

Protocol of the intercomparison at FMI, Helsinki, Finland on June  
4 to 9, 2023 with the travelling reference spectroradiometer  
QASUME from PMOD/WRC

Report prepared by Julian Gröbner

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Local operator: Anu Heikkilä

The purpose of the visit was the comparison of global solar irradiance measurements between the Brewer spectrophotometer operated by FMI and the travel reference spectroradiometer QASUME. The measurement site is located at Helsinki; Latitude 60.204 N, Longitude 24.961 E 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 1:30 UT and 20:00 UT have been analysed.

QASUME was installed on the measurement platform of FMI-Helsinki in the morning of June 4, 2023. The spectroradiometer was installed next to the Brewer spectrophotometer "FIJ" with the entrance optic of QASUME within 2 m to "FIJ". The Brewer Spectrometer #107 is a double monochromator MkIII. The intercomparison between QASUME and the Brewer Spectrometer lasted 4 1/2 days, from the morning of June 5<sup>th</sup> to the afternoon of June 9<sup>th</sup>.

QASUME was calibrated several times during the intercomparison period using a portable calibration system. Three lamps (T61251, 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  $26.7 \pm 0.2$  °C and the diffuser head was heated to a temperature of  $28.7 \pm 0.4$  °C.

The wavelength shifts relative to an extraterrestrial spectrum as retrieved from the matSHIC analysis were between  $\pm 50$  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 nm to 363 nm, every 0.5 nm, and 3.0 seconds between each wavelength increment. QASUME recorded the spectra in 30 min intervals with 0.25 nm increments from 290 nm to 400 nm.

DOY	Date	DAY	Weather	Comment (times are in UT)
155	04-Jun	Sunday	Mix of sun and clouds (Cu)	Installed at 7:40 by GH 12:00 start UV measurements
156	05-Jun	Monday	Clear sky in the morning Small Cu developing during the afternoon	10:05 Calibration T68522
157	06-Jun	Tuesday	Alto cumulus mix of sun and clouds in the afternoon Rain in the evening	12:40 Calibration T68522
158	07-Jun	Wednesday	Clear sky in the morning small Cu in front of sun between 8:30-12:00	12:55 Install QASUME head in 1000W unit 12:35 Calibration T68522
159	08-Jun	Thursday	Clear sky in the morning 8:30 Overcast AS	
160	09-Jun	Friday	Clear sky in the morning	7:40 Calibration T68522, T61251 QASUME OFF

**Results:**

In total 124 synchronised simultaneous spectra from QASUME and FIJ are available from the measurement period. Measurements between 1:30 UT and 19:30 UT have been analysed (SZA smaller than  $90^\circ$ ).

**Conclusions:**

1. The average spectral ratio between FIJ and QASUME has a slight spectral trend, from 1.00 at 305 nm decreasing to 0.97 at 363 nm.
2. The temporal variation of the spectra between FIJ and QASUME was very stable, with variations less than 2% during the whole campaign.
3. The wavelength shifts of FIJ relative to the high spectral resolution solar spectrum TSIS-1 HSRS are between  $\pm 50$  pm in the spectral range 290 to 365 nm.
4. The signal to noise ratio at short wavelengths smaller than about 305 nm rises at solar zenith angles larger than about  $70^\circ$ .

**Comparison to previous QASUME site visits**

The long-term stability of FIJ was assessed by comparing QASUME site visits performed since 2002. The measurements before 2014 were performed at Jokioinen.

As seen in figure 1, the campaign average ratio to QASUME has been stable to within 2% since 2014. Measurements before 2014 were slightly higher than QASUME by between 3% (2002 and 2003) to 6% (2007, 2010).

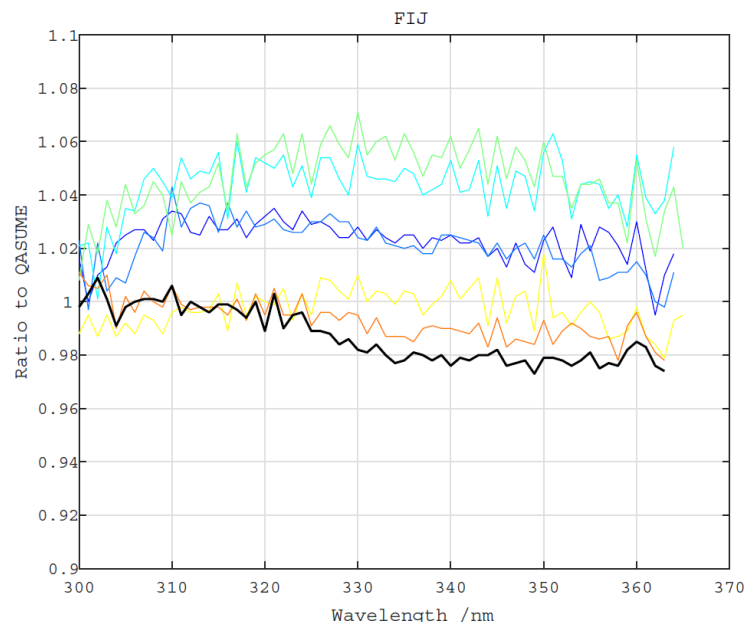
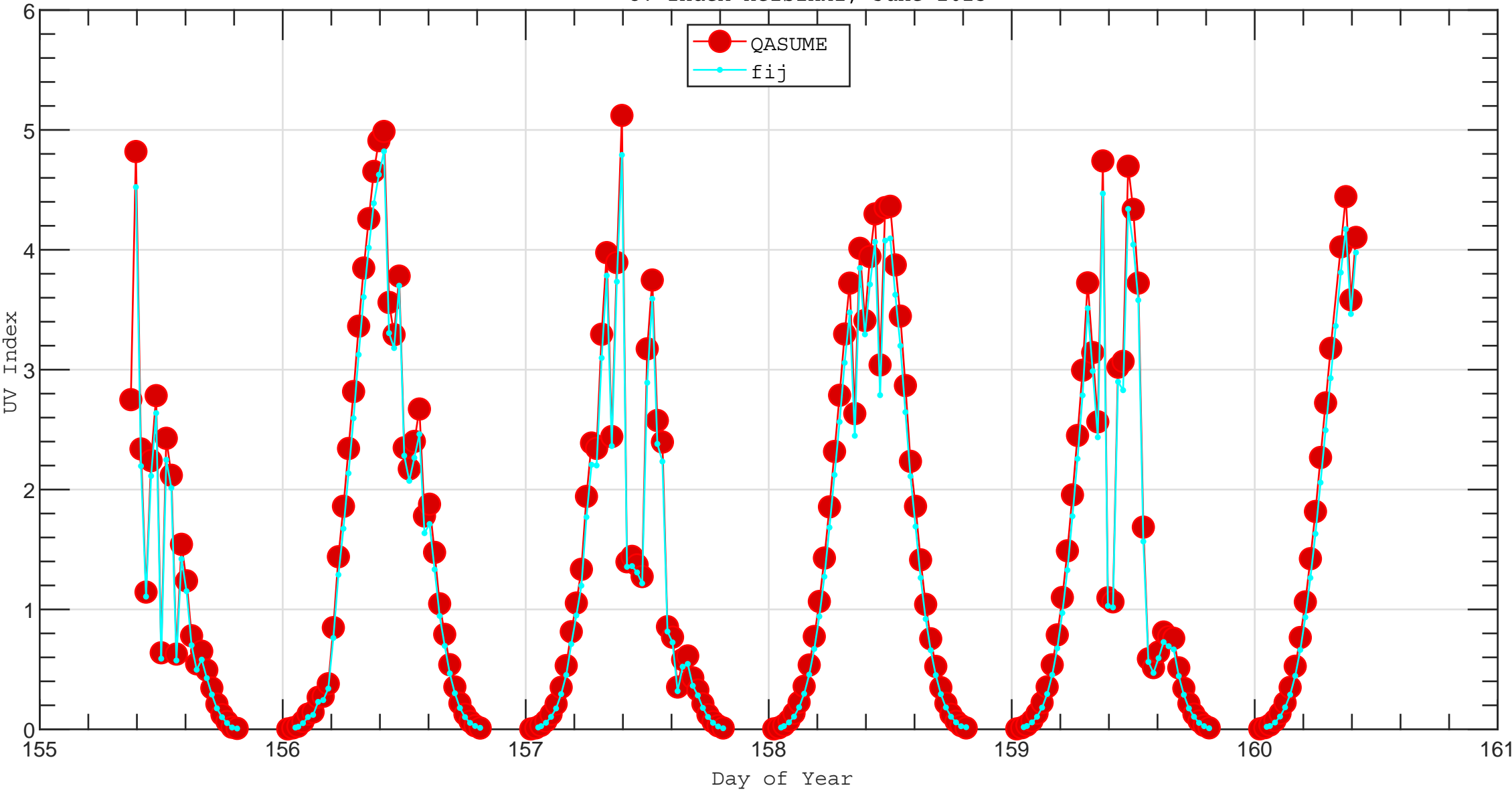


Figure 1 solar spectral ratios of FIJ to QASUME averaged over each QASUME site visit.

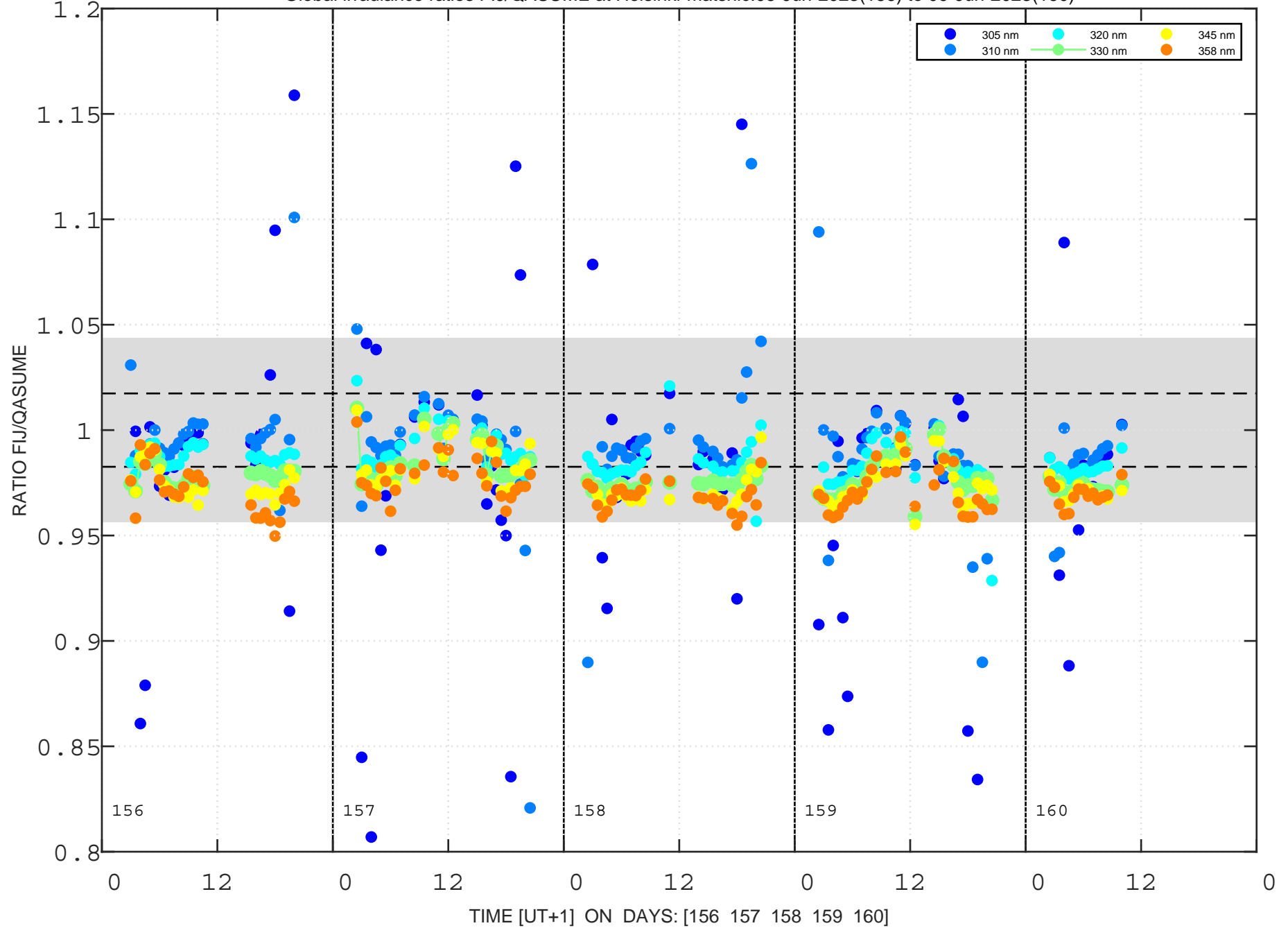
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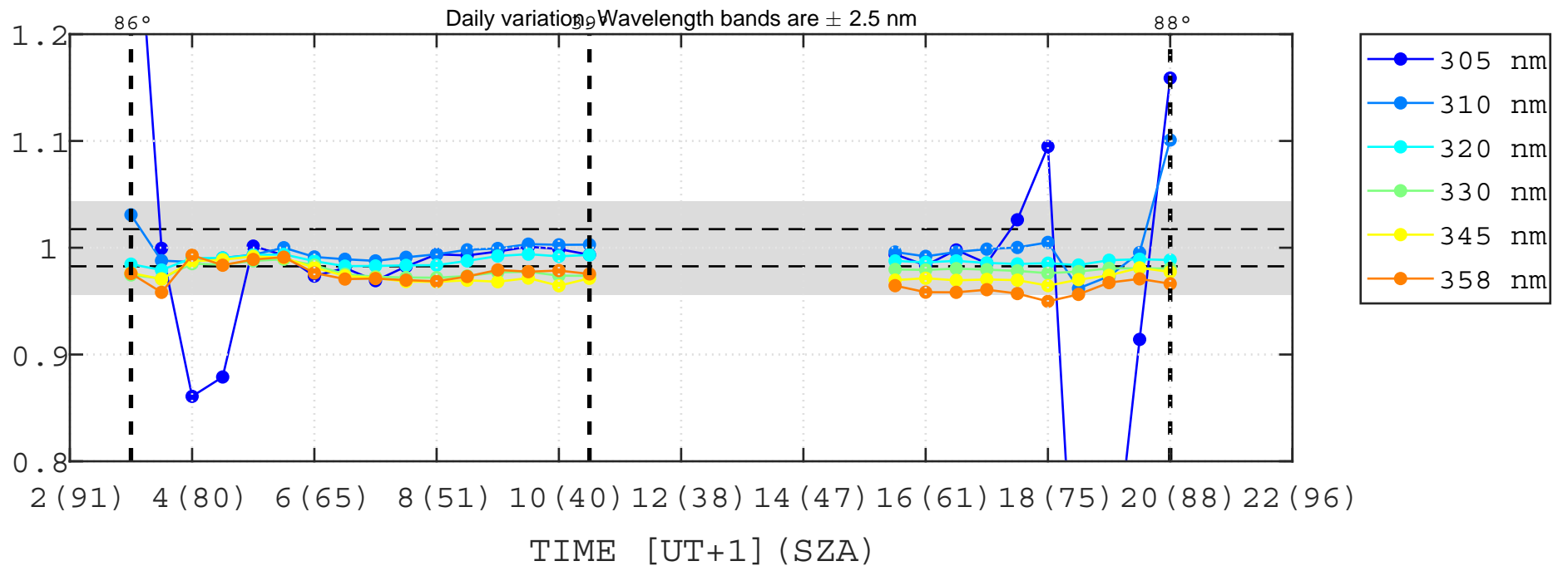
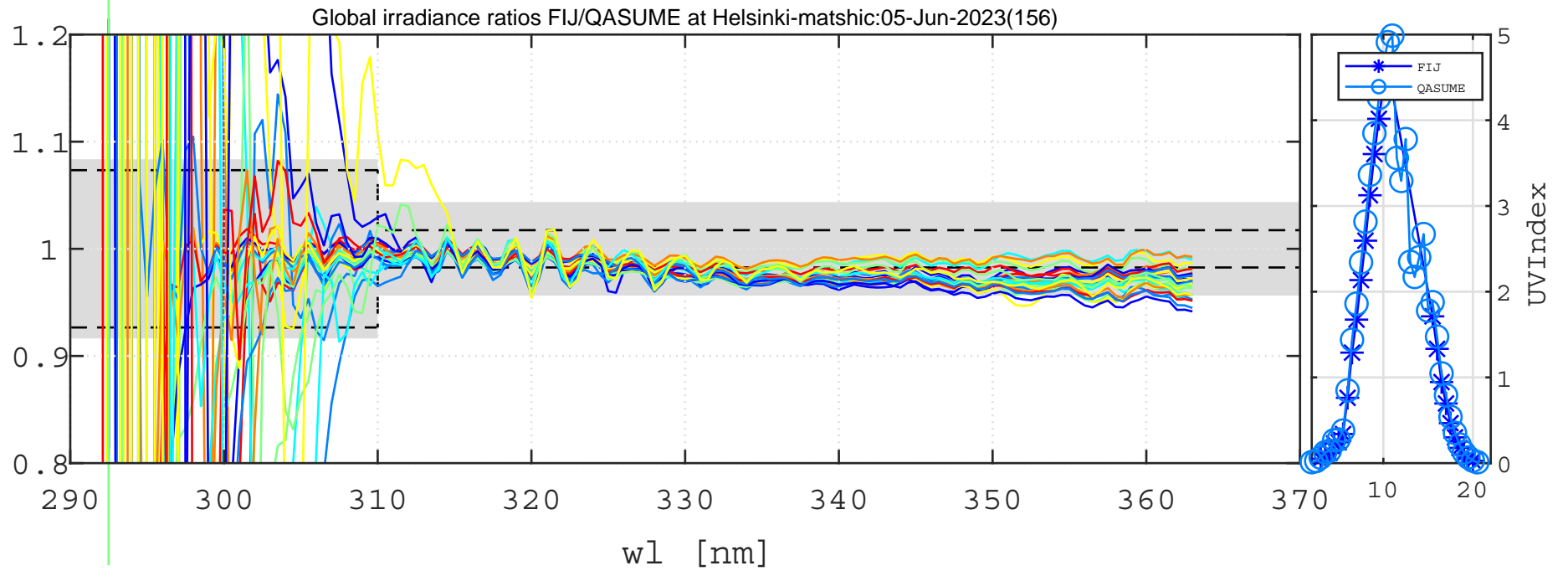


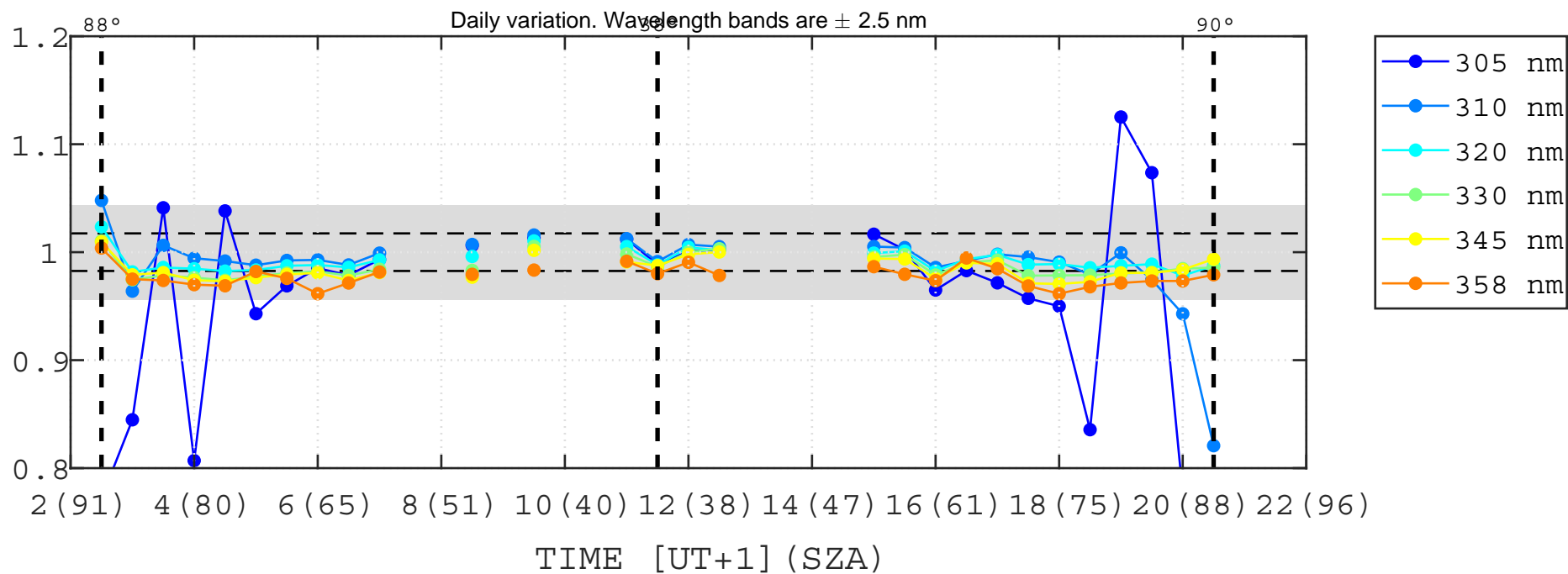
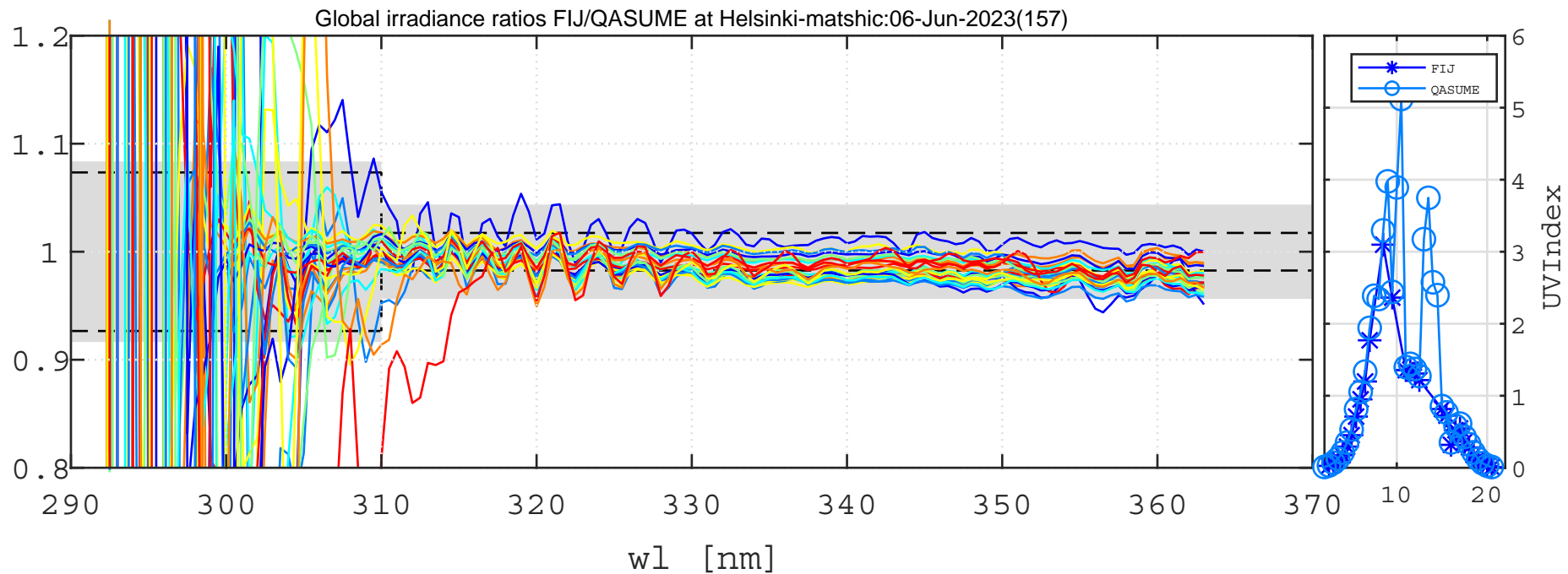
UV Index Helsinki, June 2023



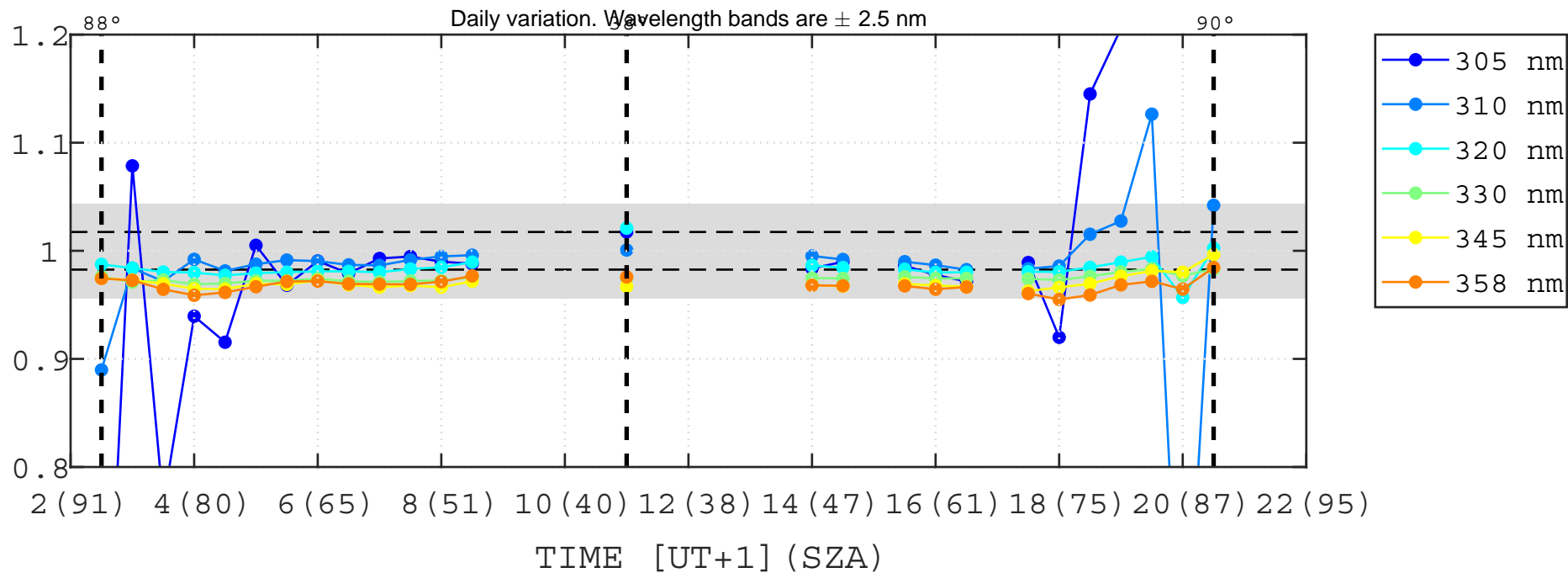
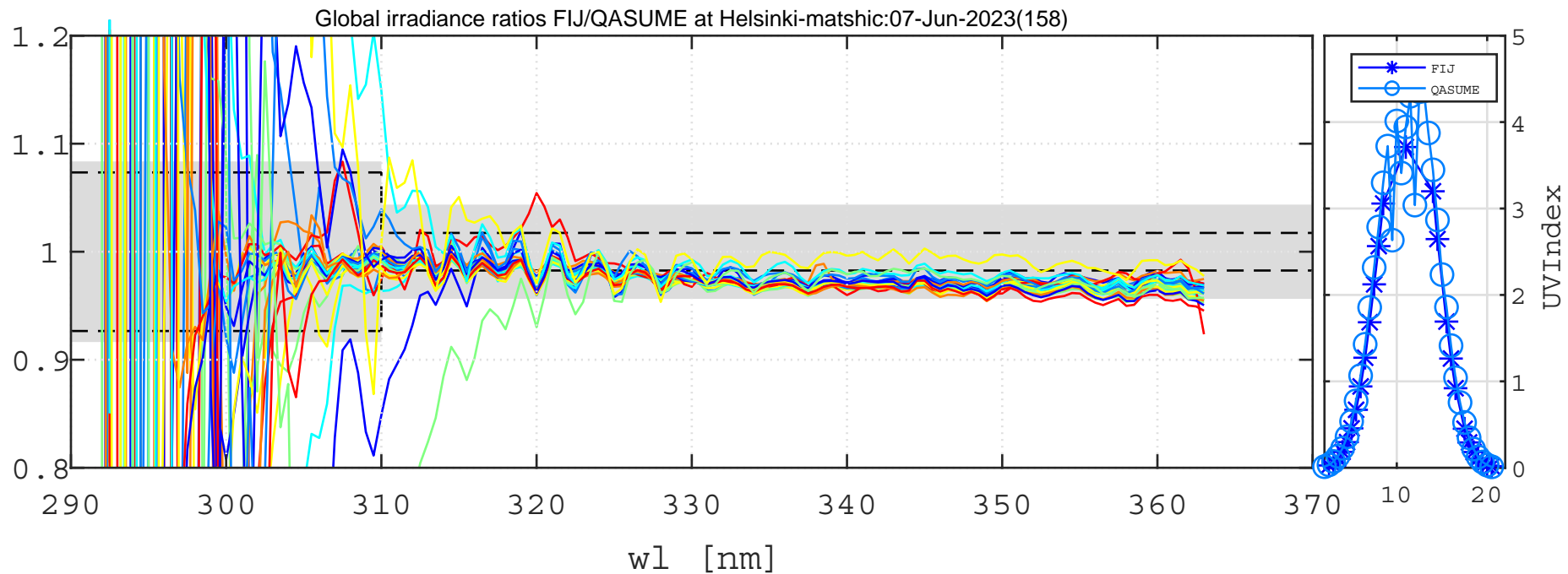
Global irradiance ratios FIJ/QASUME at Helsinki-matshic:05-Jun-2023(156) to 09-Jun-2023(160)

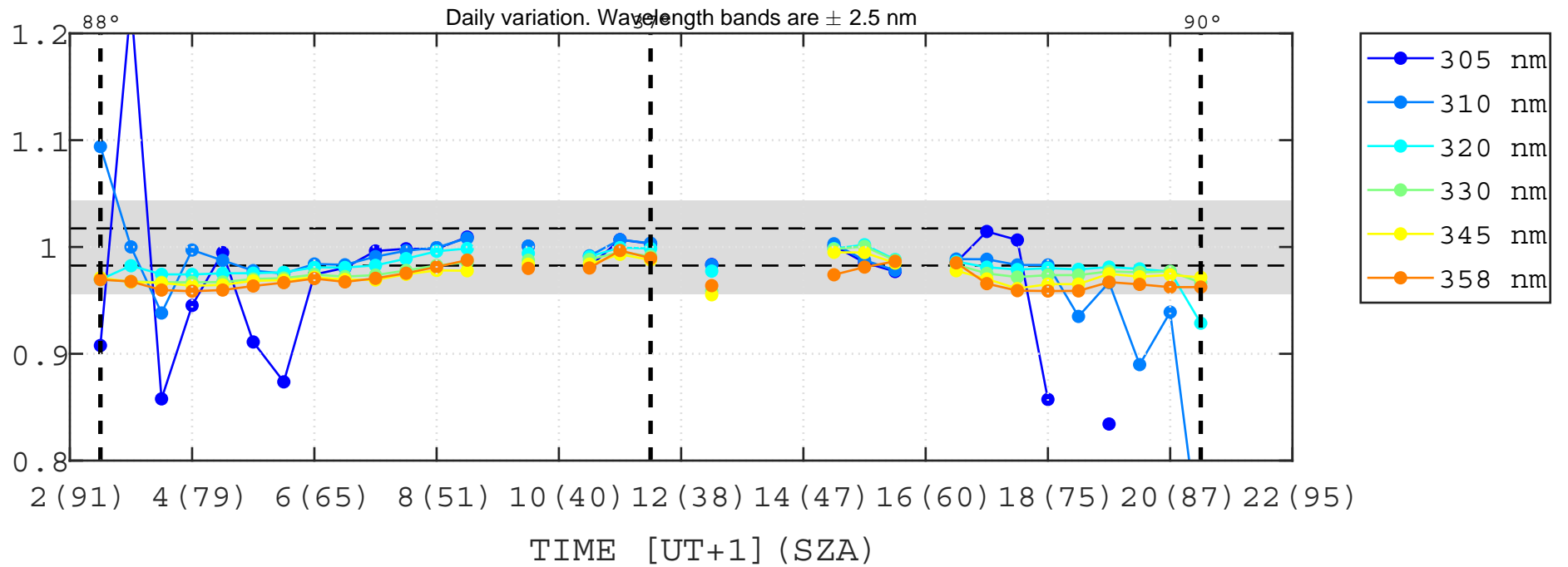
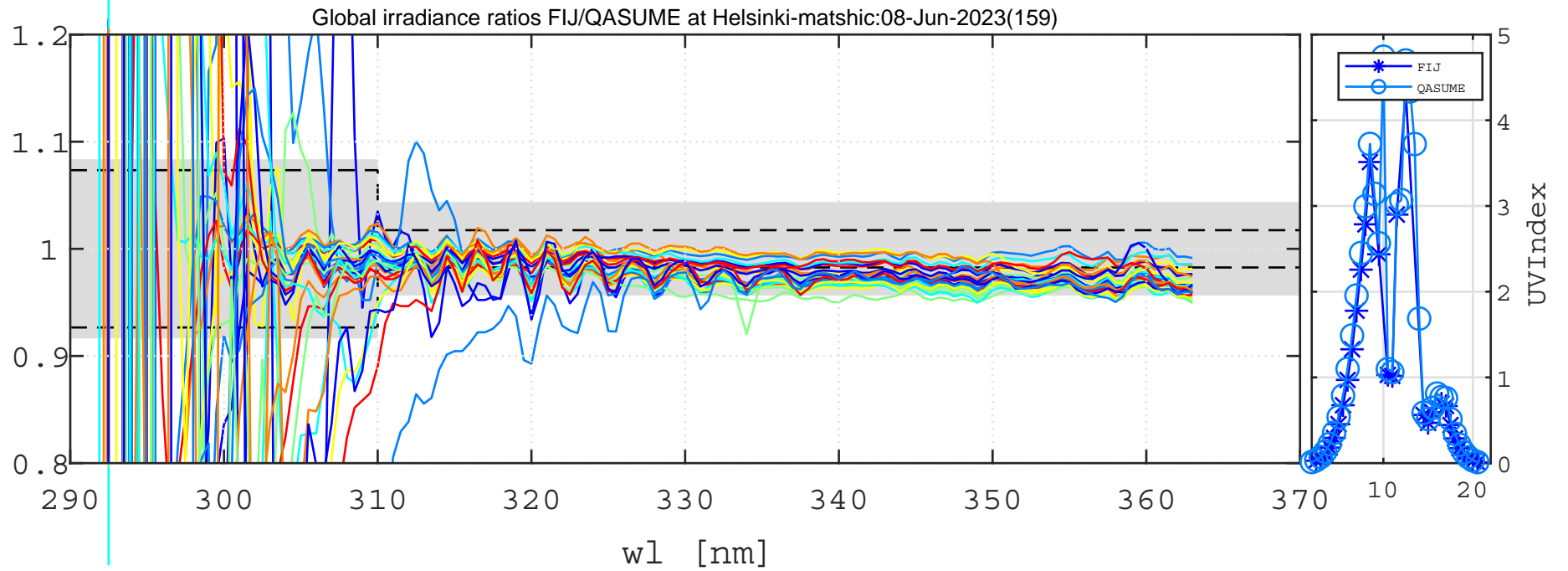


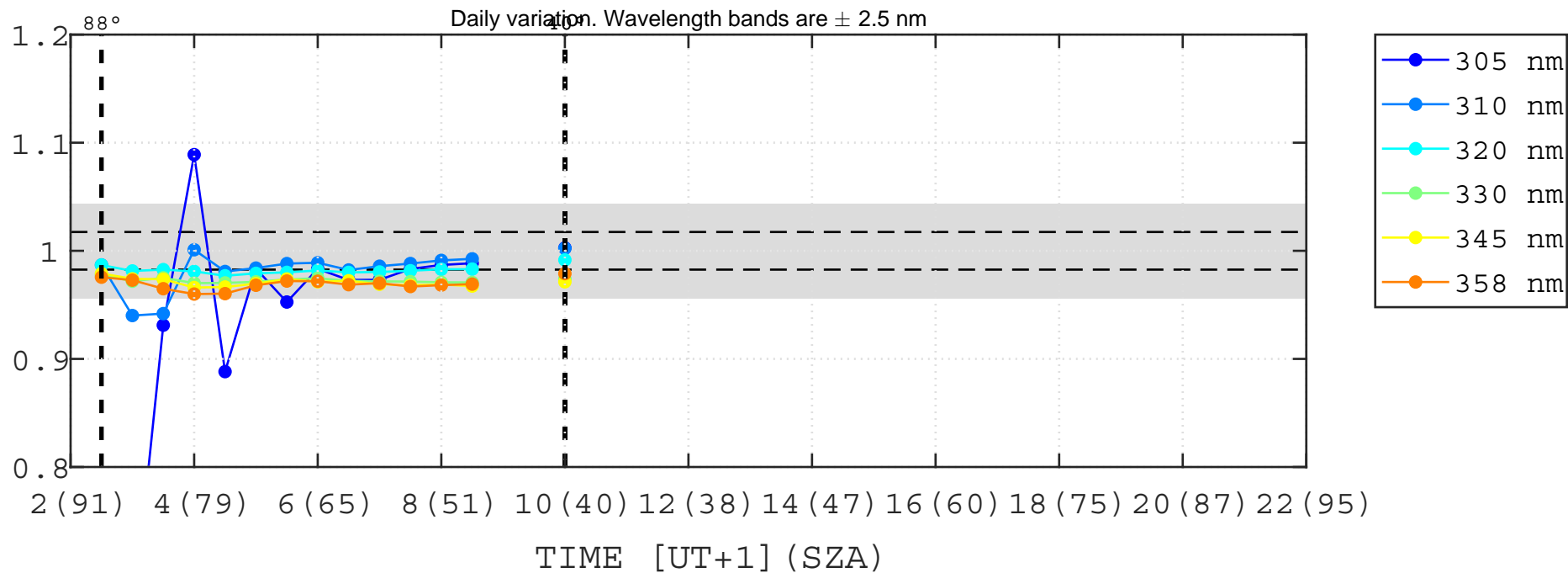
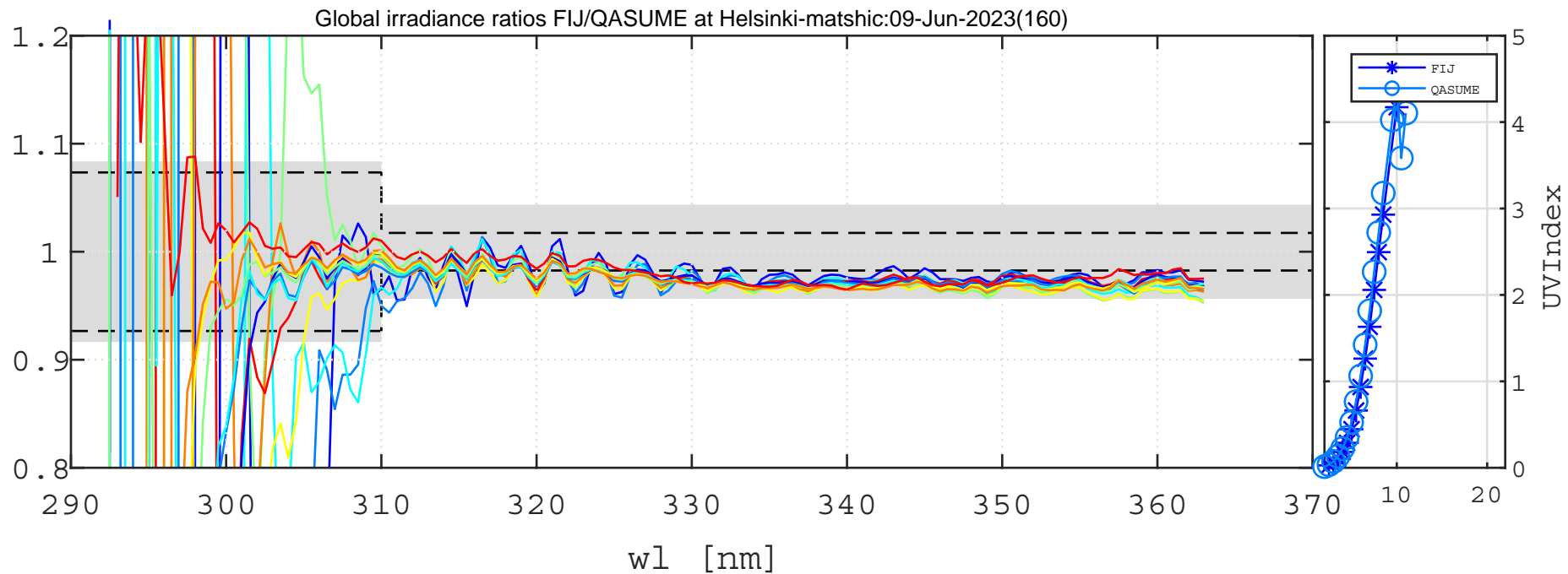




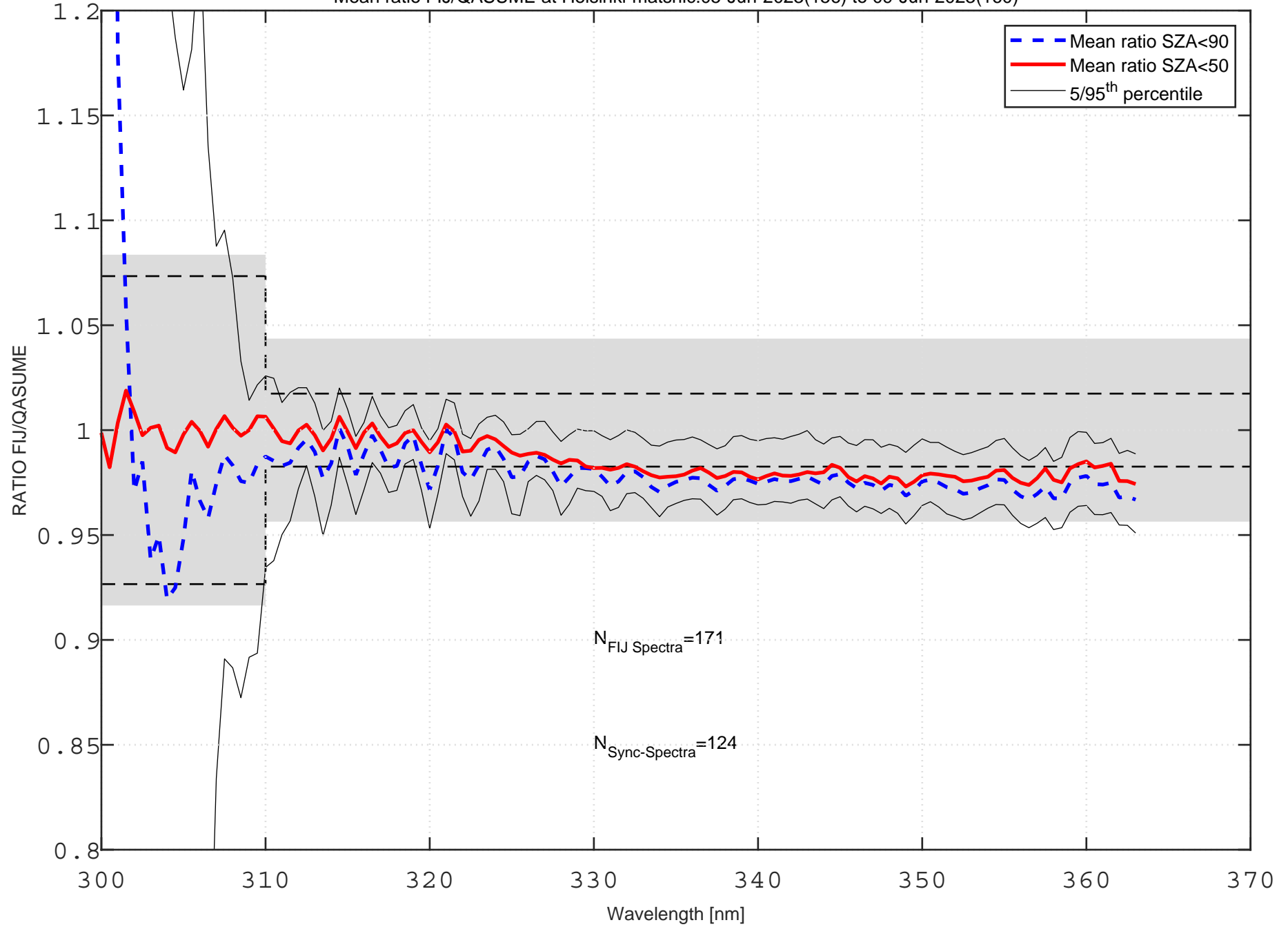


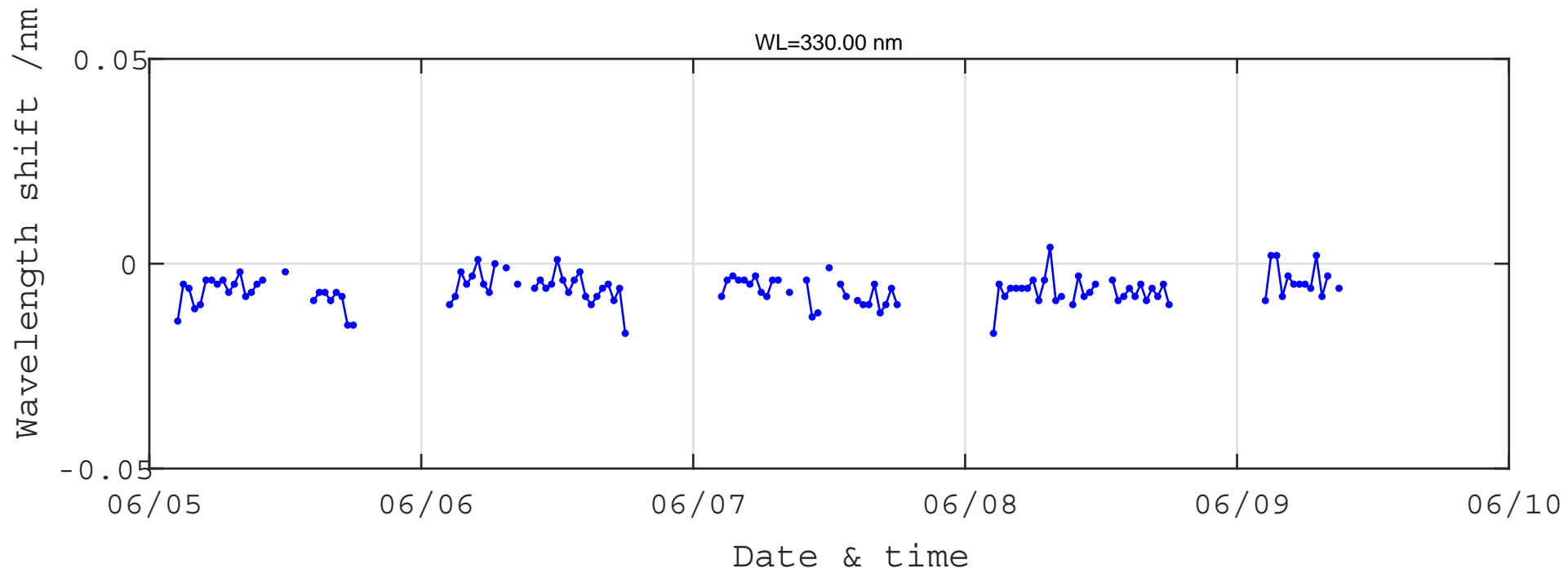
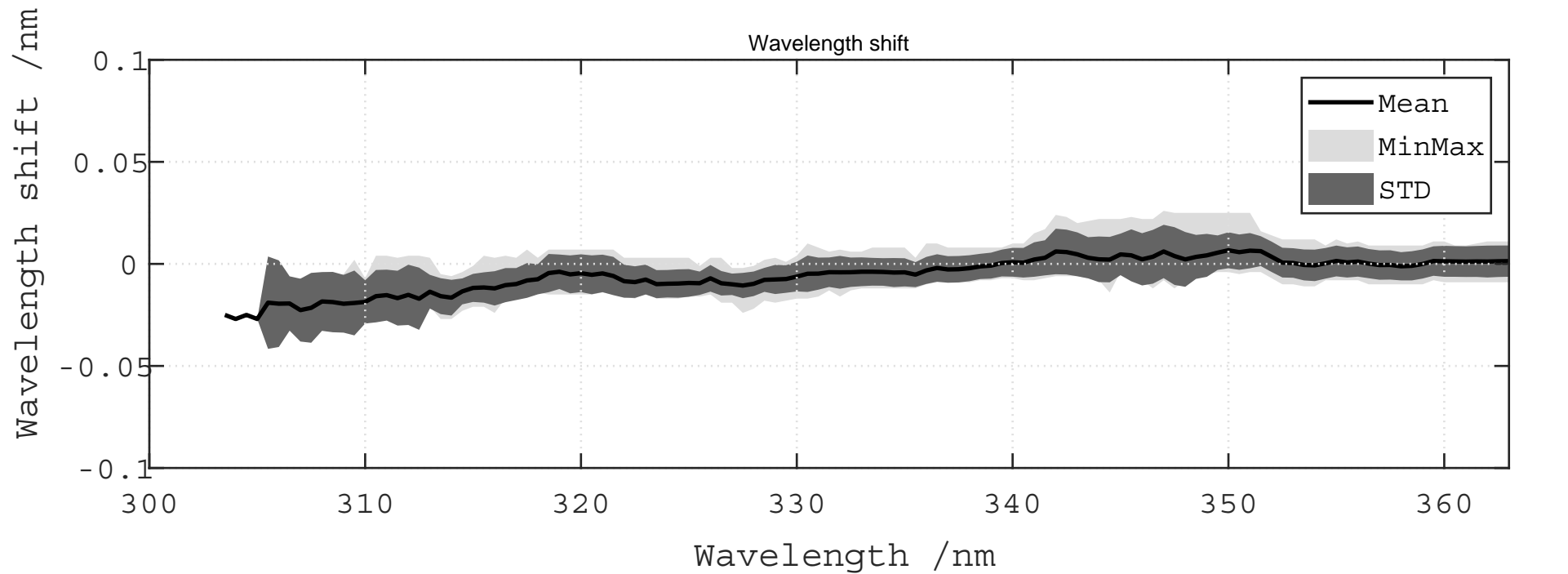




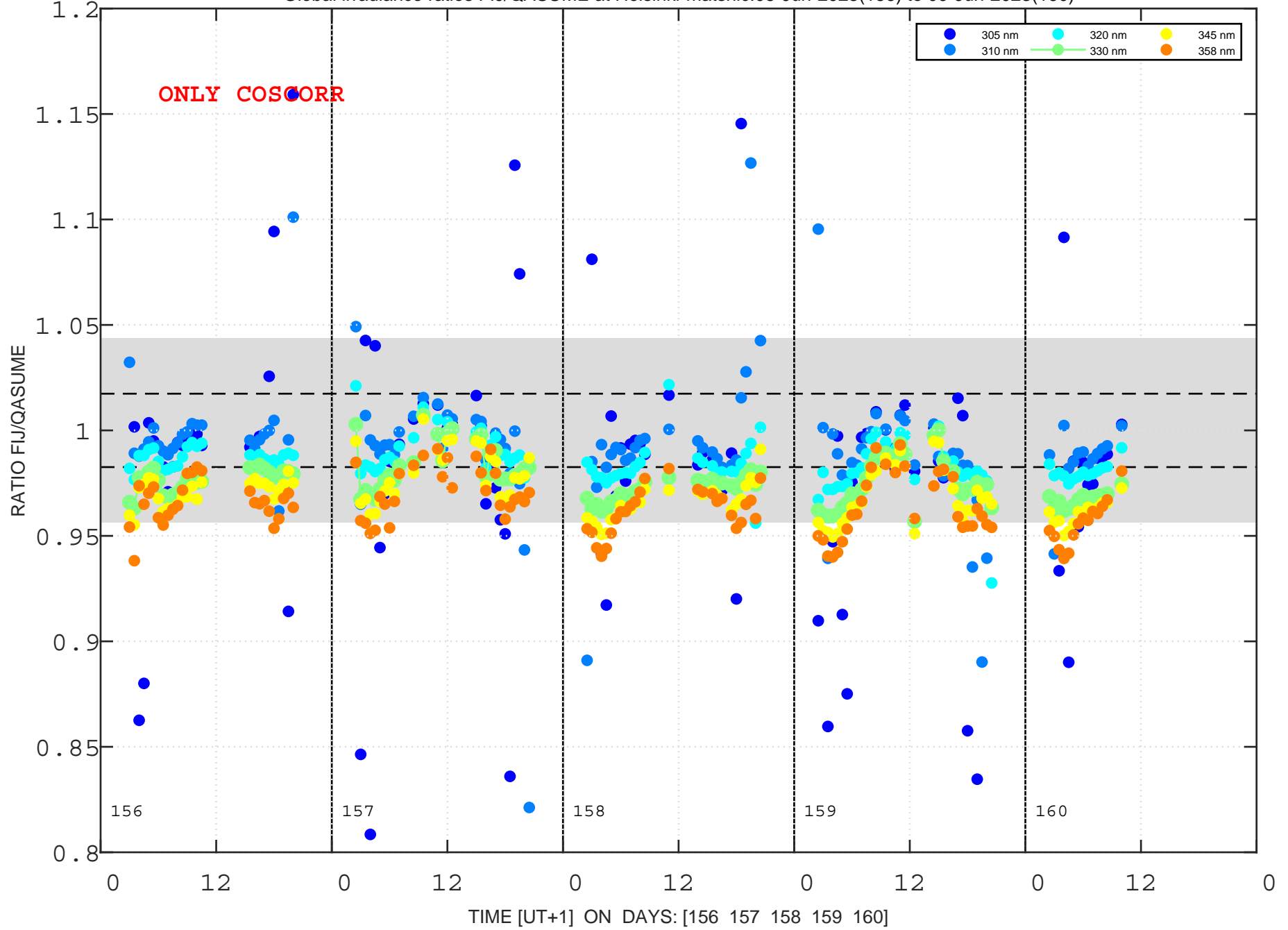


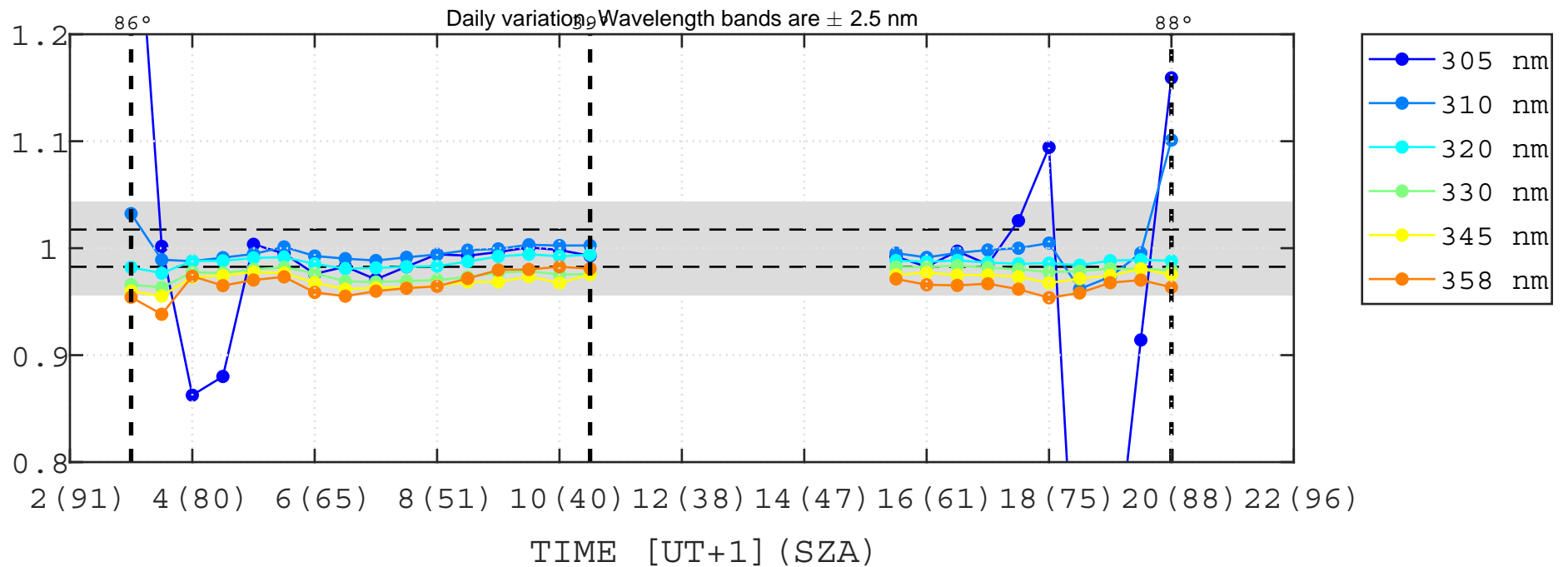
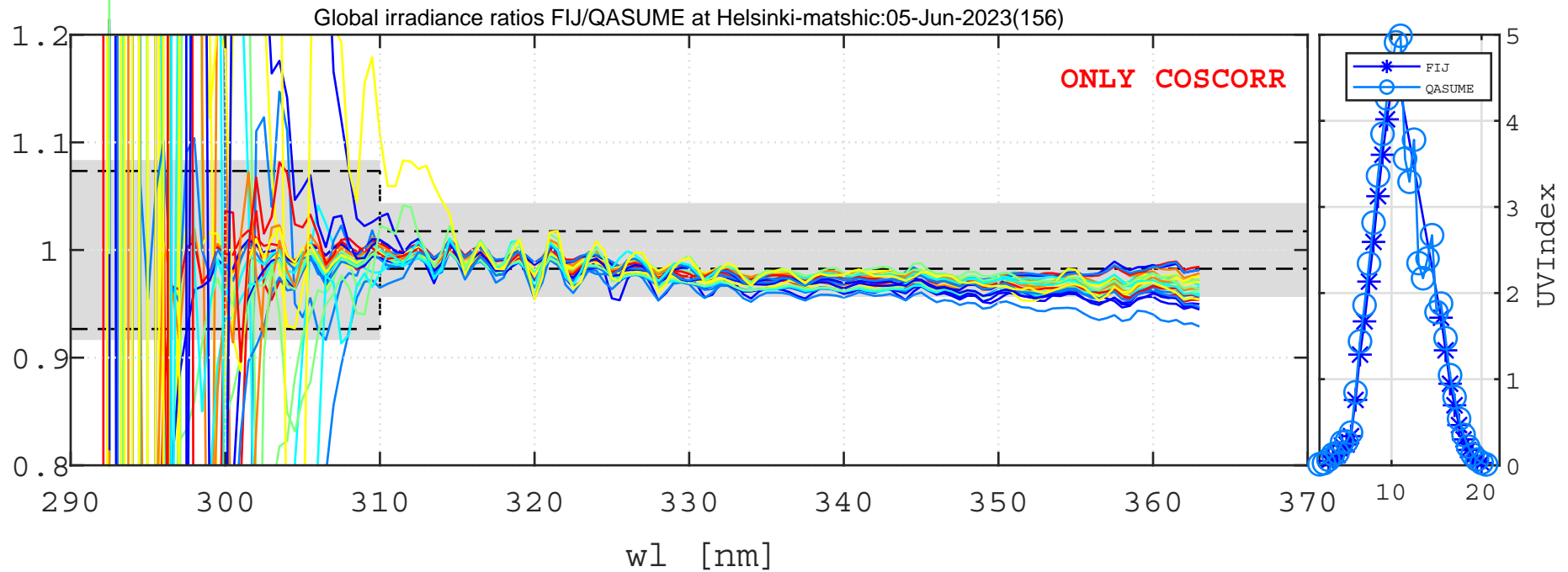
Mean ratio FIJ/QASUME at Helsinki-matshic:05-Jun-2023(156) to 09-Jun-2023(160)

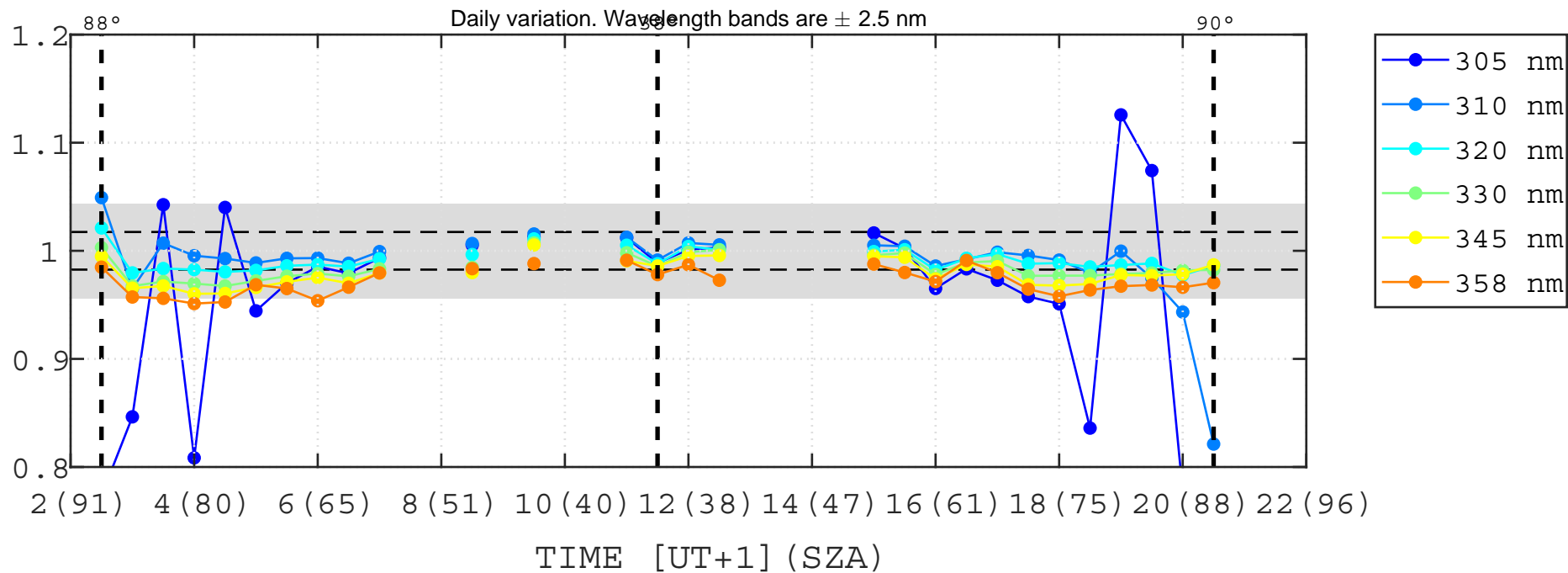
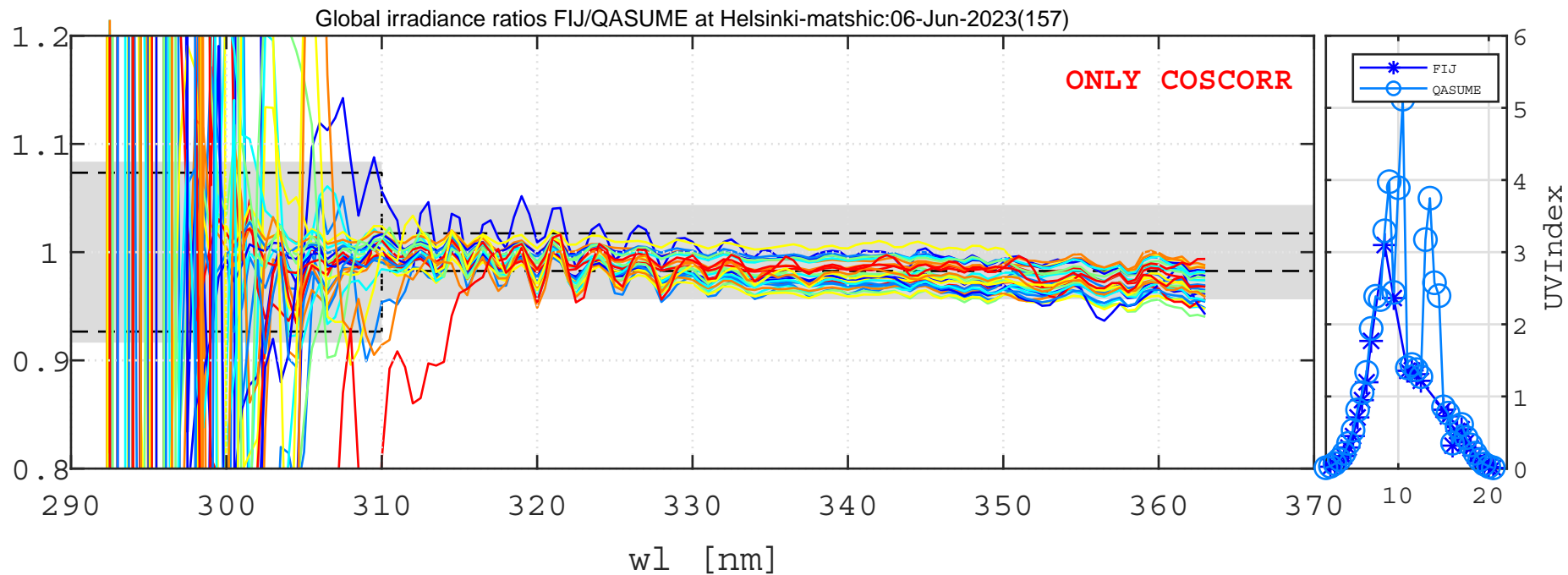




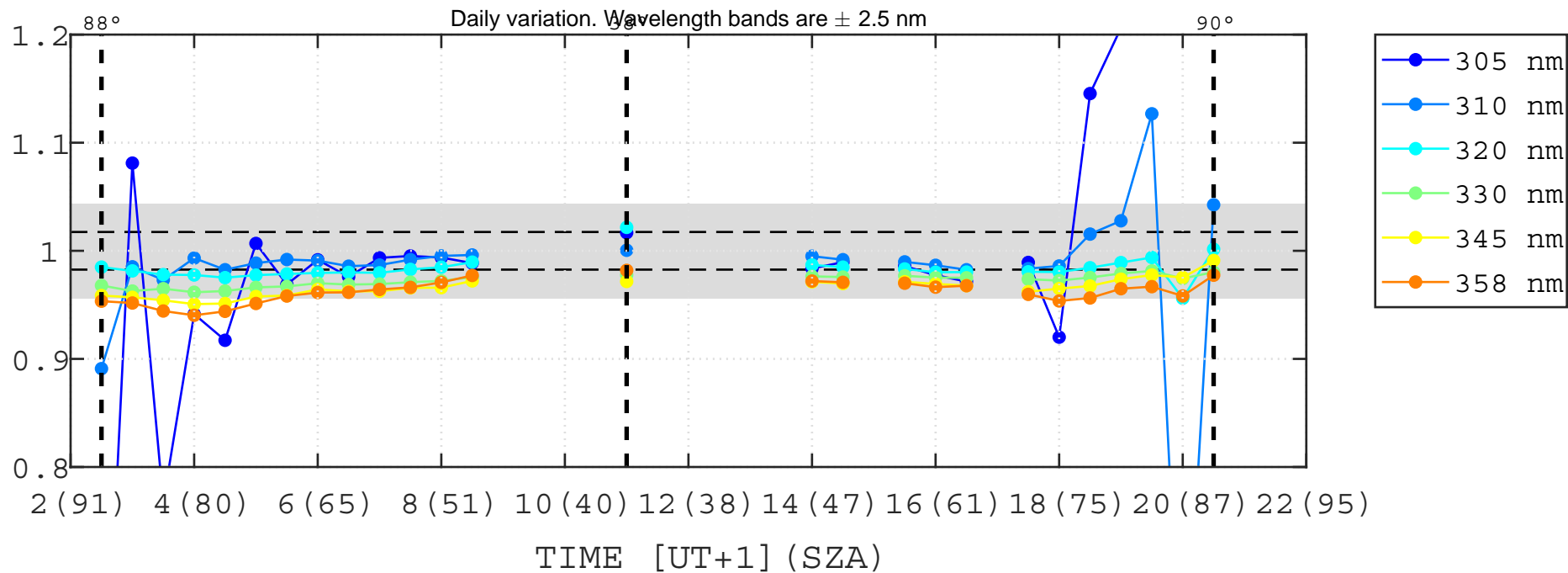
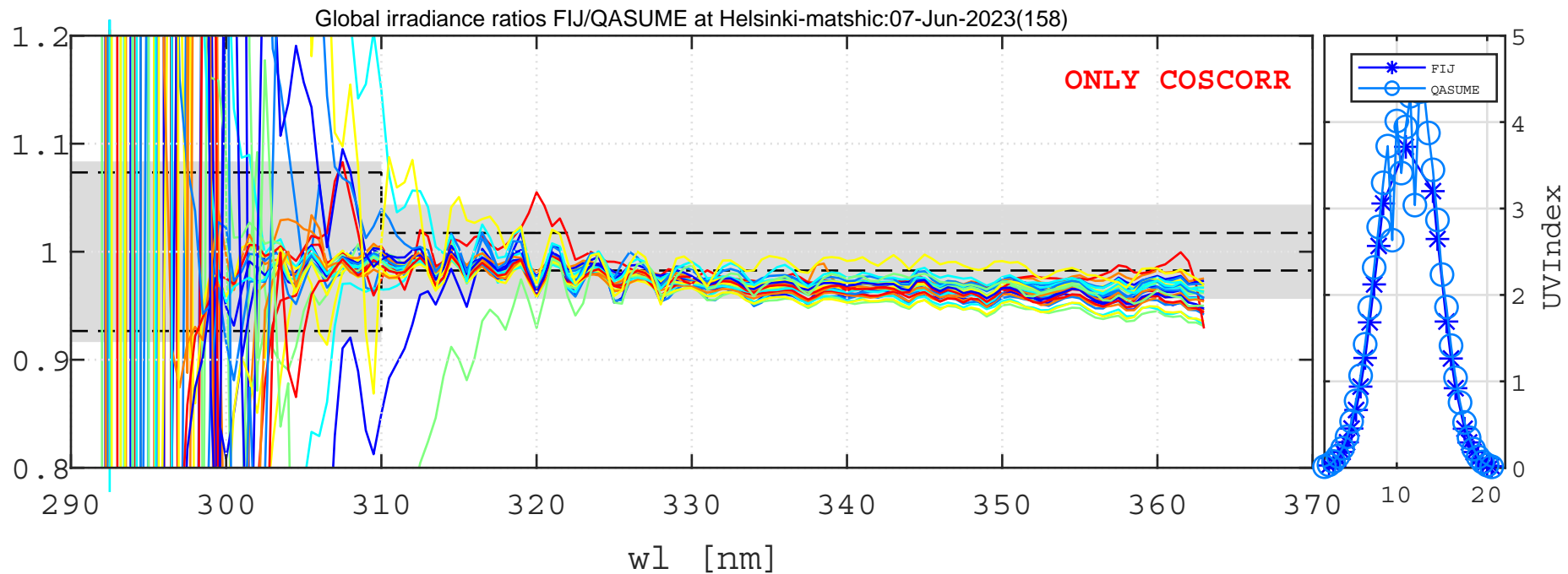
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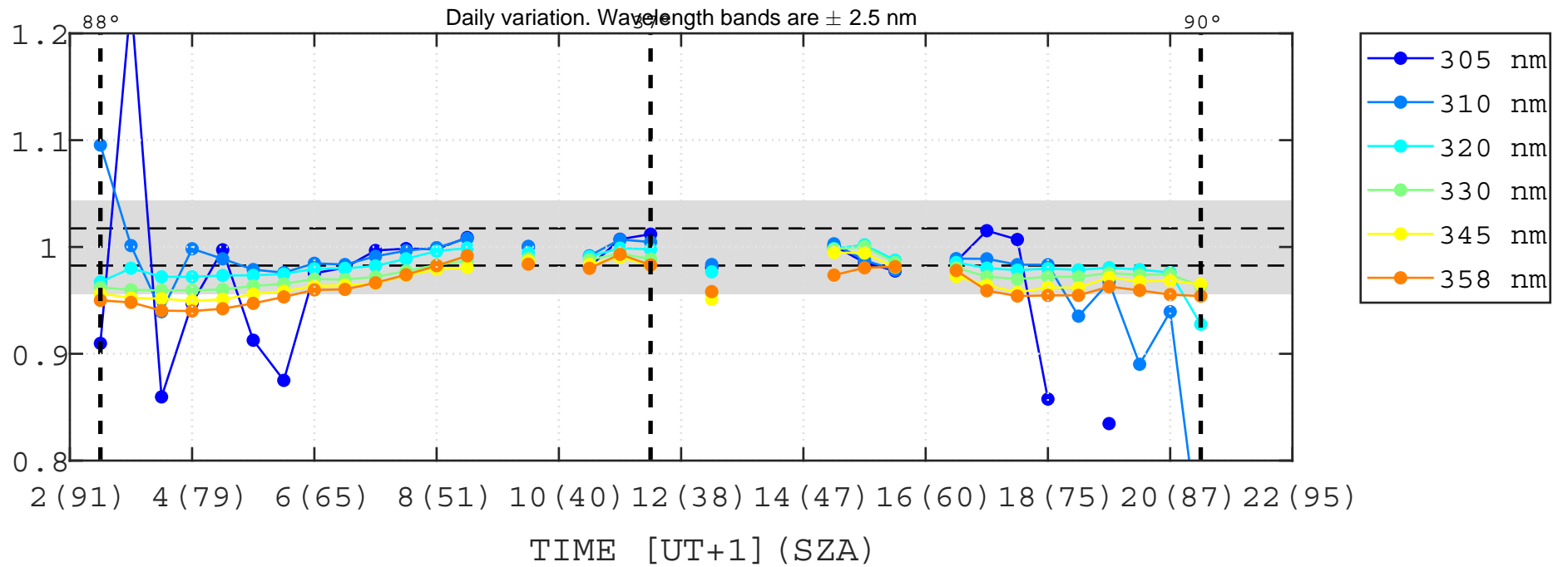
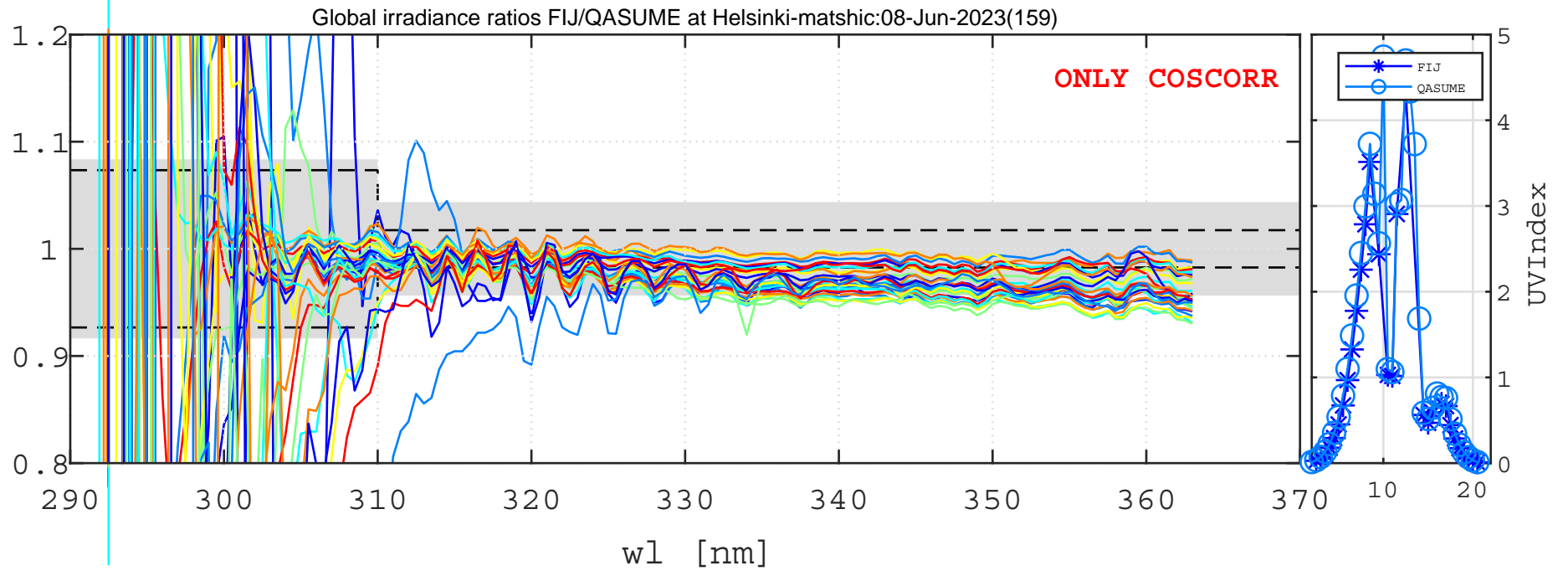


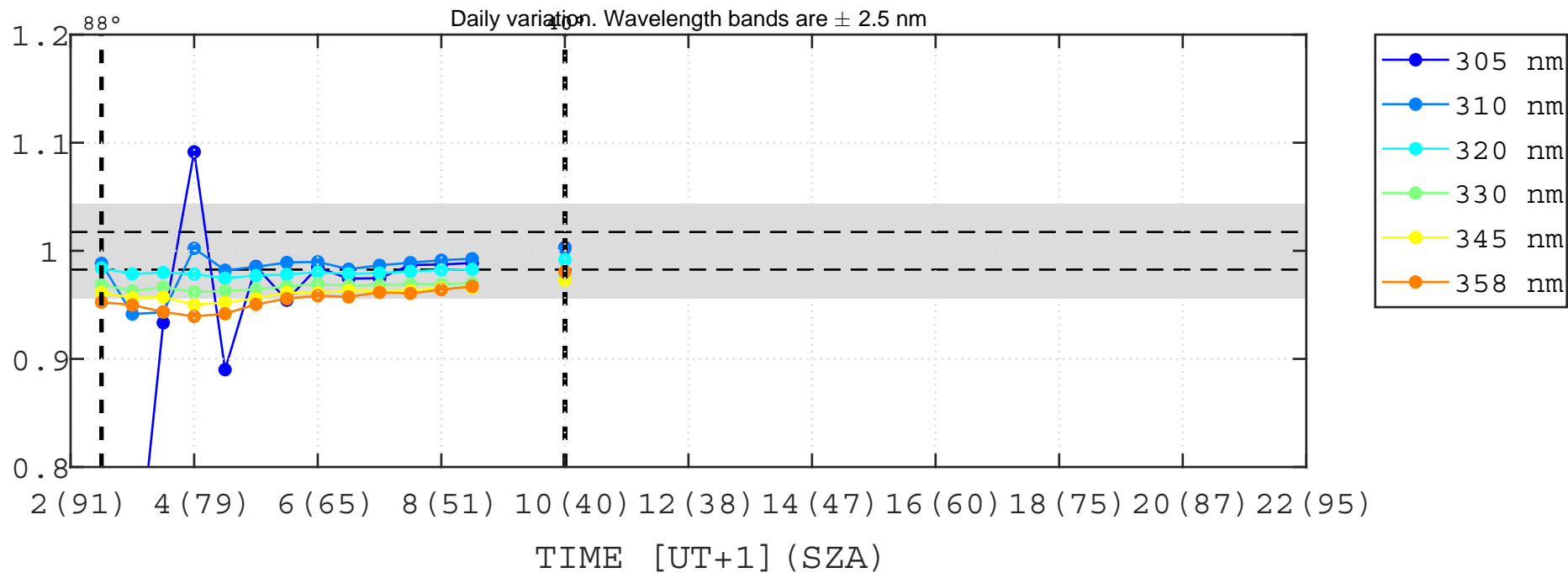
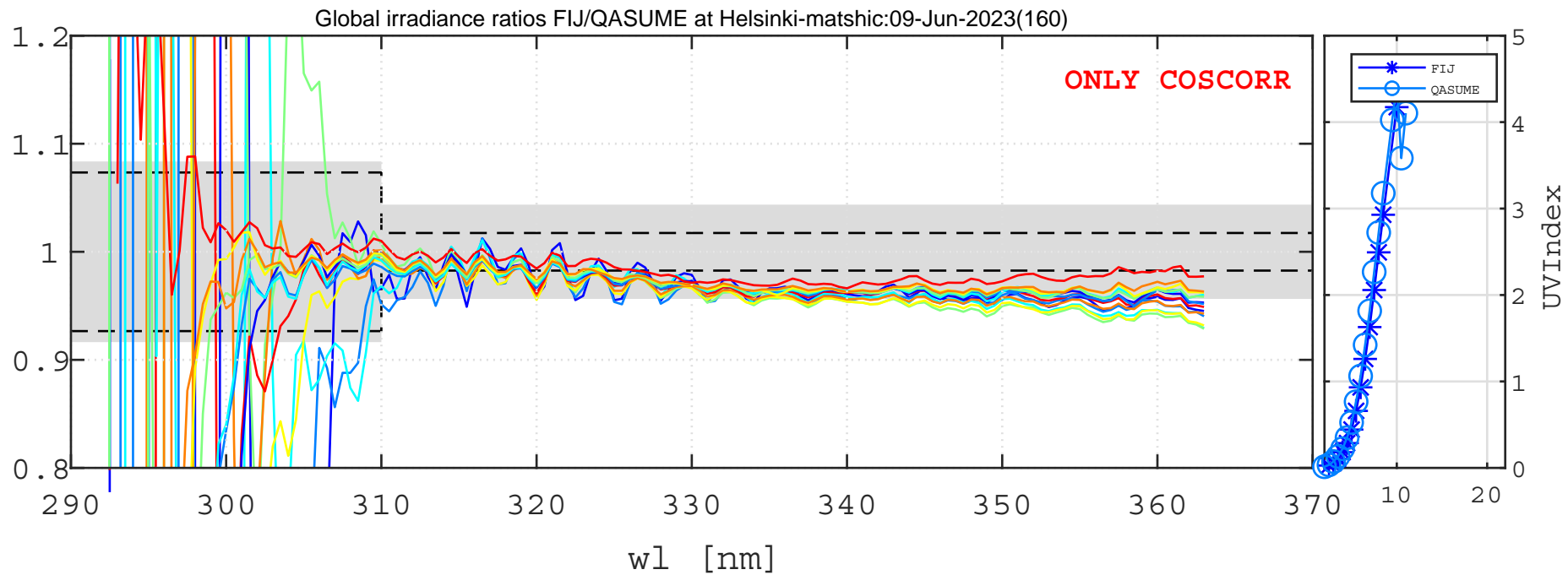




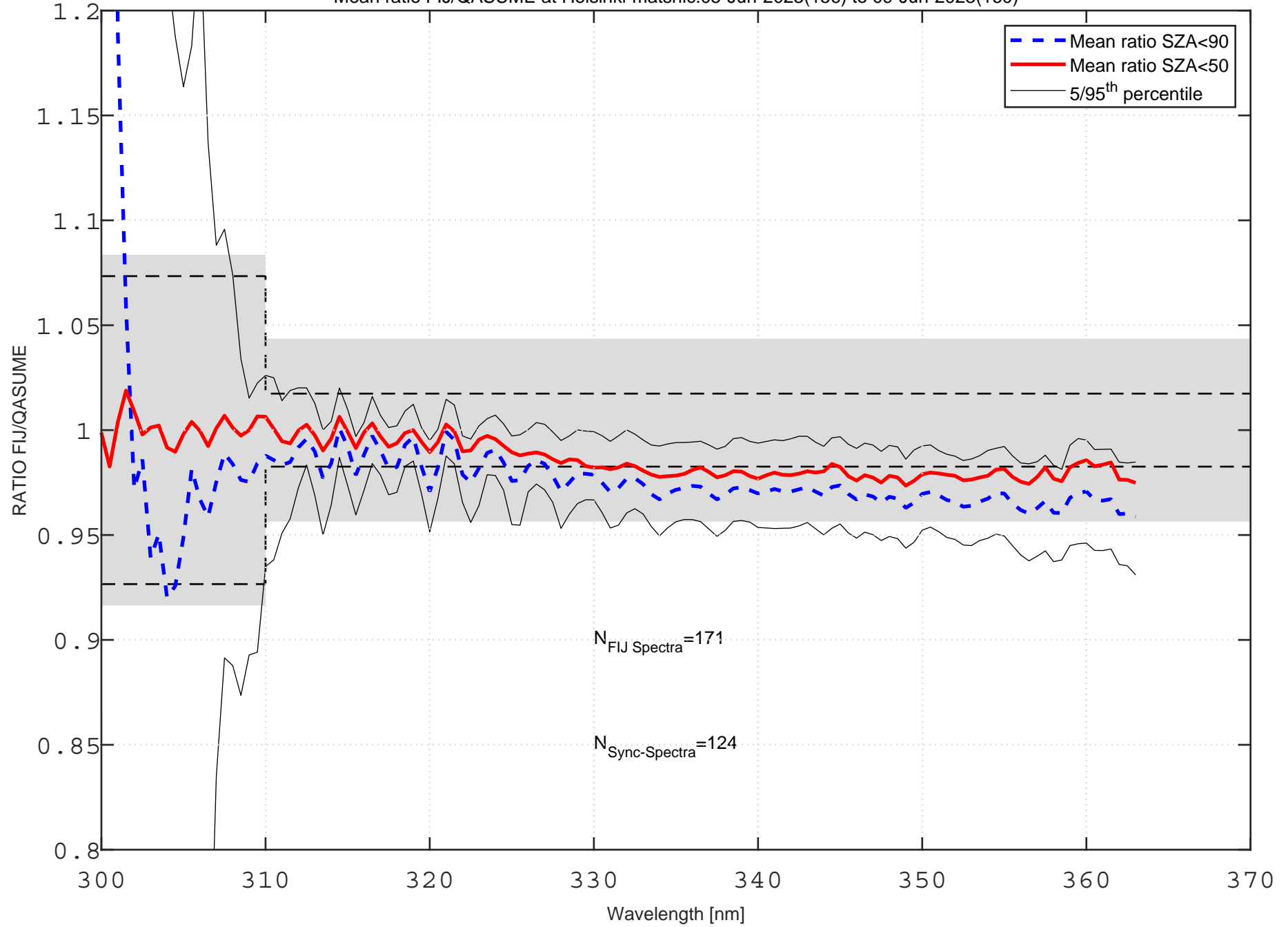




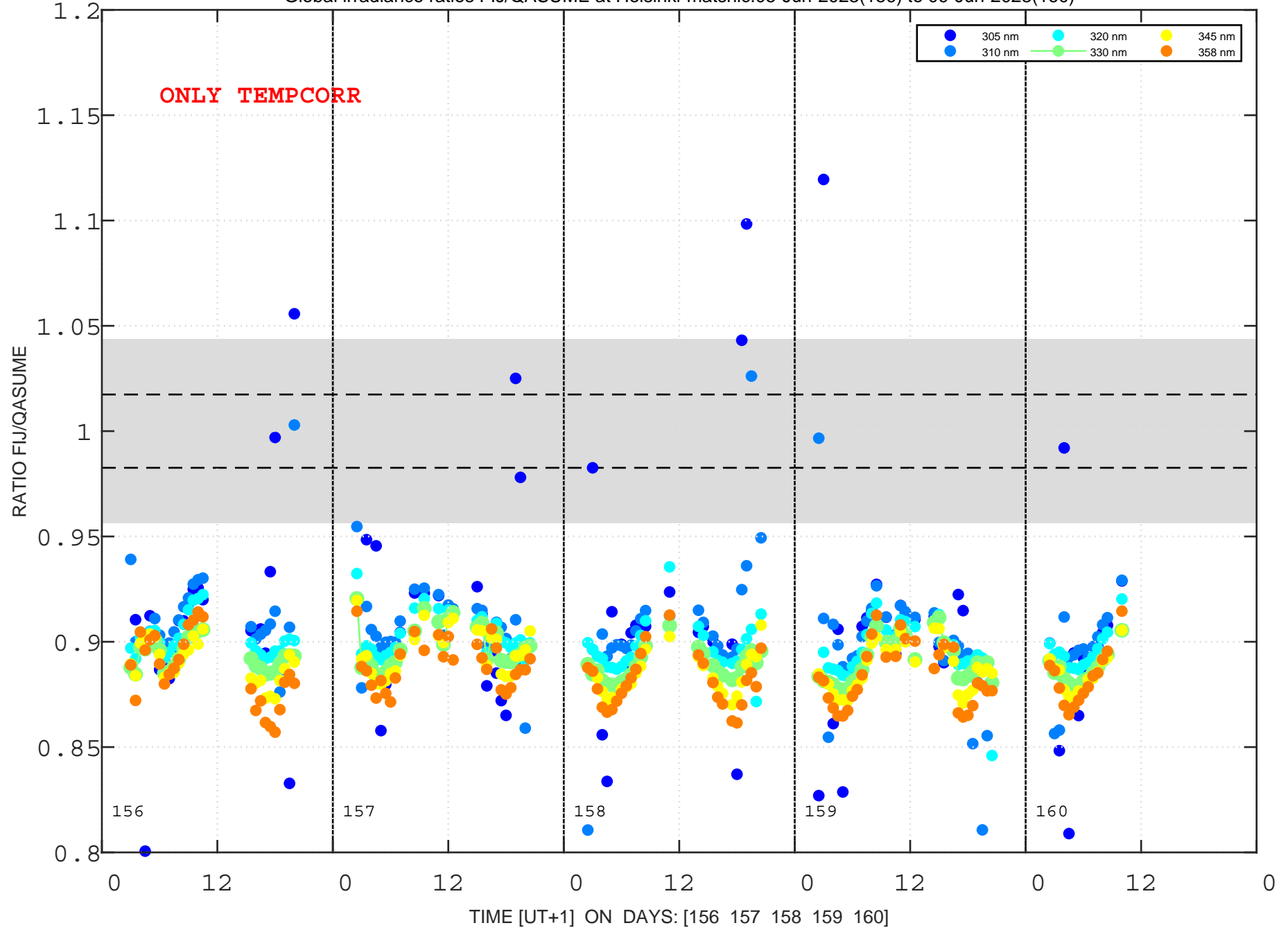




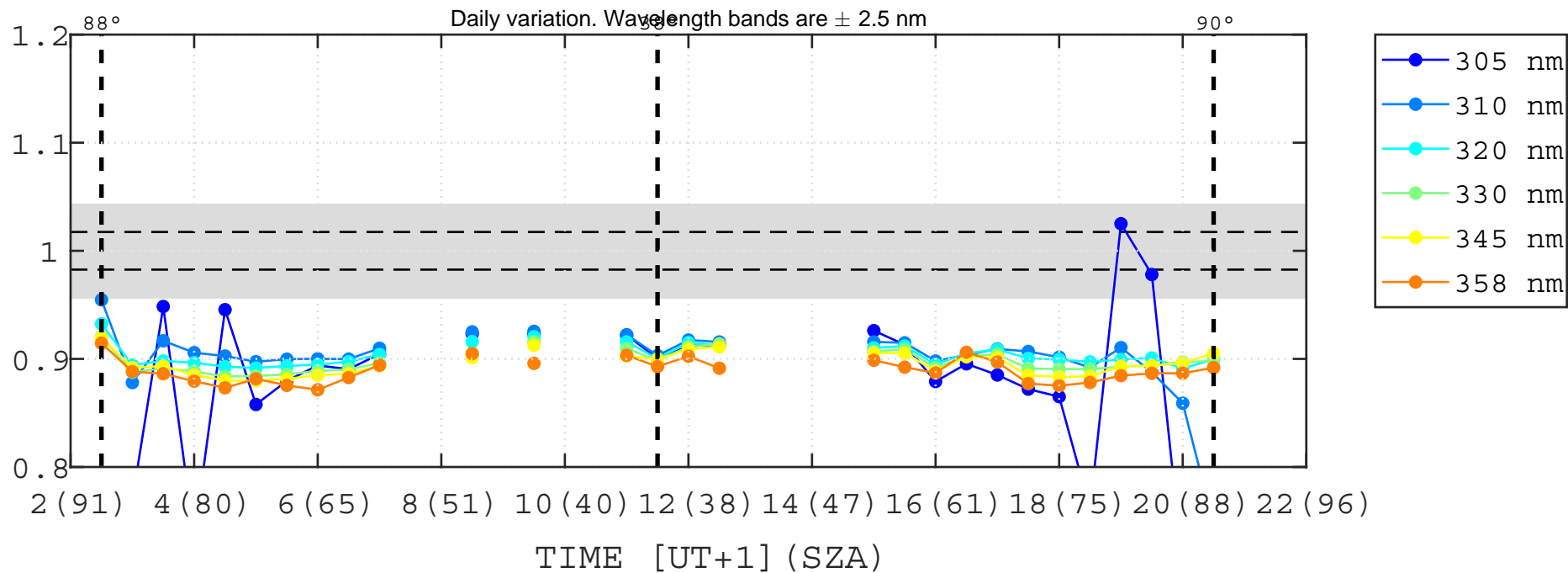
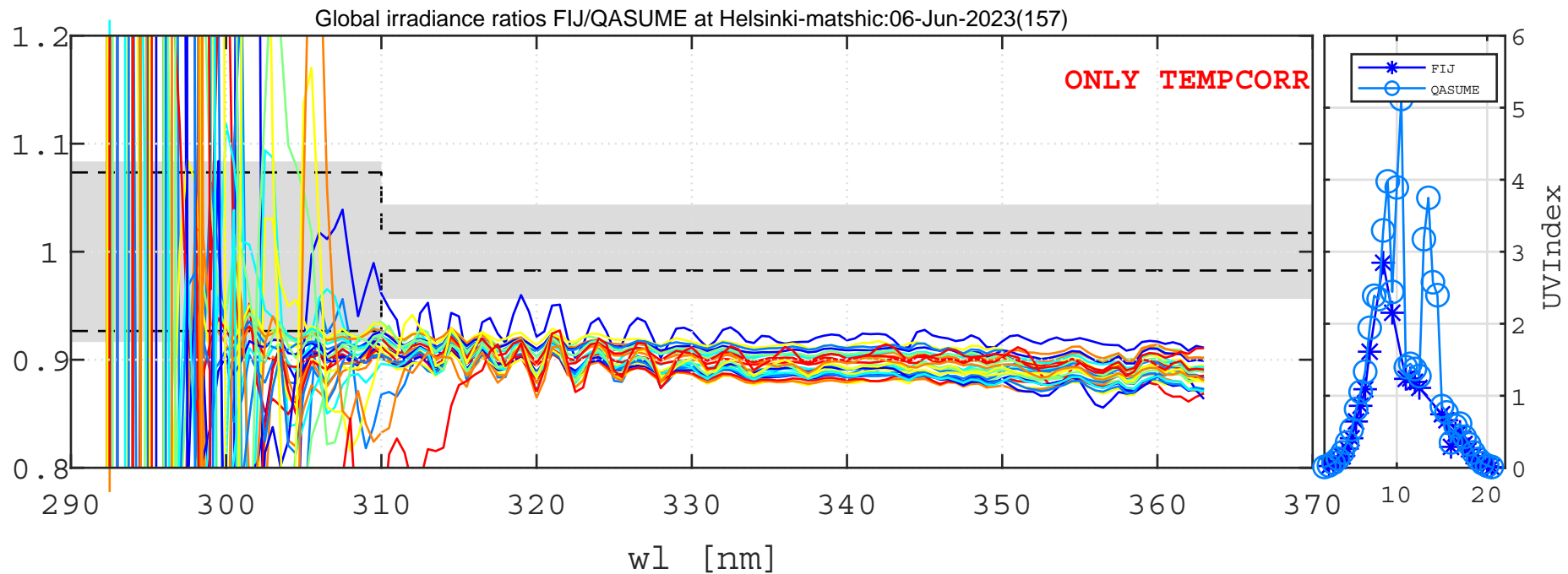
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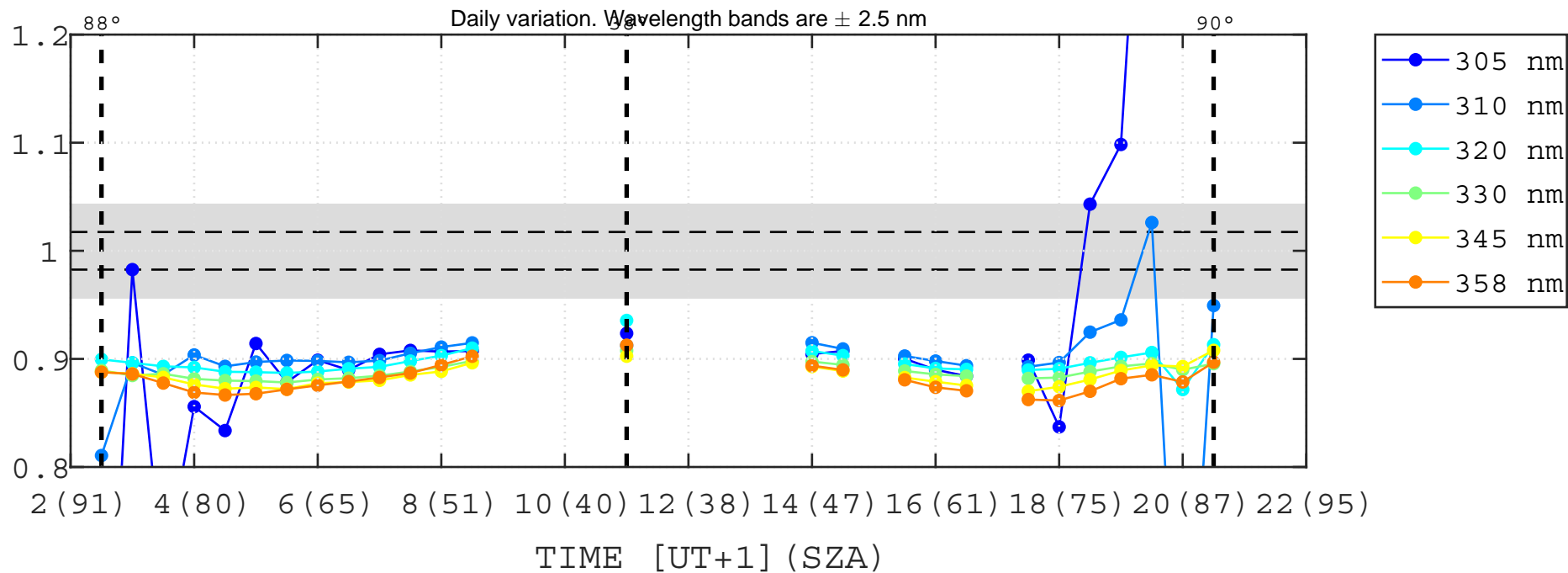
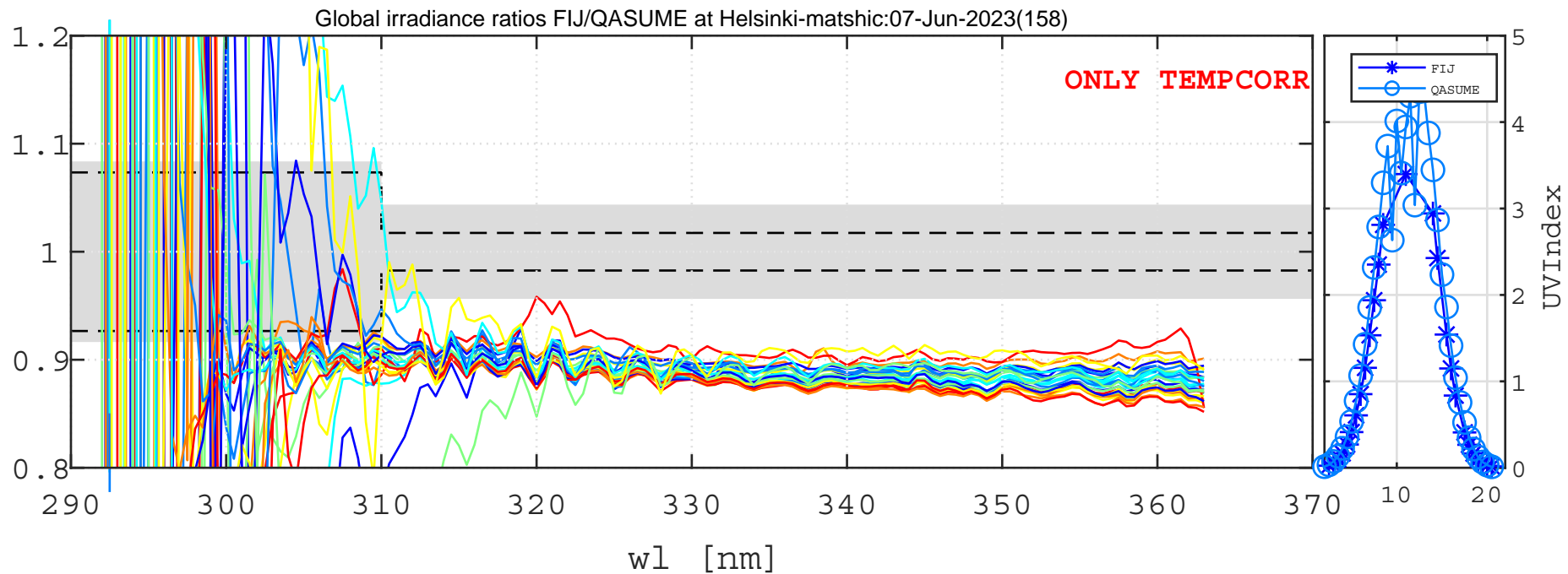


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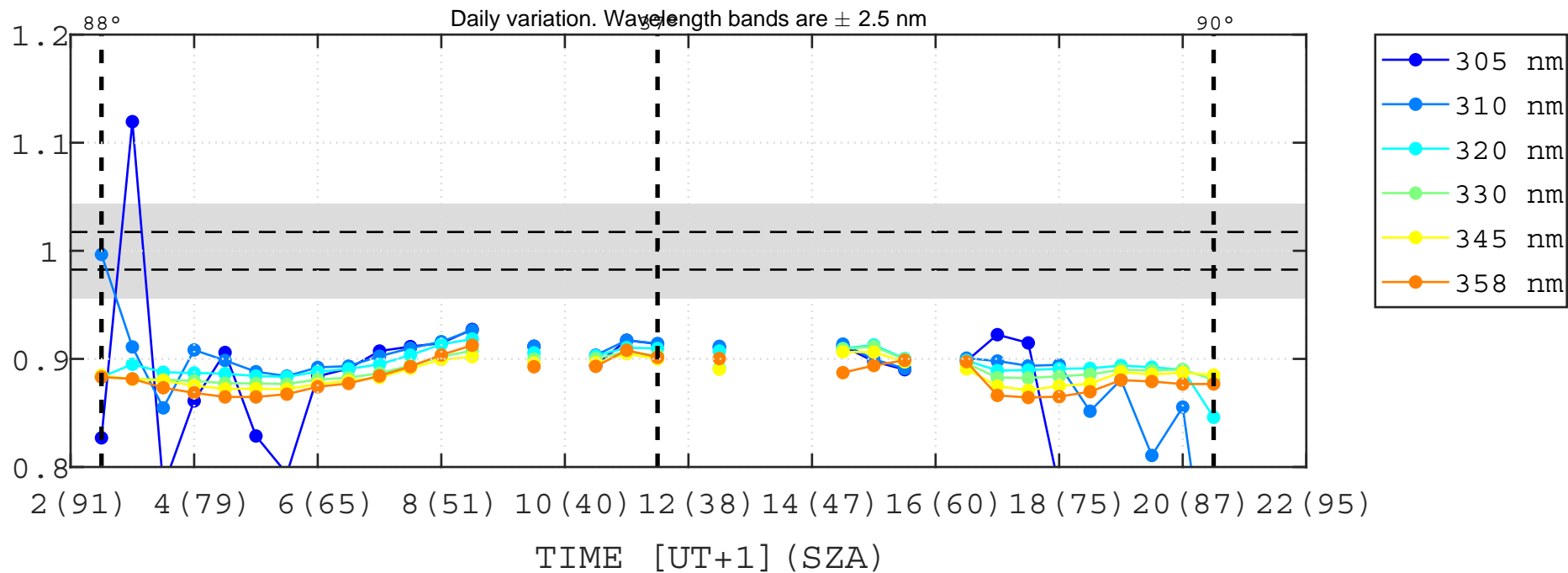
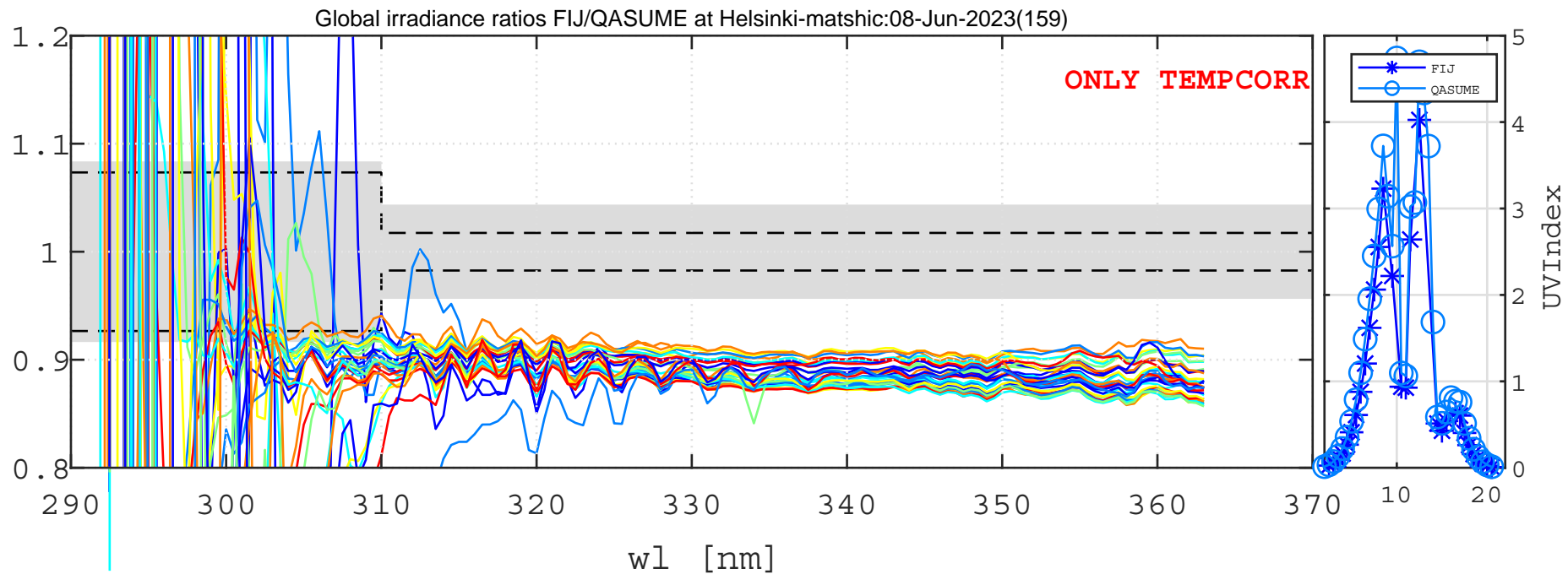


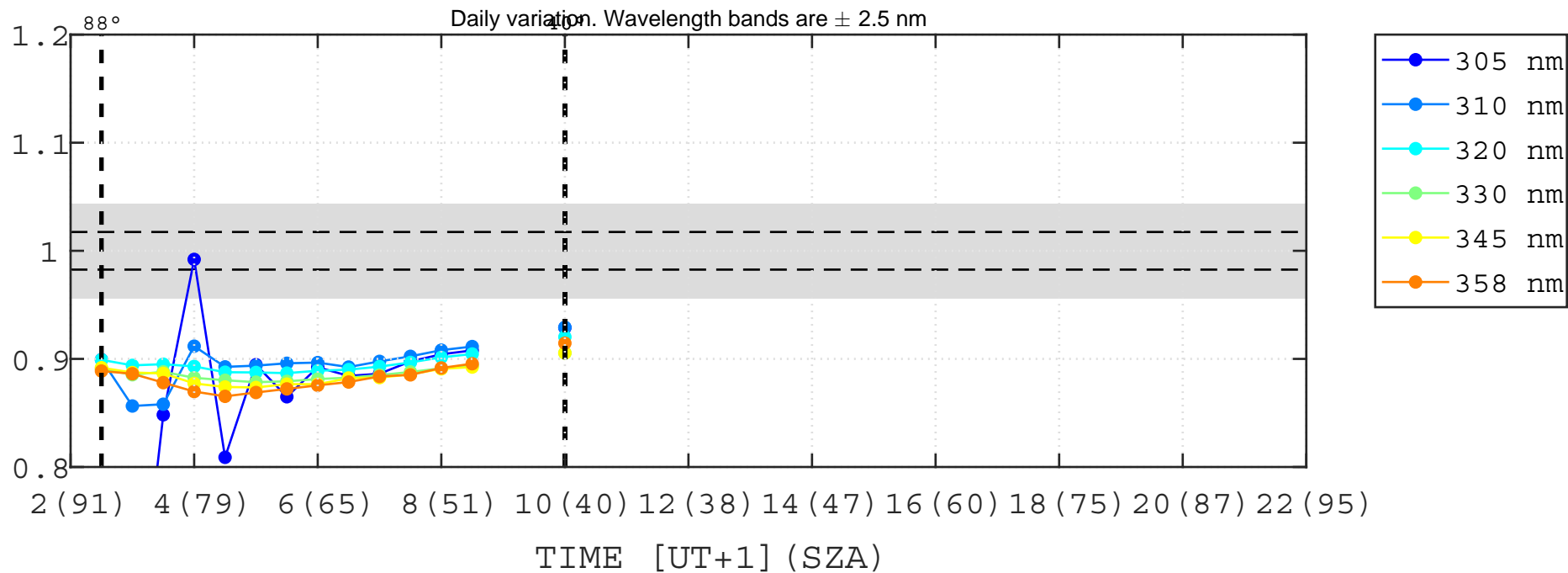
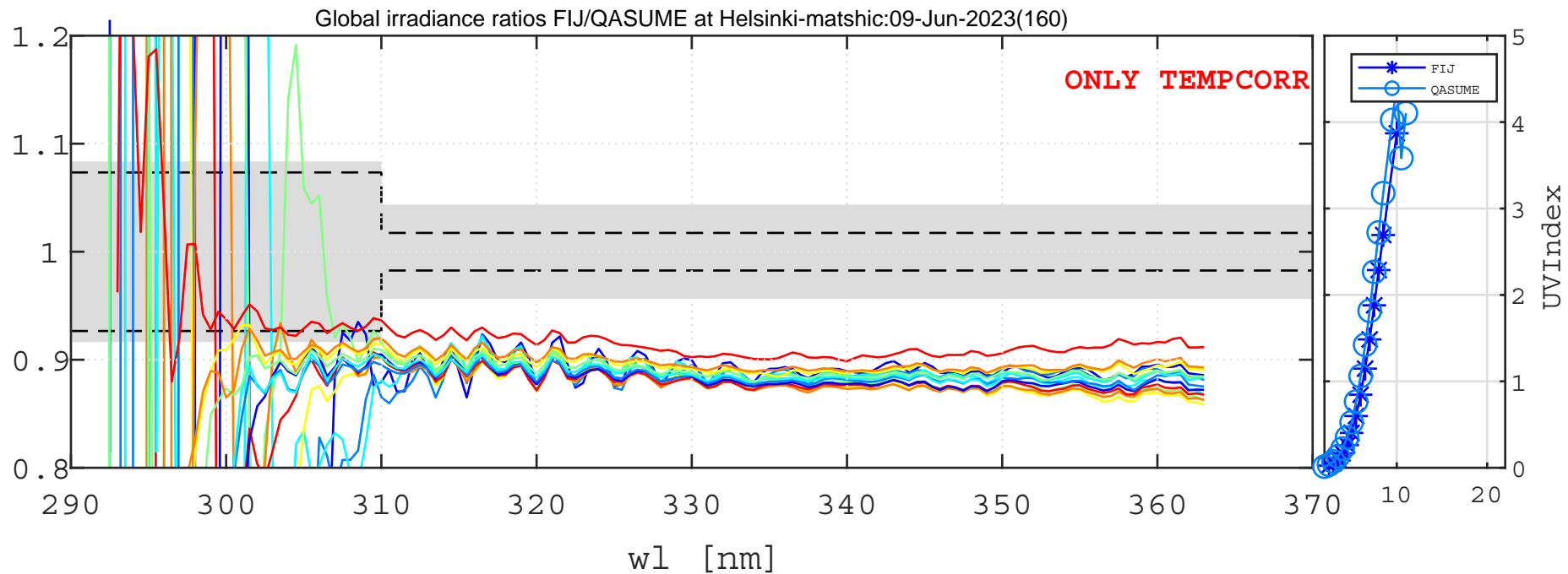




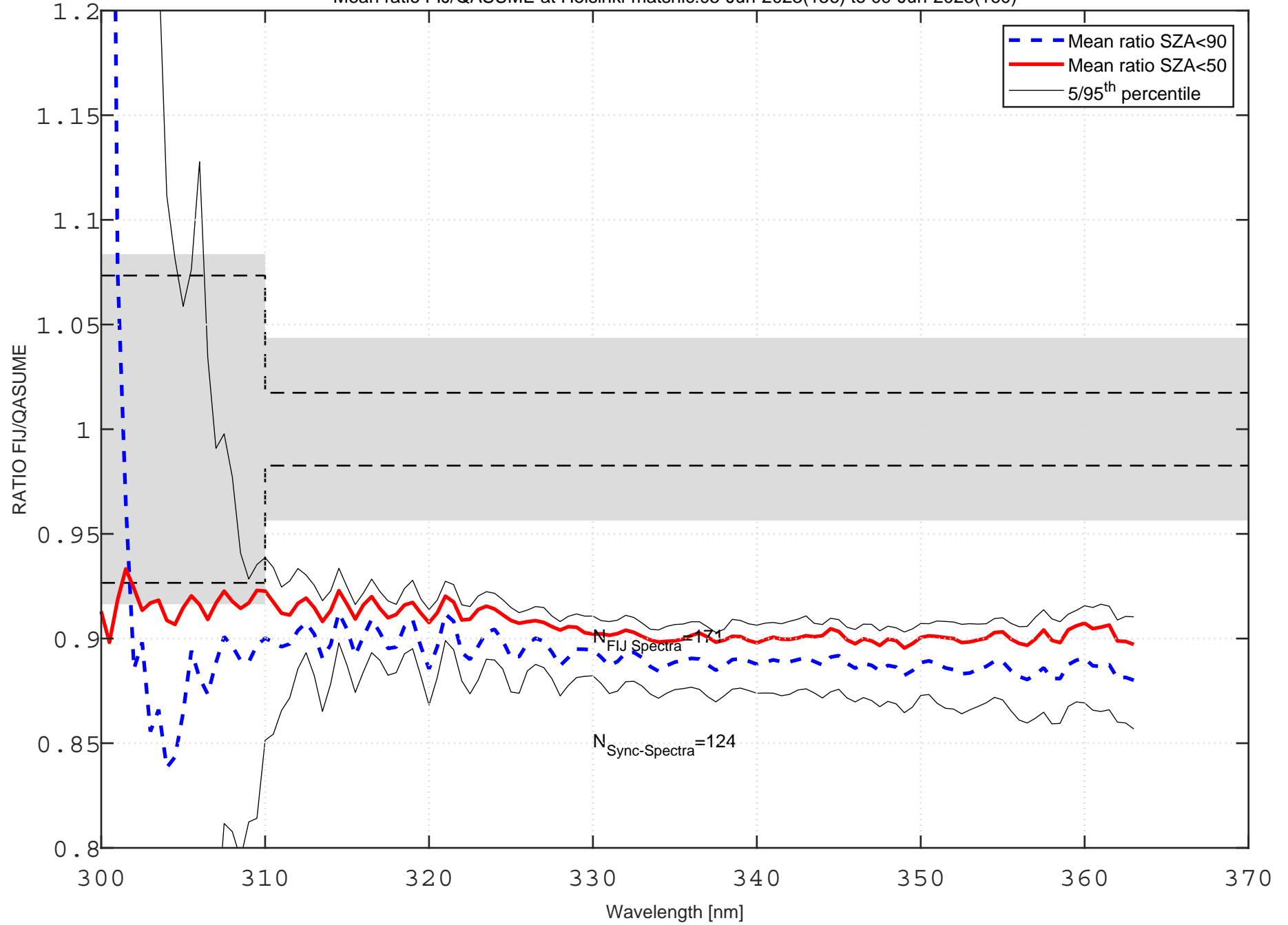


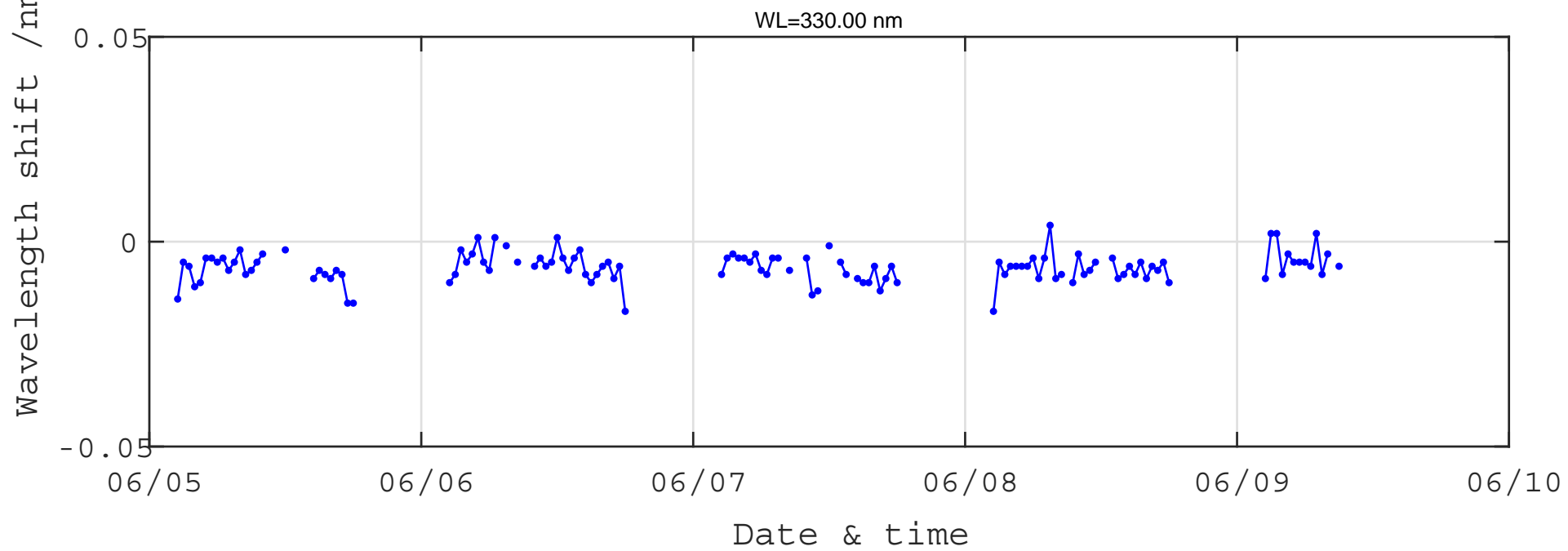
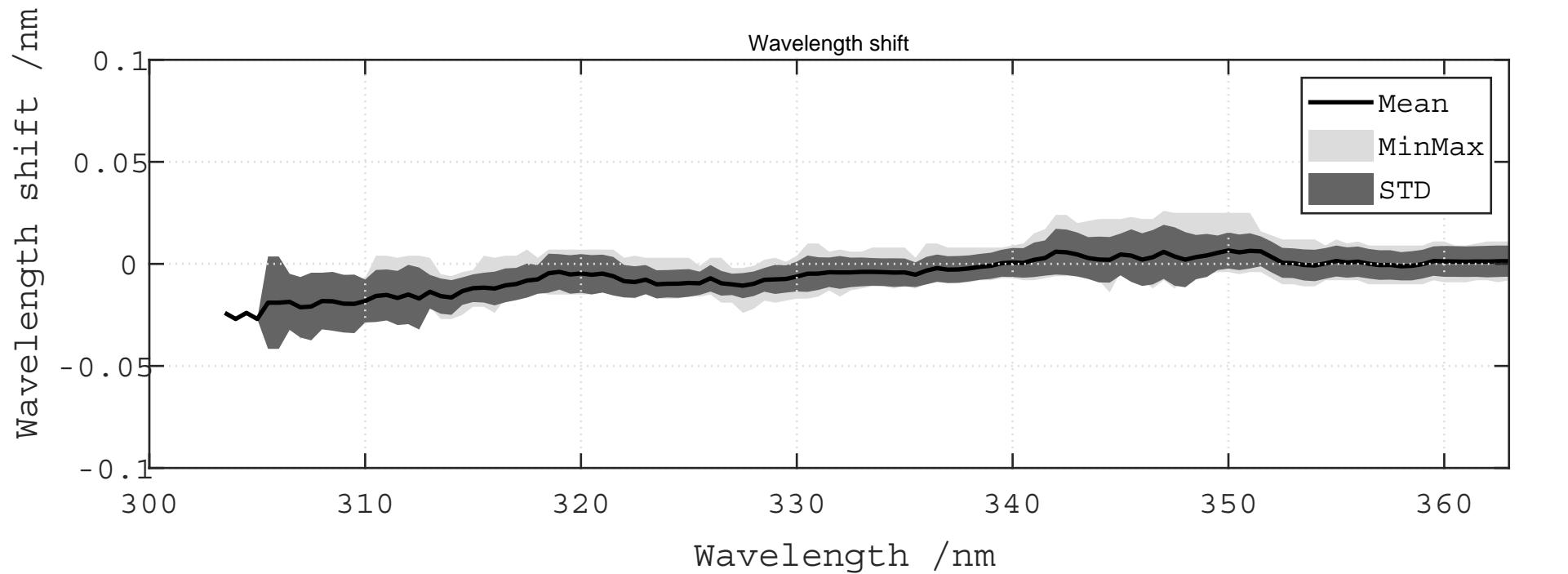




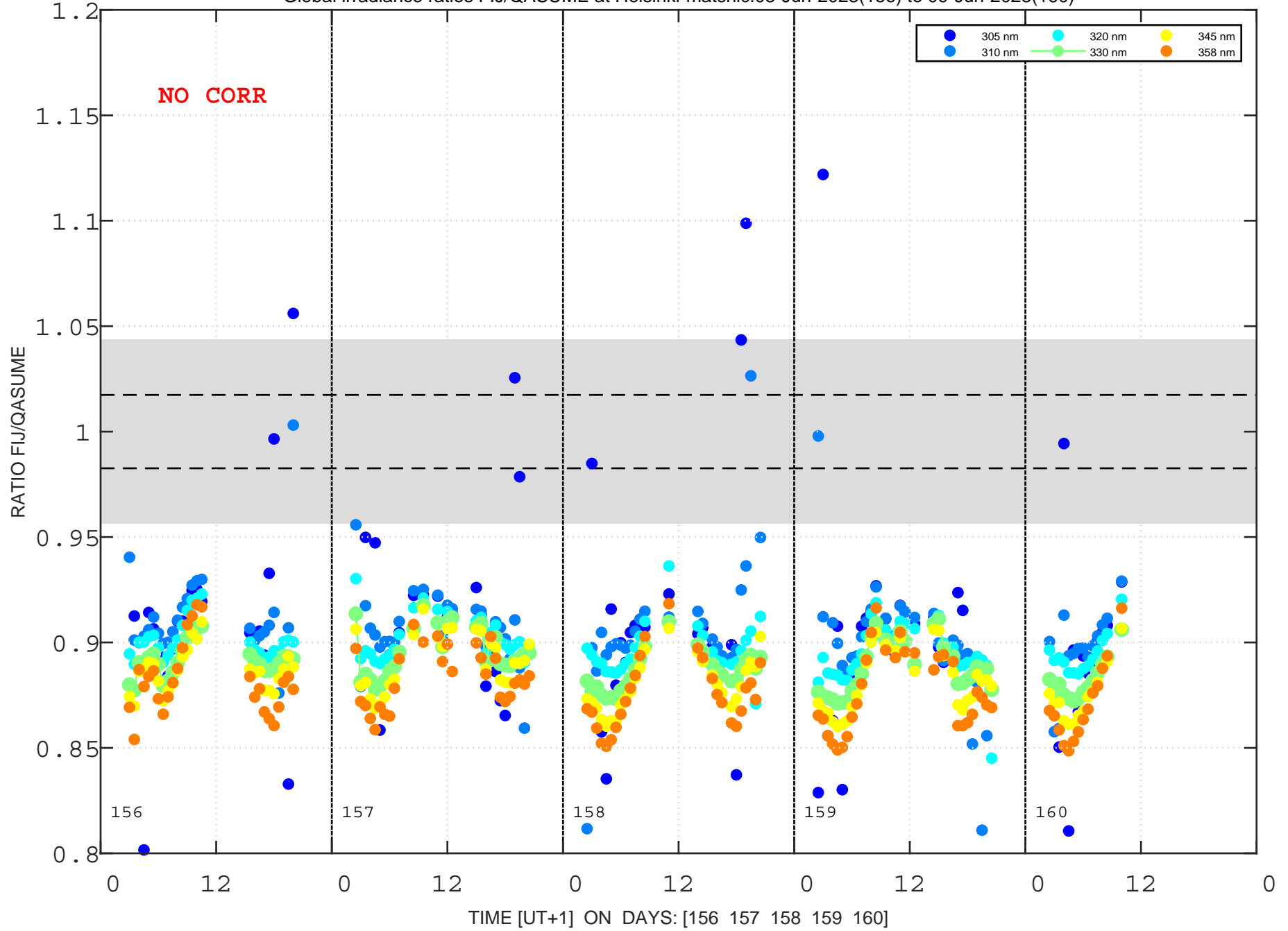


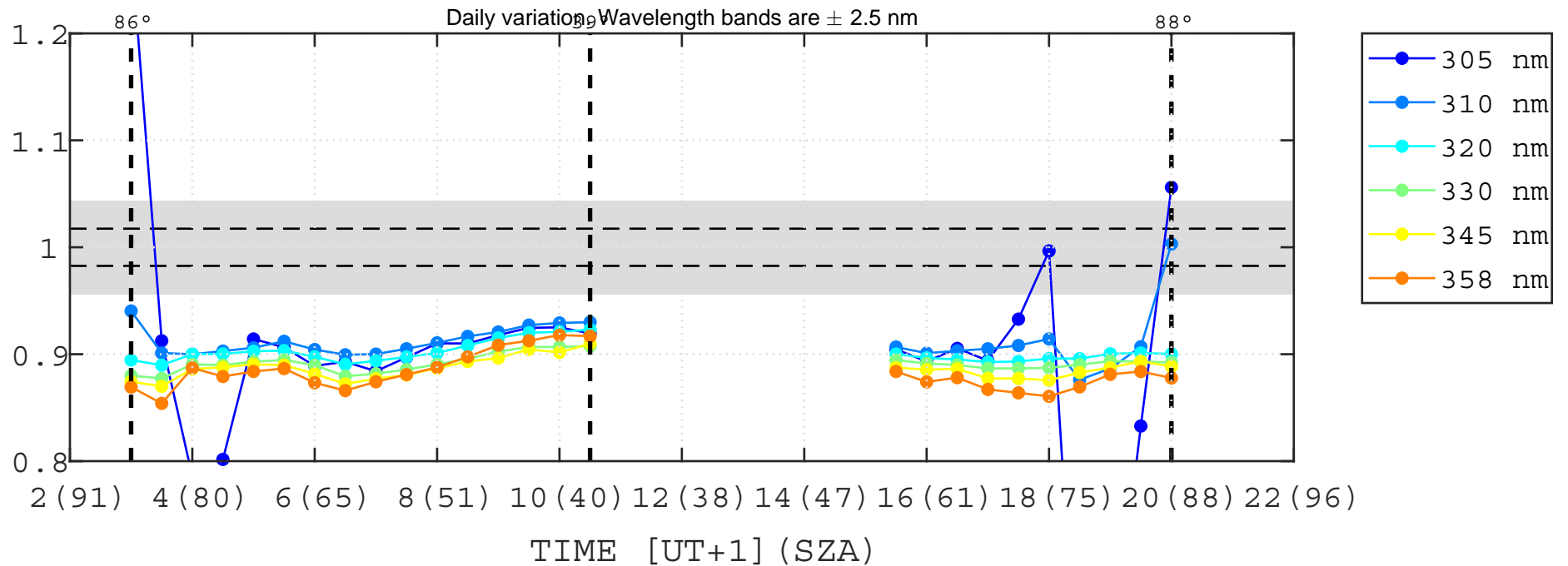
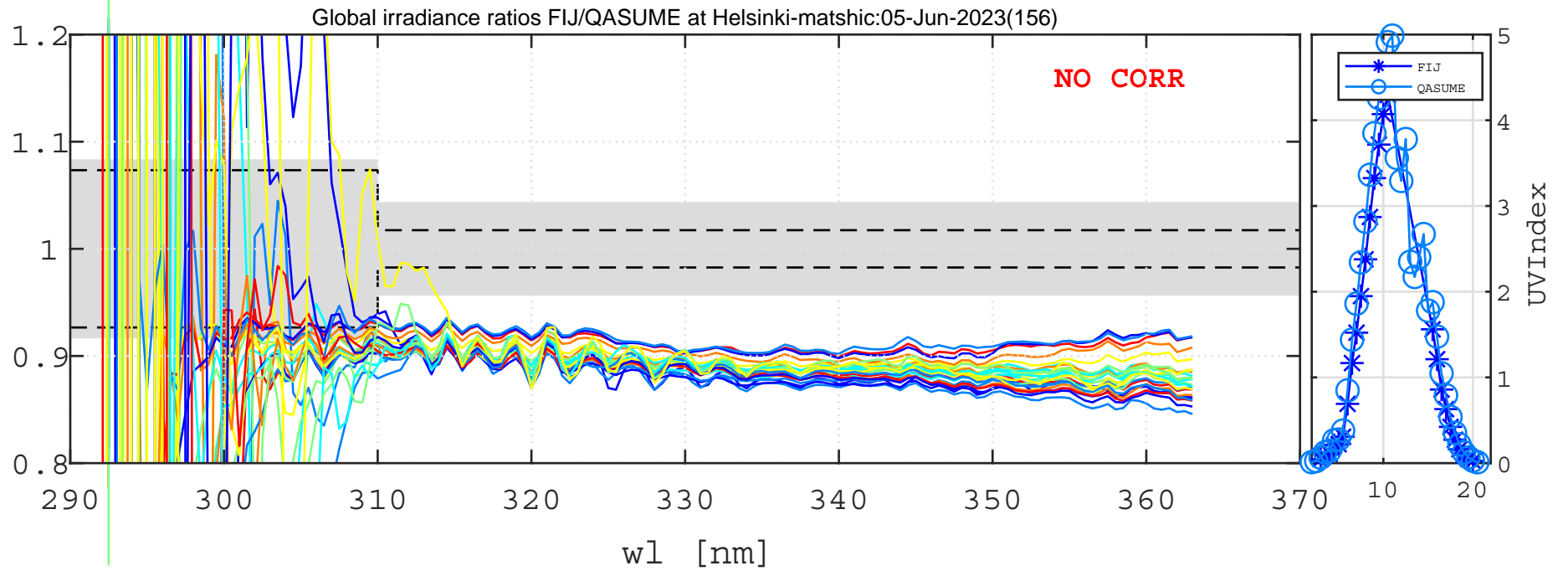
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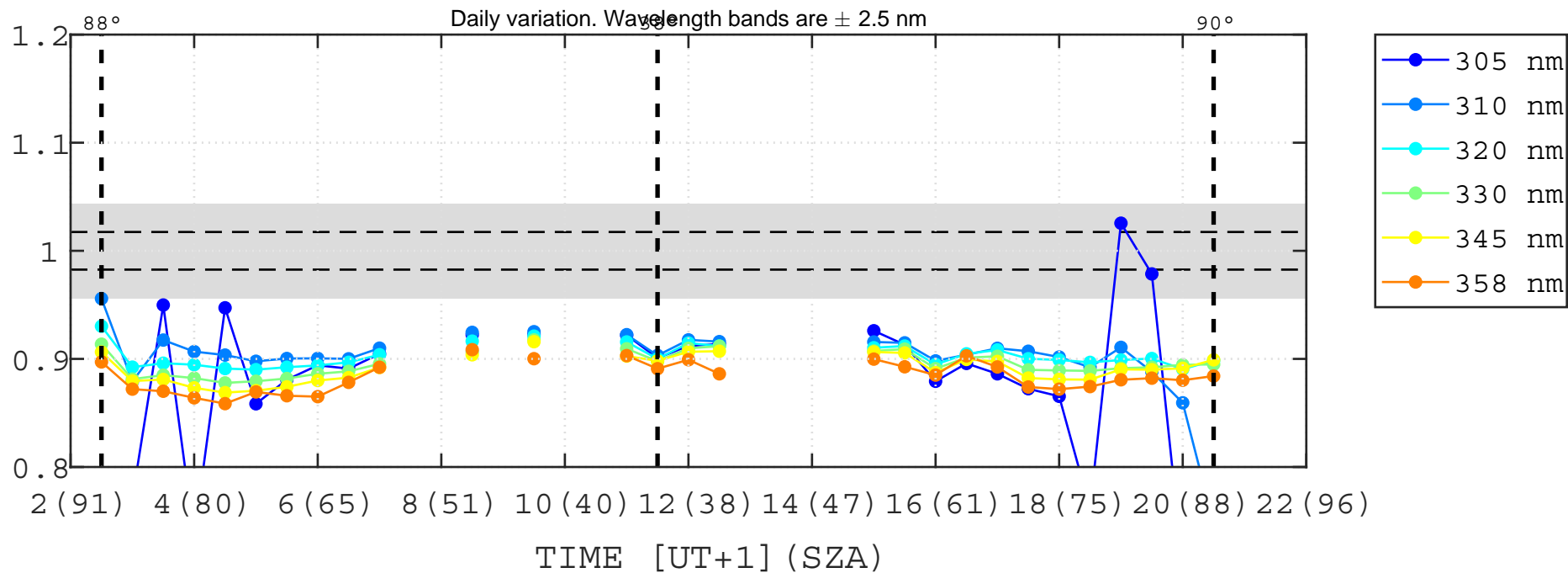
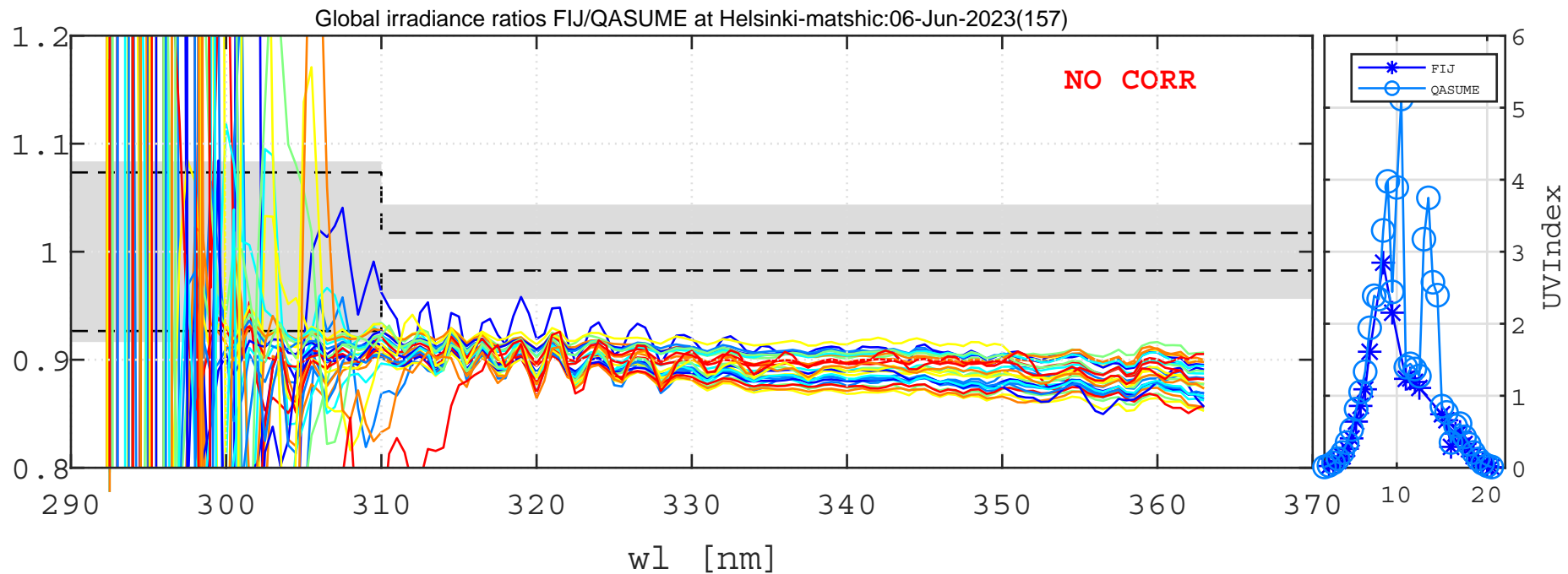


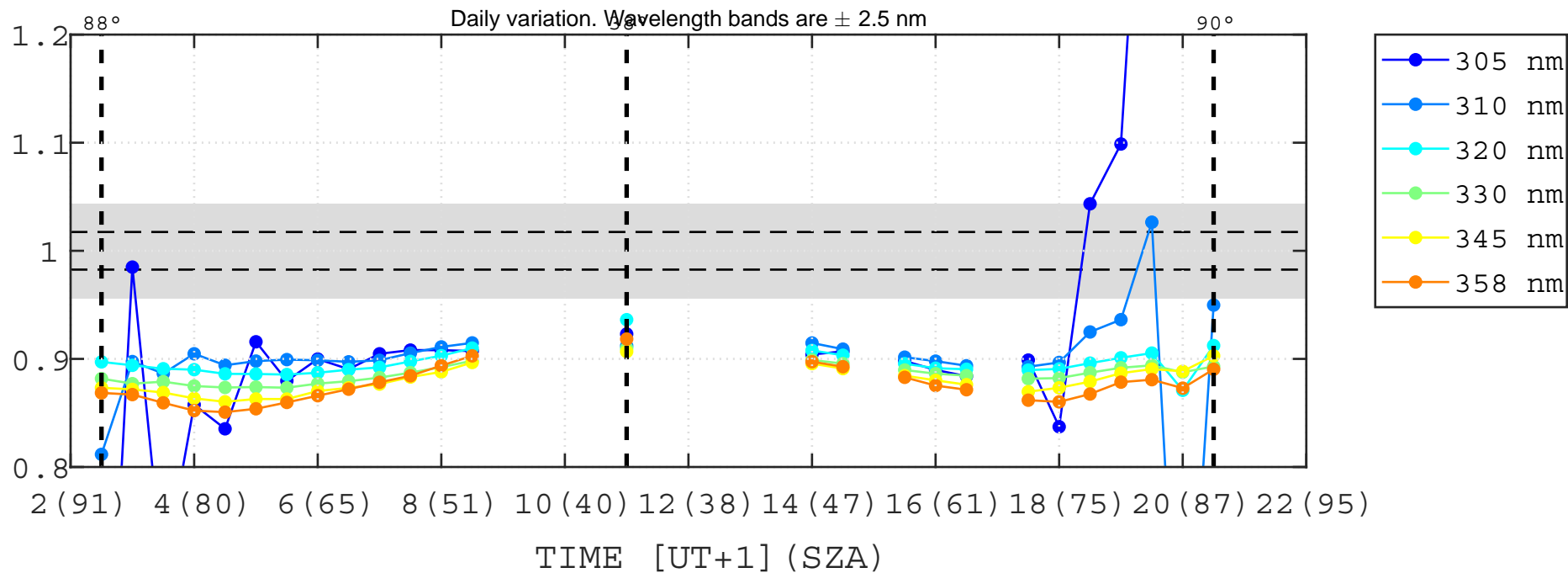
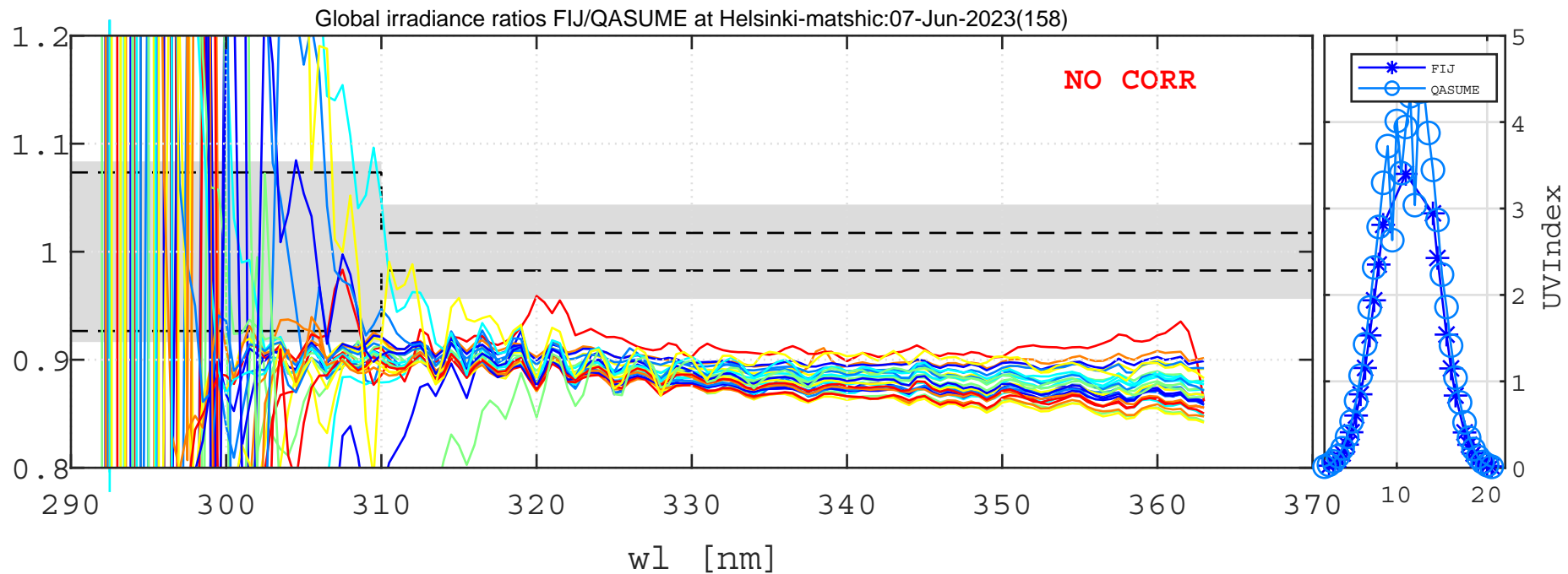


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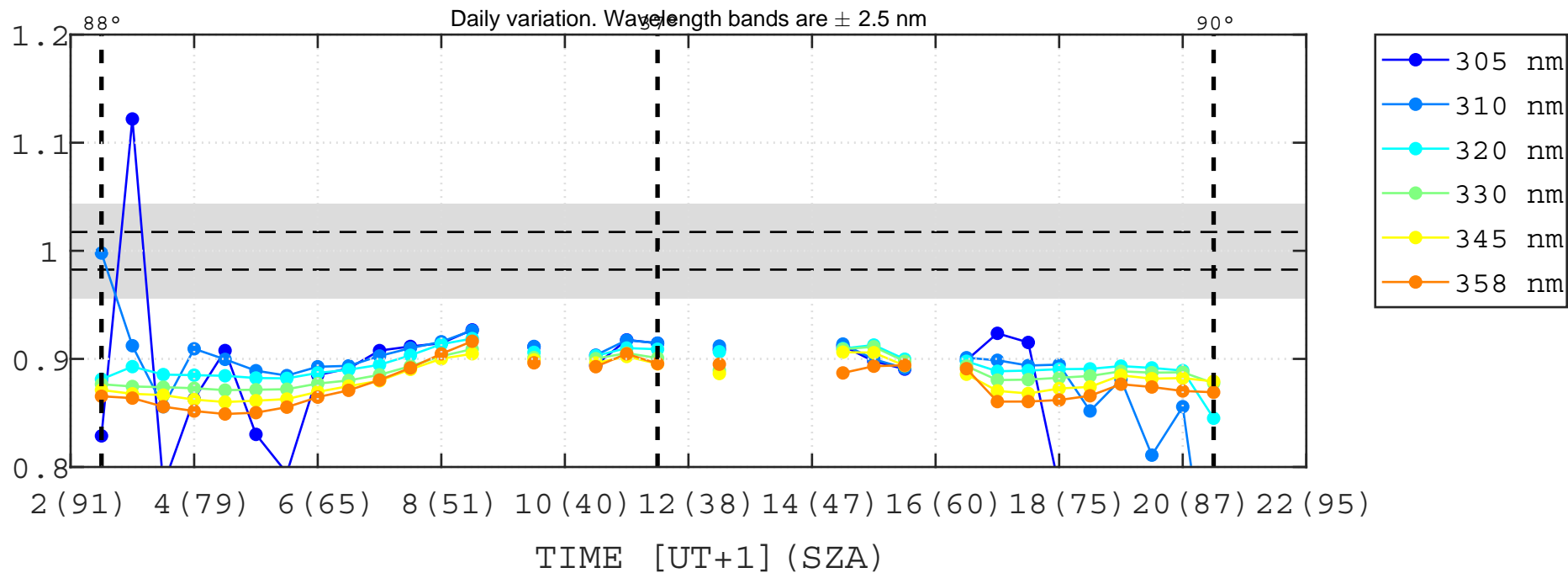
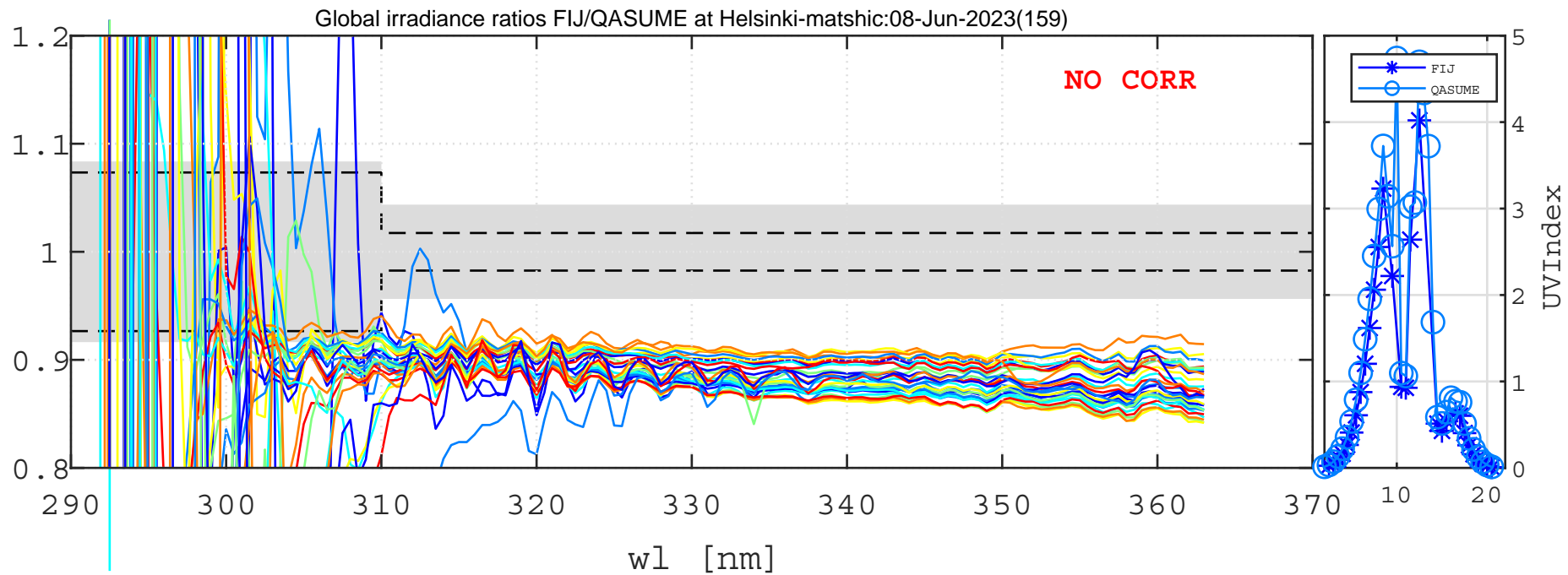


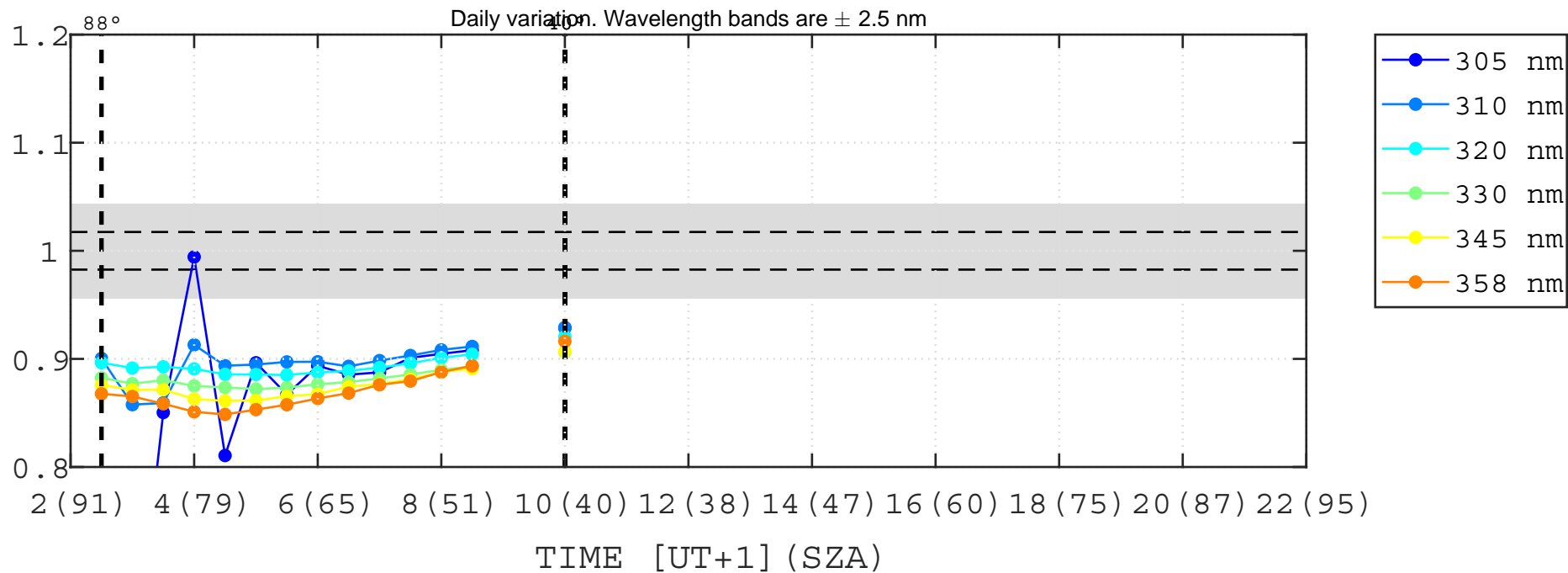
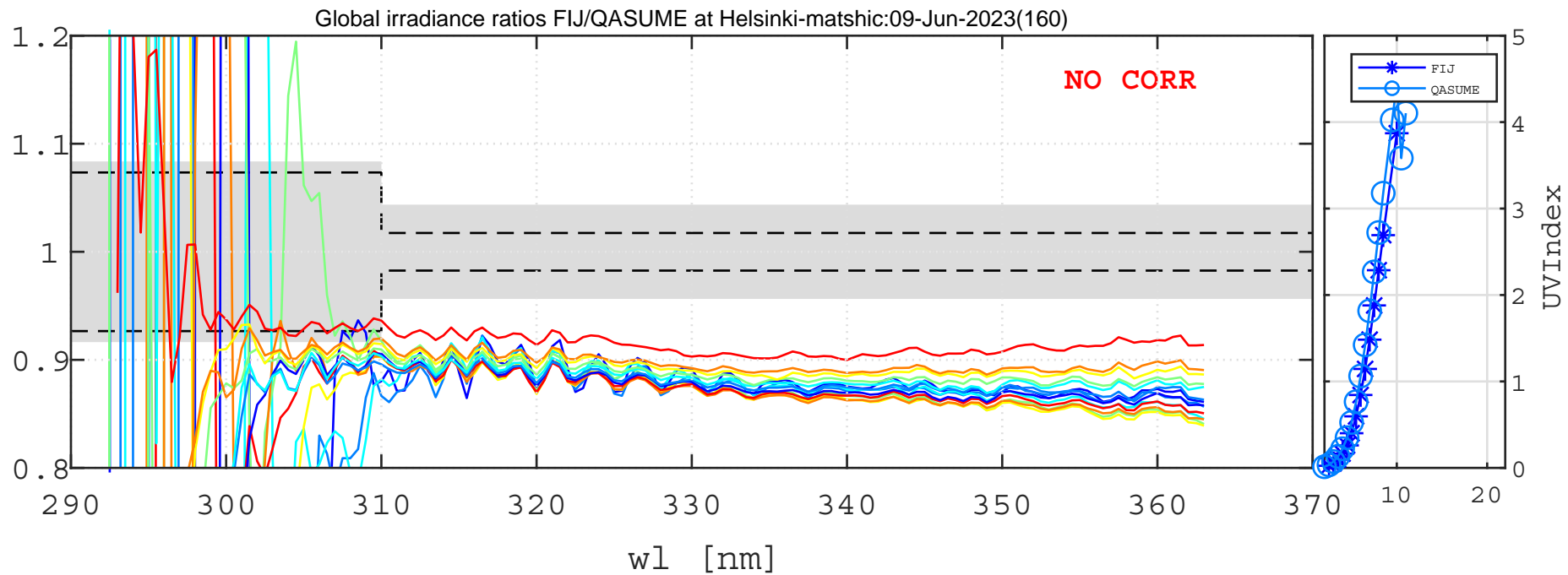




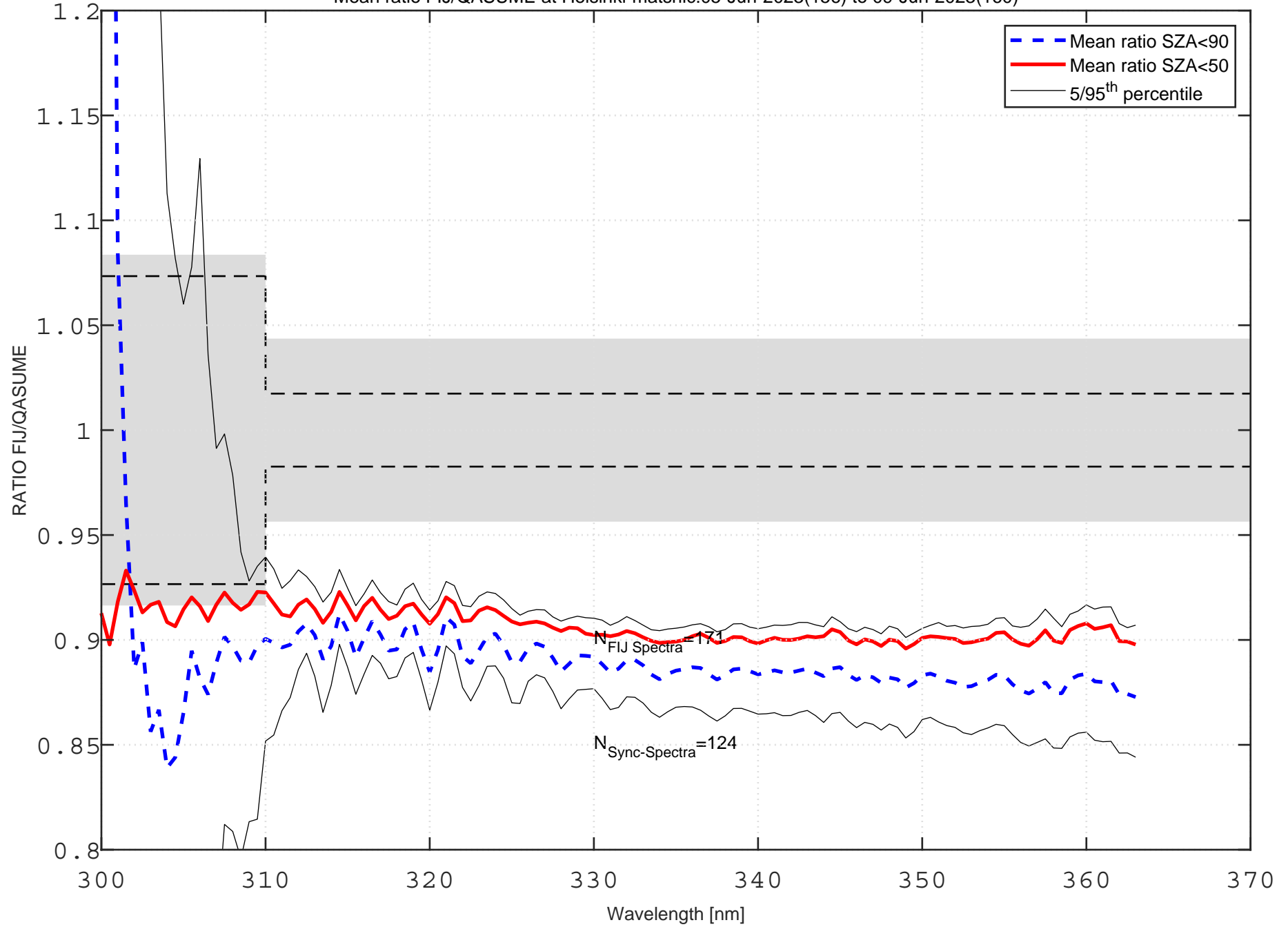


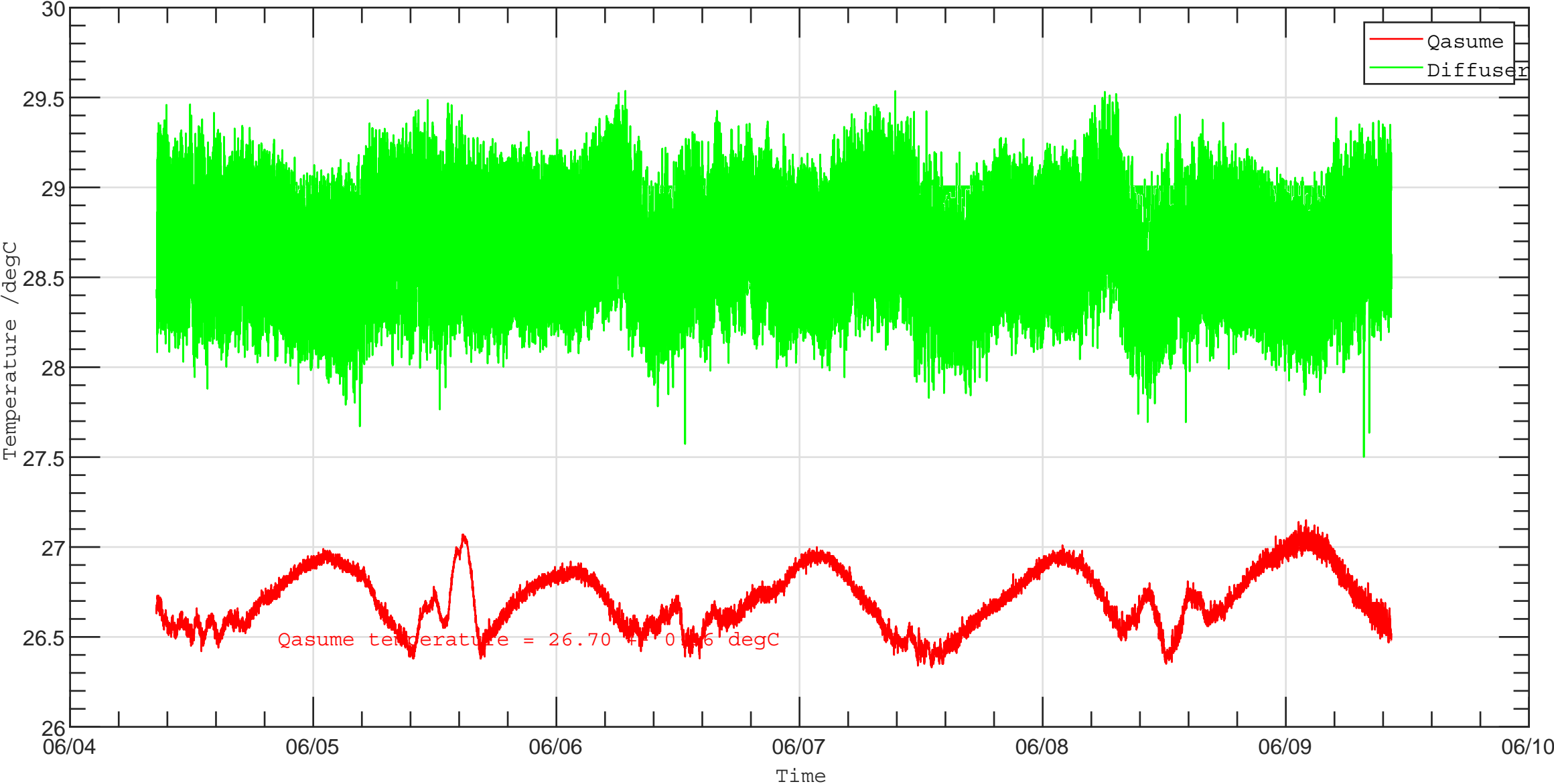






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# UVRES/SSDS for b5503

