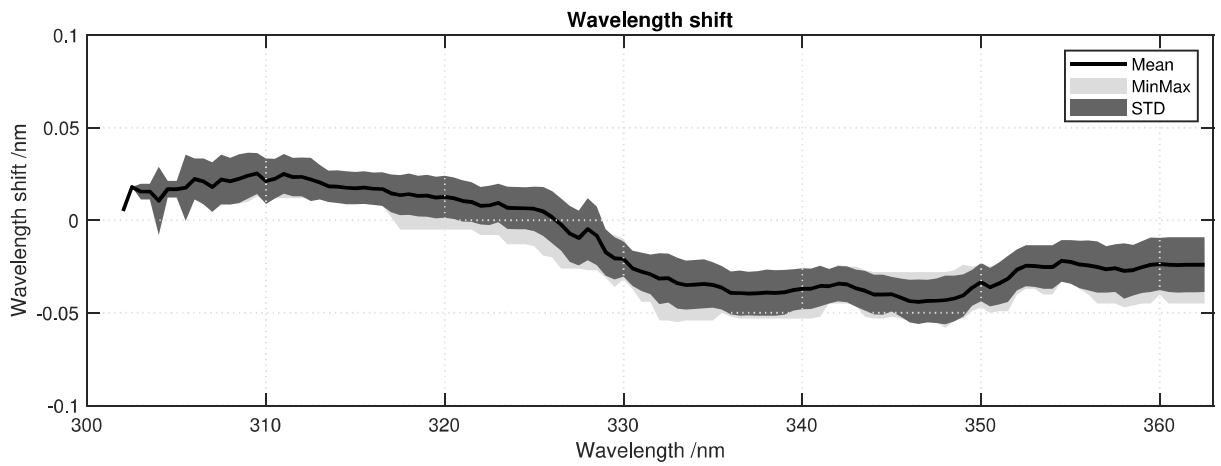
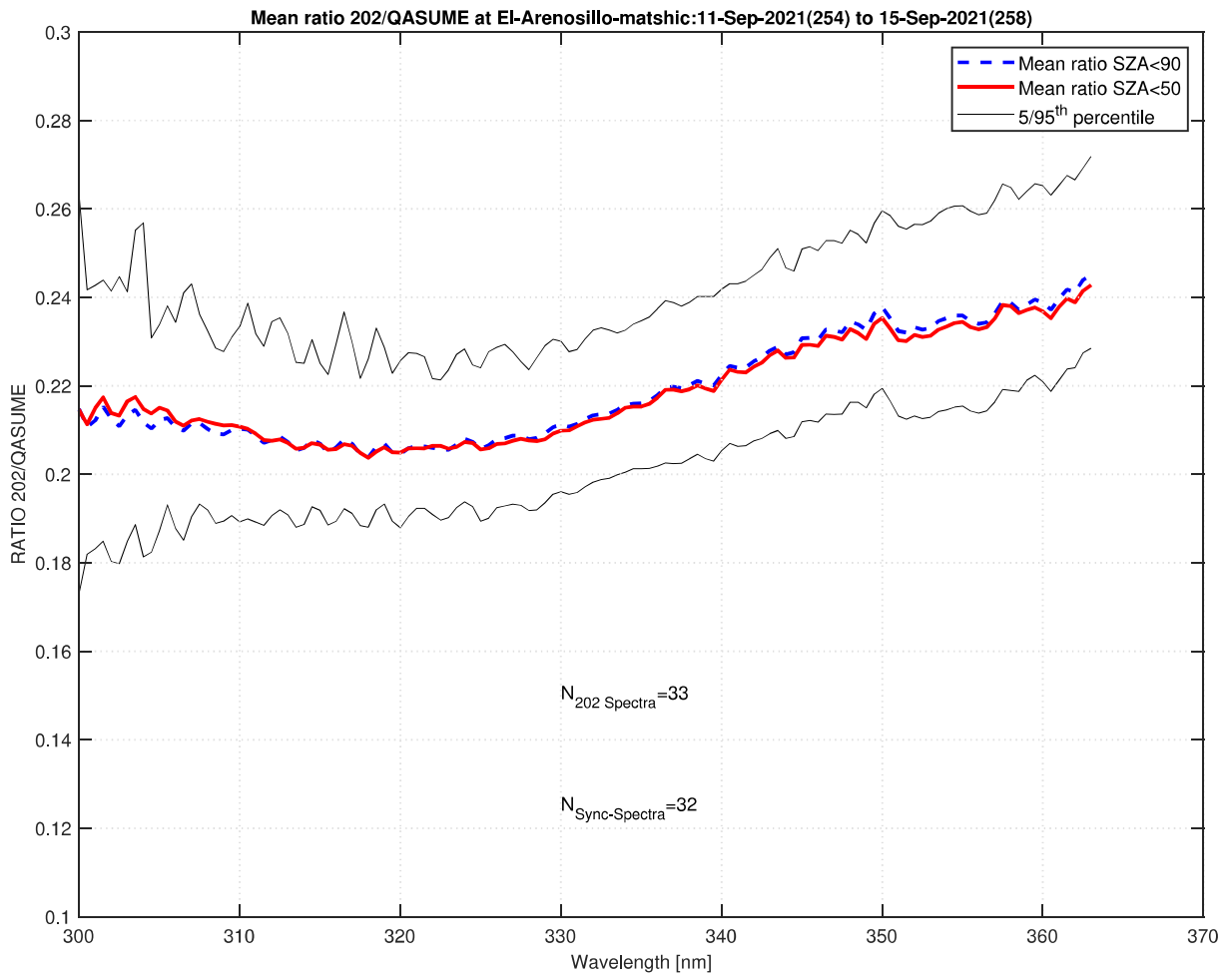


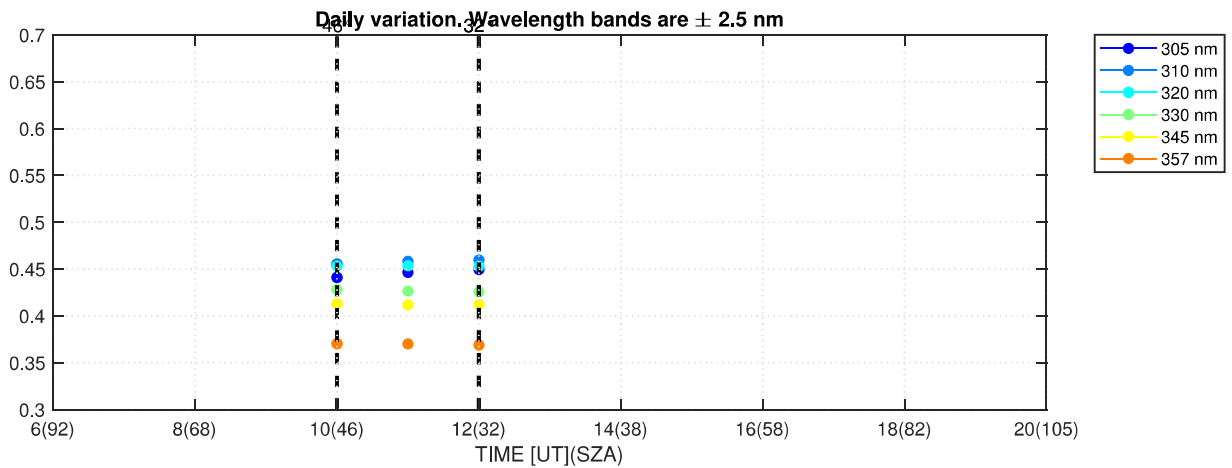
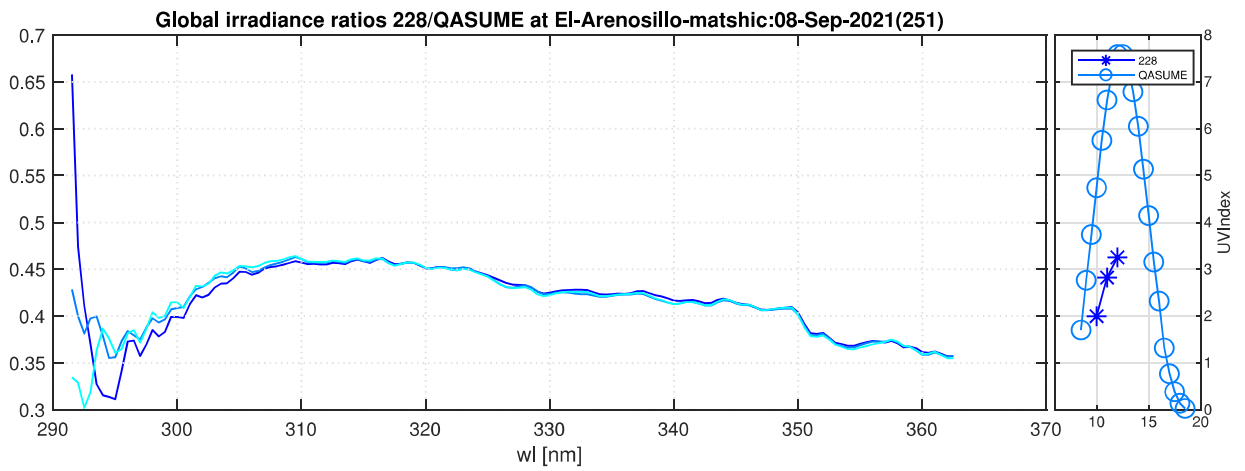
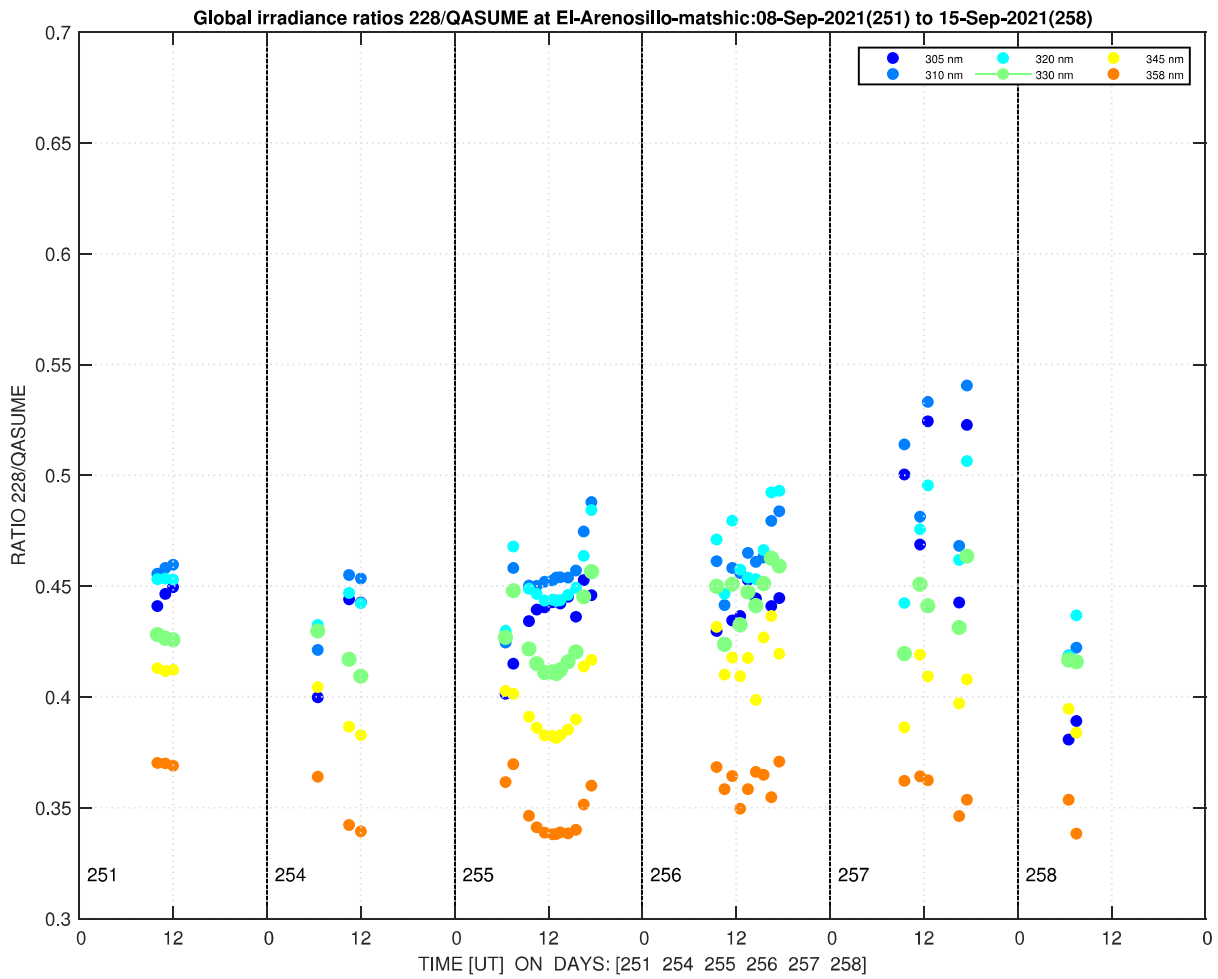


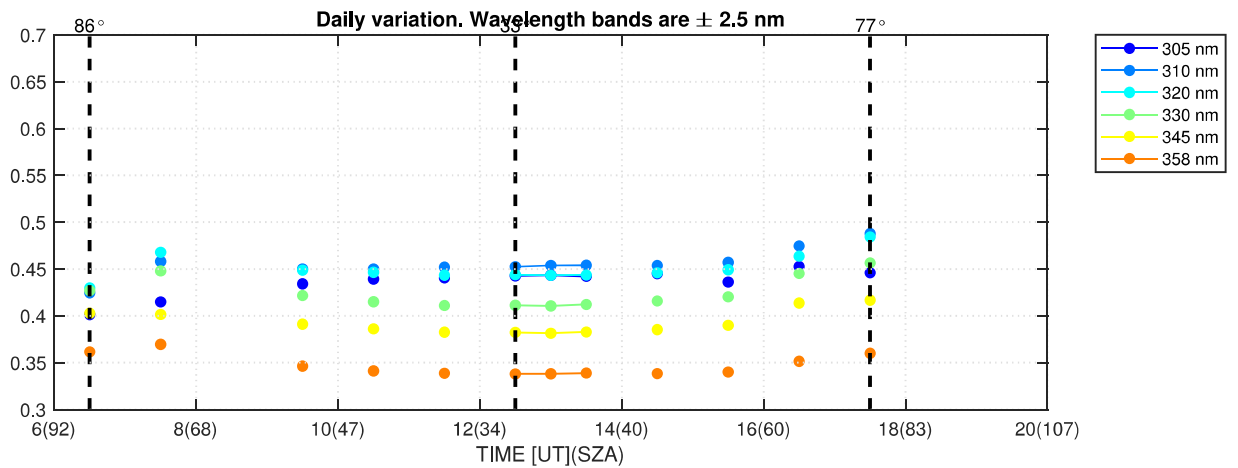
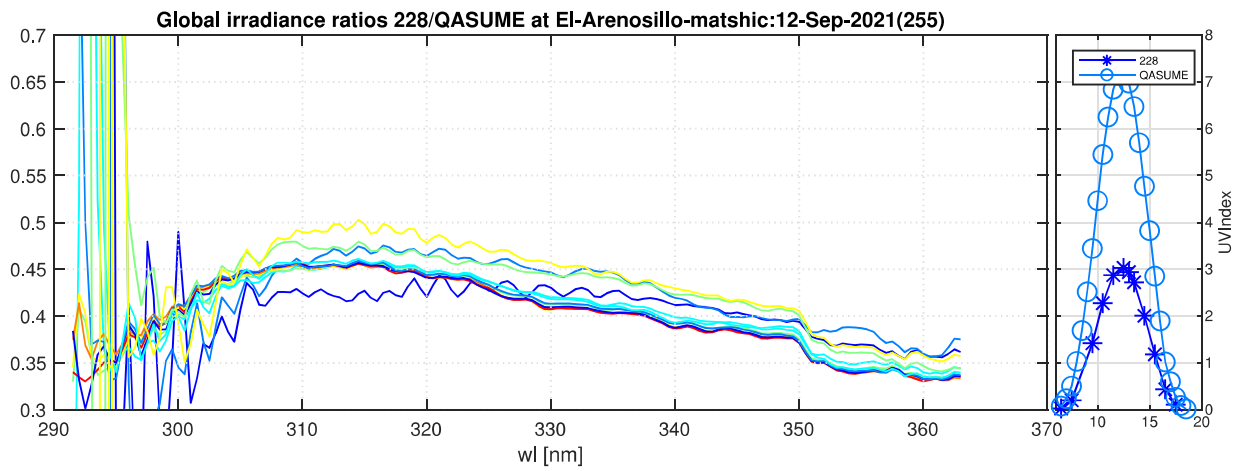
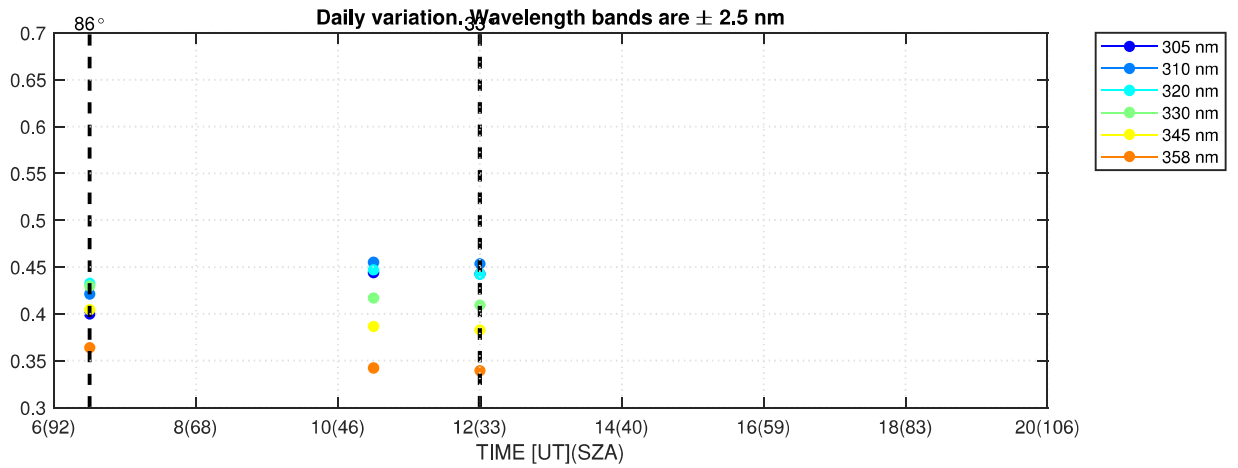
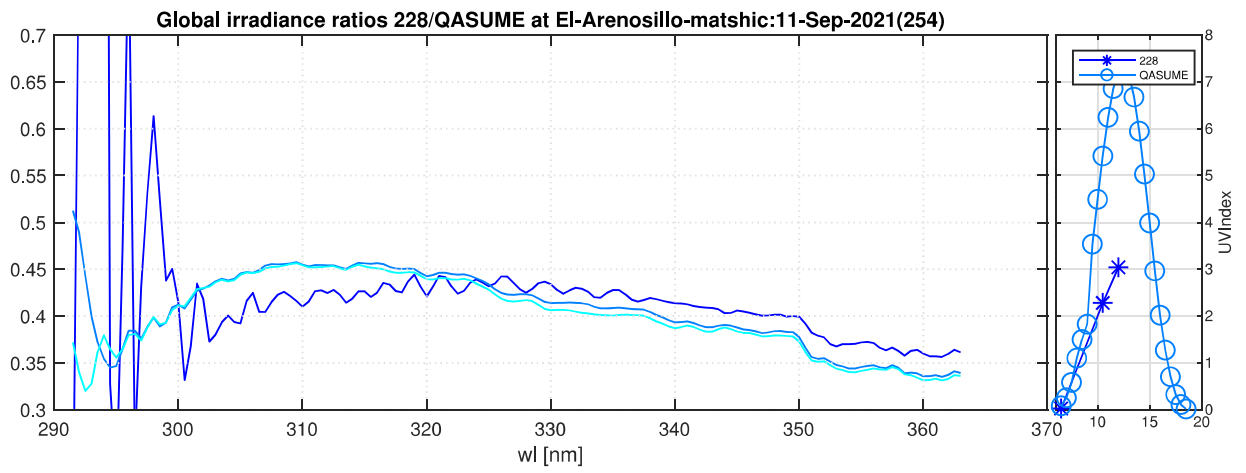


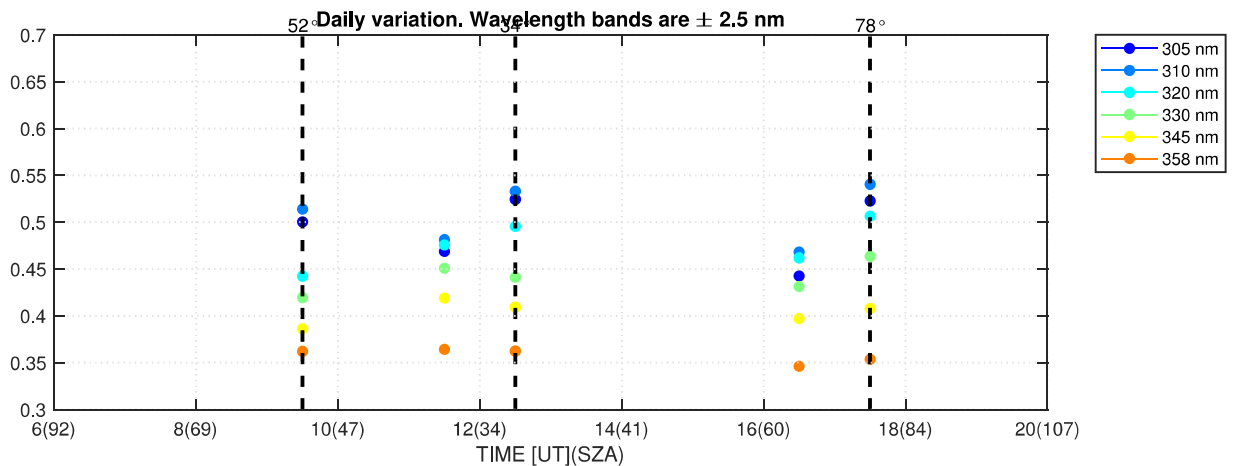
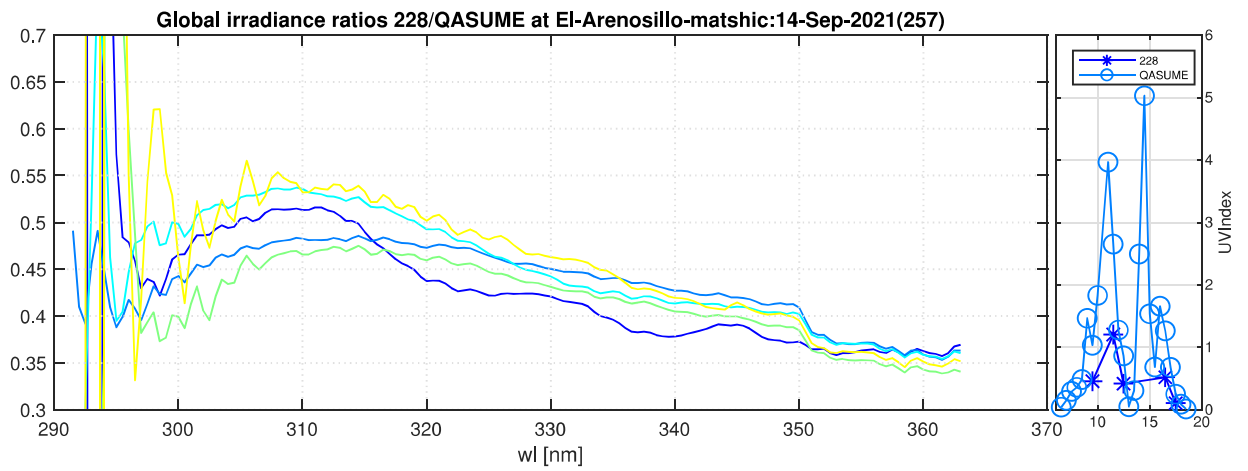
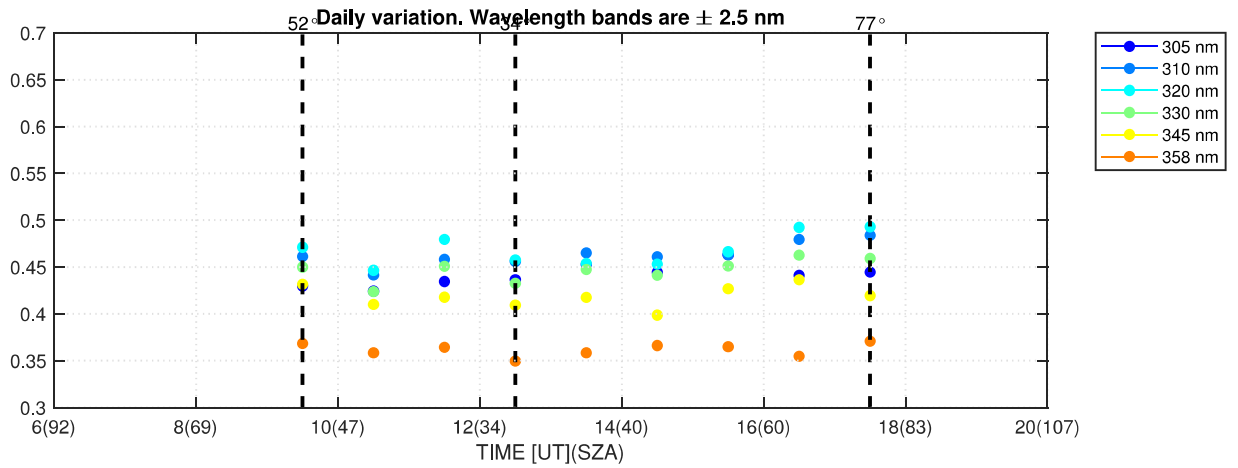
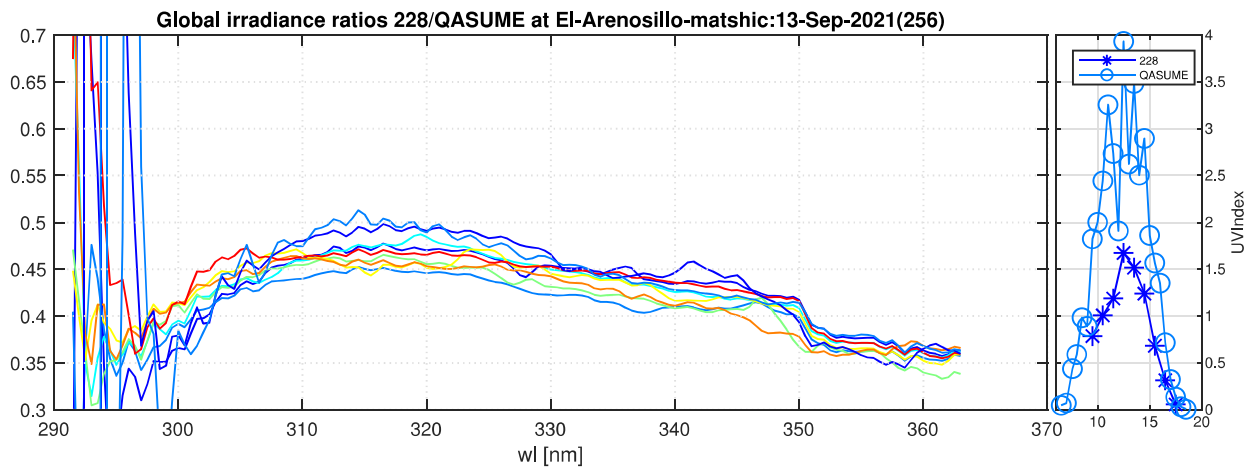


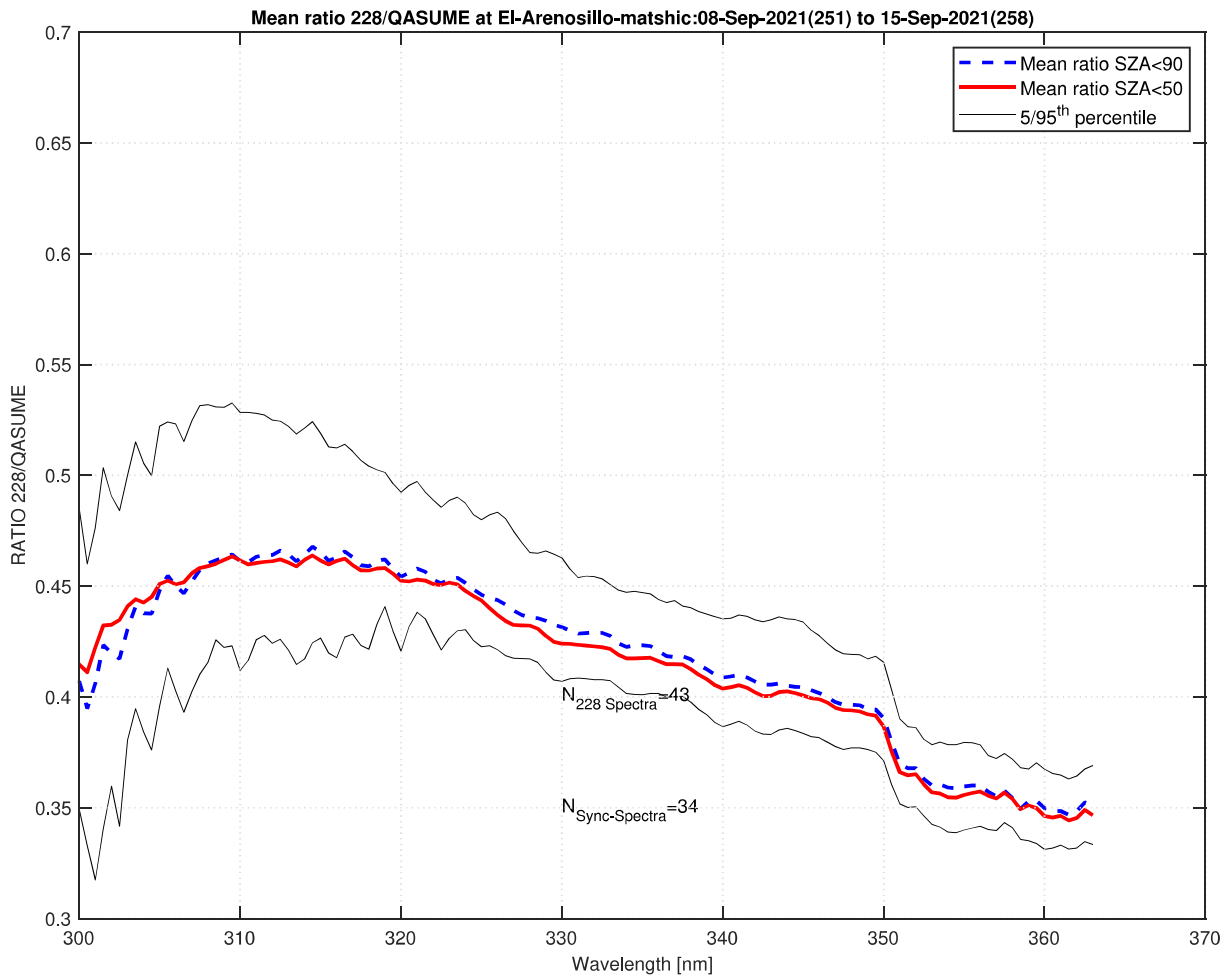
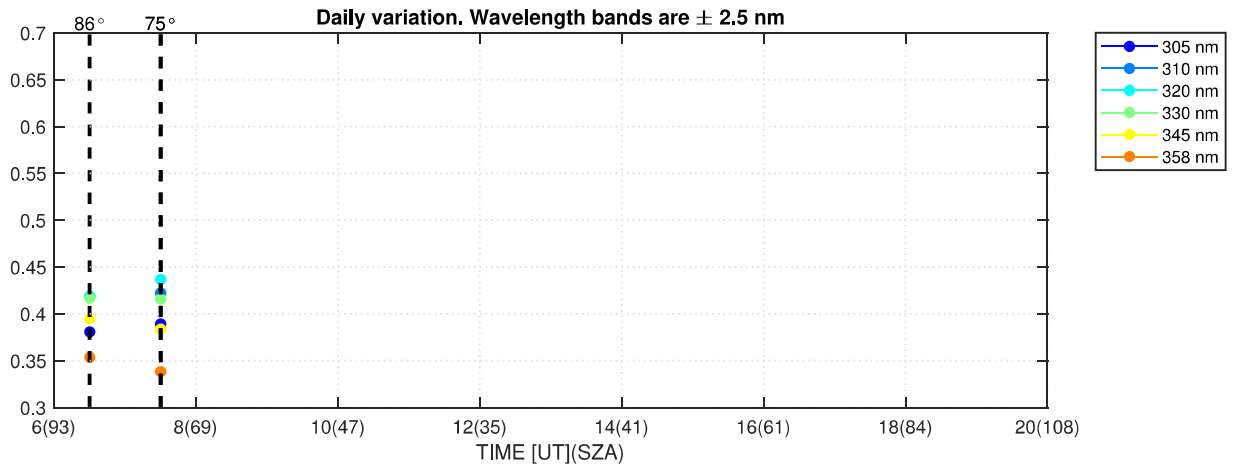
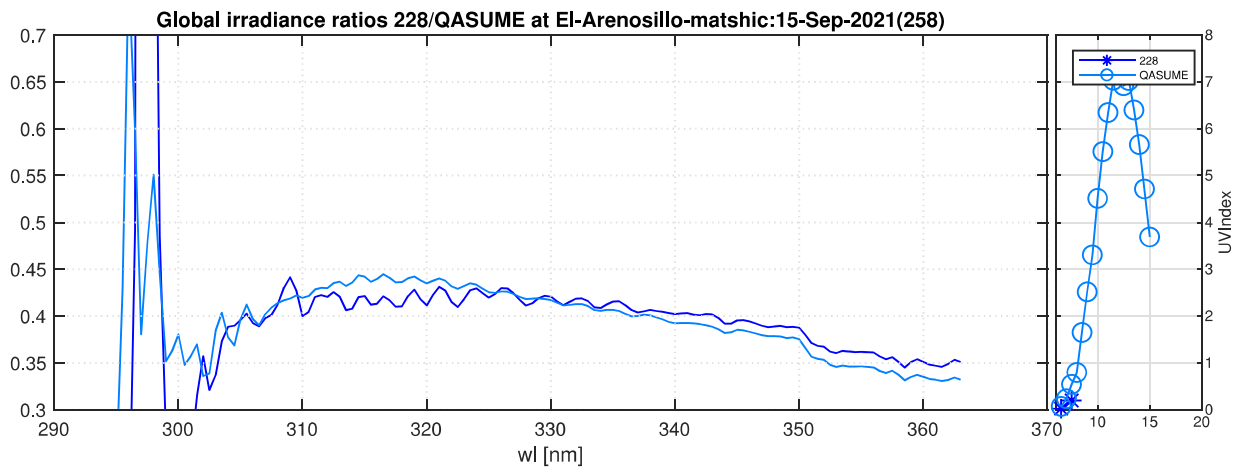


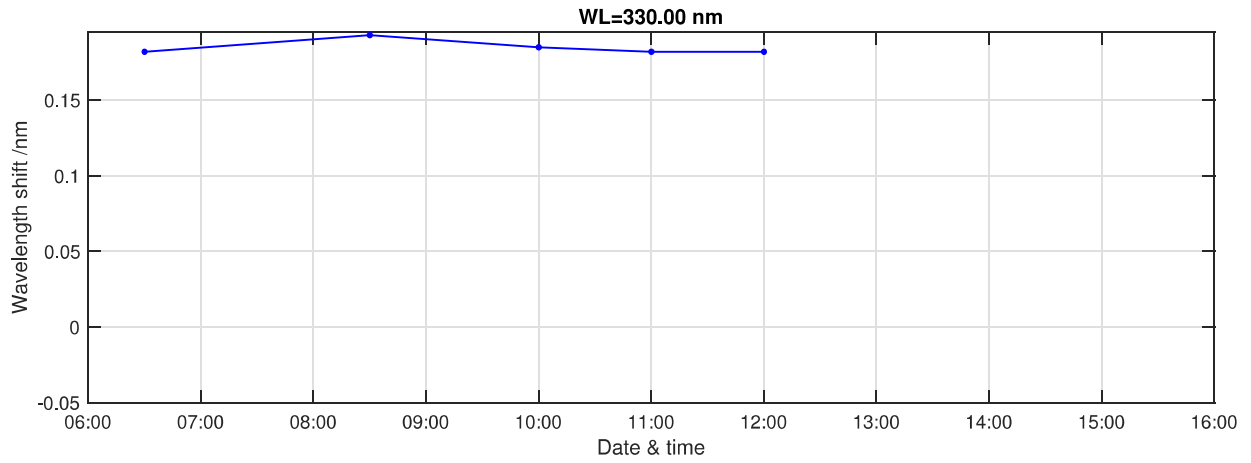
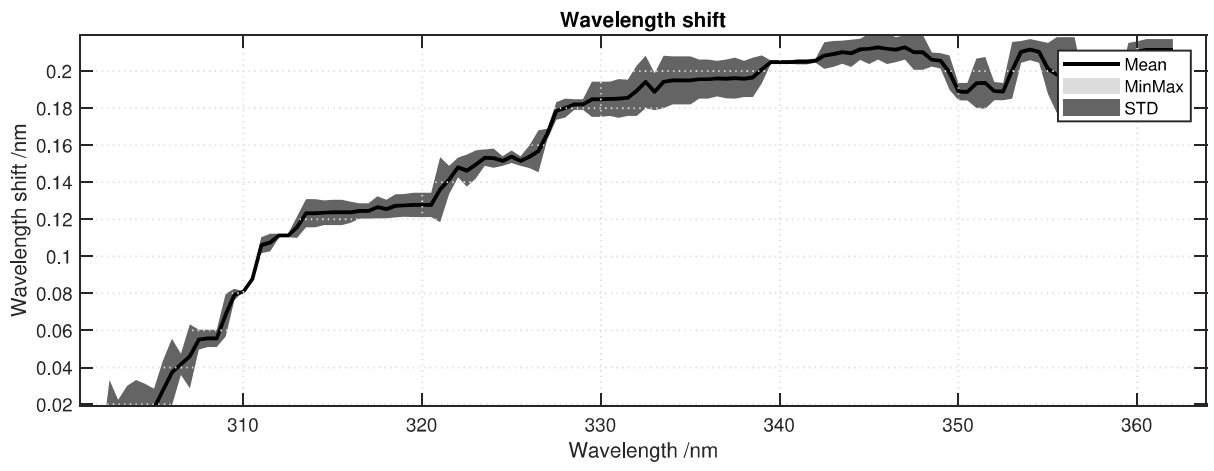












Qasume Responsivity Change, September 2021, El Arenosillo (T16573, T68522, T685240)

