

Protocol of the intercomparison at Jokioinen, Finland from June 15 to 20, 2007 with the travelling reference spectroradiometer QASUME from PMOD/WRC

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The purpose of the visit was the comparison of global solar irradiance measurements between the spectroradiometer (FIJ) operated by the Finnish Meteorological Institute (FMI) and the travel reference spectroradiometer QASUME[†]. The measurement site is located at Jokioinen; Latitude 60.814 N, Longitude 23.499 E and altitude 104 m.a.s.l.

The horizon of the measurement site is free down to 85° solar zenith angle (SZA). Measurements between 2:00 UT and 18:00 UT have been analysed.

QASUME arrived at Jokioinen in the morning of June 14, 2007. The spectroradiometer was installed on the same measurement platform as Brewer #107 (FIJ). The spectroradiometer in use at Jokioinen is a Brewer #107 double monochromator. The intercomparison between QASUME and the FIJ spectroradiometer lasted 5 days, from morning of June 15 to the morning of June 20.

QASUME was calibrated several times during the intercomparison period using a portable calibration system. Three lamps (T68522, 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 responsivity of the instrument based on these calibrations varied by less than 1% during the intercomparison period. The internal temperature of the QASUME spectroradiometer was 18.5 ± 0.2 °C. The entrance optic was temperature stabilised to a temperature of 26.2 ± 0.7 °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.

[†] The QASUME spectroradiometer B5503 is made available by the Physical and Chemical Exposure Unit of the Joint Research Centre of the European Commission, Ispra, Italy through a collaboration agreement with PMOD/WRC.

Protocol:

The measurement protocol was to measure one solar irradiance spectrum every 30 minutes from 290 to 365 nm, every 0.5 nm, and 3 seconds between each wavelength increment.

June 14 (165) Thursday:

QASUME was installed on the measurement site at 9:00 UT. Only test measurements were performed during this day.

June 15 (166) Friday:

Synchronised measurements are available from 1:00 to 20:00 UT. Weather conditions: Rain over night, and in the morning until 4:30 UT. Remaining day was mix of sun and clouds SC. After 17:00 clear sky. QASUME was calibrated at 8:30 UT.

June 16 (167) Saturday:

Synchronised scans are available from 1:00 to 20:00 UT. Clear sky with Ci 1/10 Cu 1/10 in the afternoon. QASUME was calibrated at 2:42, 7:42, and 12:42 UT.

June 17 (168) Sunday:

Synchronised scans are available from 1:00 to 20:00 UT. Weather conditions: Cirrostratus until 10:00 UT, sun partially covered, then change to AS sun fully covered for the rest of the day. Some raindrops around 16:30 UT.

June 18 (169) Monday:

Synchronised scans are available from 1:00 to 20:00 UT. The weather conditions were Altostratus 8/10 to 10/10 with sun fully covered until about 13:30 UT. Then, mix of sun and clouds (AC), and CS. QASUME was calibrated at 7:41 UT.

June 19 (170) Tuesday:

Synchronised scans are available from 1:00 to 20:00 UT. The weather conditions were cloudy without sun and a few occasional rain drops. Thus the scan at 1:30, 2:00, 5:30 and 6:30 UT are affected by rain drops. QASUME was calibrated at 12:41 UT.

June 20 (171) Tuesday:

Laboratory: Measurements of Lamp D01 and D14 of FMI. QASUME was calibrated using T68522, T68523

End of the campaign at 9:30 UT.

Results:

In total 181 synchronised simultaneous spectra from QASUME and FIS are available from the measurement period. Measurements between 1:00 and 20:00 UT has been analysed (SZA smaller than 90°).

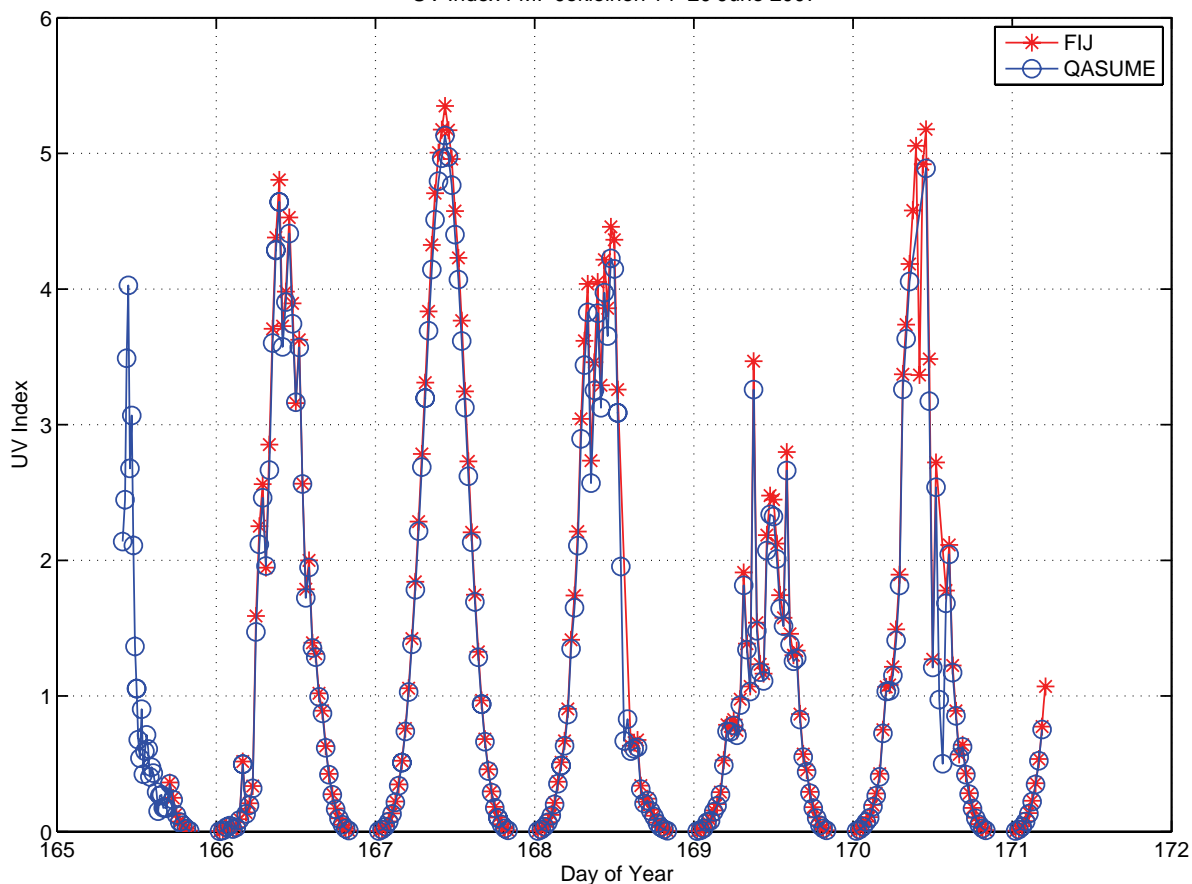
Remarks:

1. The spectral ratios between FIJ and QASUME have on average an offset of +4 to +5 %.
2. For all solar scans the wavelength shifts of the FIS are below ± 60 pm.
3. The scans on 19 June at 11:00 and 11:30 UT were excluded from the analysis because of the large discrepancy to QASUME.
4. The average spectral ratio between FIJ and QASUME is on average +3 % when the lamp differences are taken into account.
5. The remaining differences between FIJ and QASUME are partly due to the angular response errors of either instrument (no corrections are applied to the QASUME instrument). The diffuse cosine error of QASUME is 0.985 ± 0.02 , i.e. measurements of diffuse irradiance by the QASUME spectroradiometer could be increased by up to 1.5%, thereby reducing the observed differences between FIJ and QASUME. The diurnal variability of about 3 % on June 16 (clear sky day), might be in part due to the uncorrected angular response of QASUME. Cosine corrected QASUME measurements of June 16 assuming a Rayleigh atmosphere are shown in the corresponding figure, which show significantly reduced diurnal variability, especially around 70 deg where the angular response error is the most important.

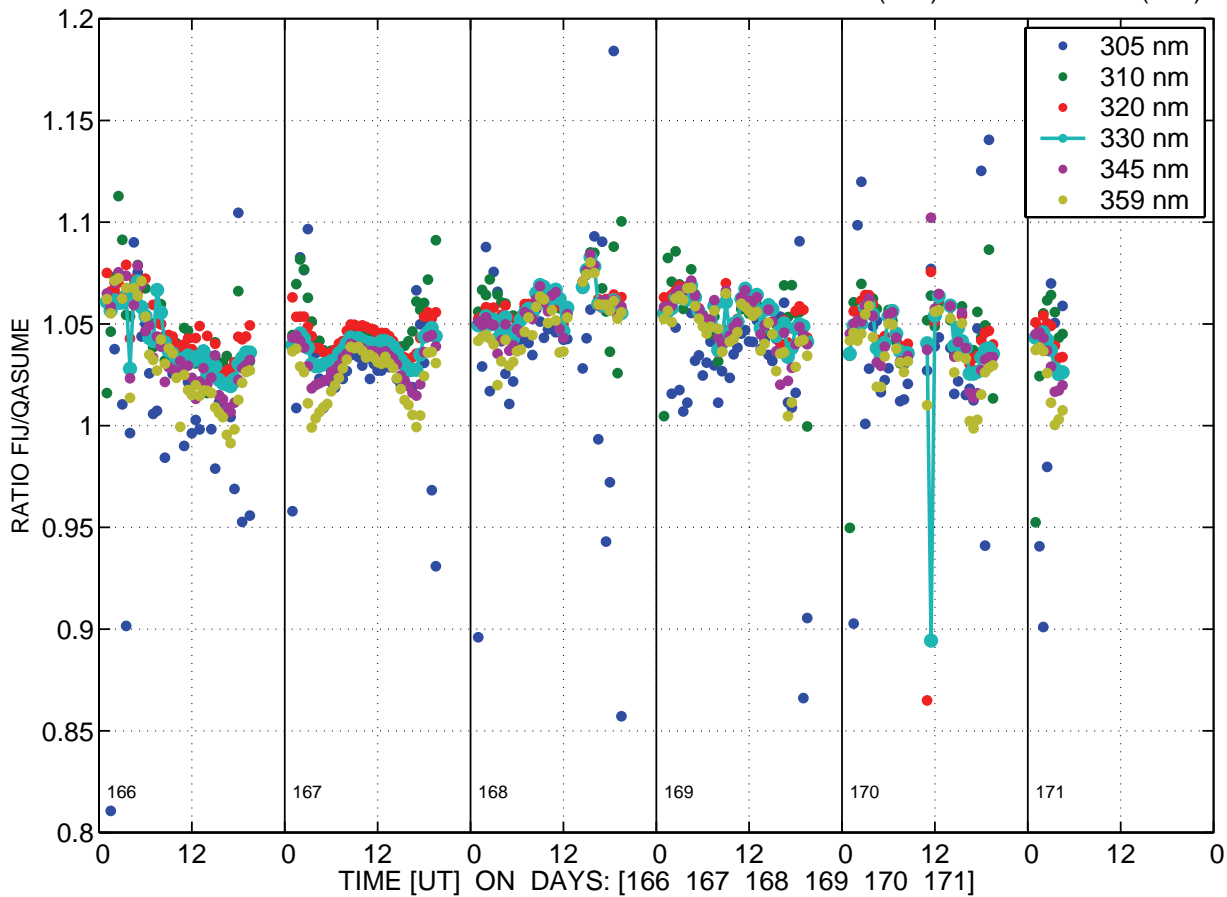
Lamp measurements of D01 and D14:

1. Straylight in LAB (with and without Baffles) is 0.5 % (see figure).
2. Ratio RES_D14 / RES_T68522 is 0.98 (up to 340 nm), then increasing to 0.986 (365 nm). This means that QASUME solar measurements with RES_D14 would be higher by about 2 %. This further means that ratio FIJ / QASUME would decrease by 2 %, but only by 1.4 % at high wavelengths.
3. Ratio D1 / D14 is same for FMI and QASUME measurement (see figure).

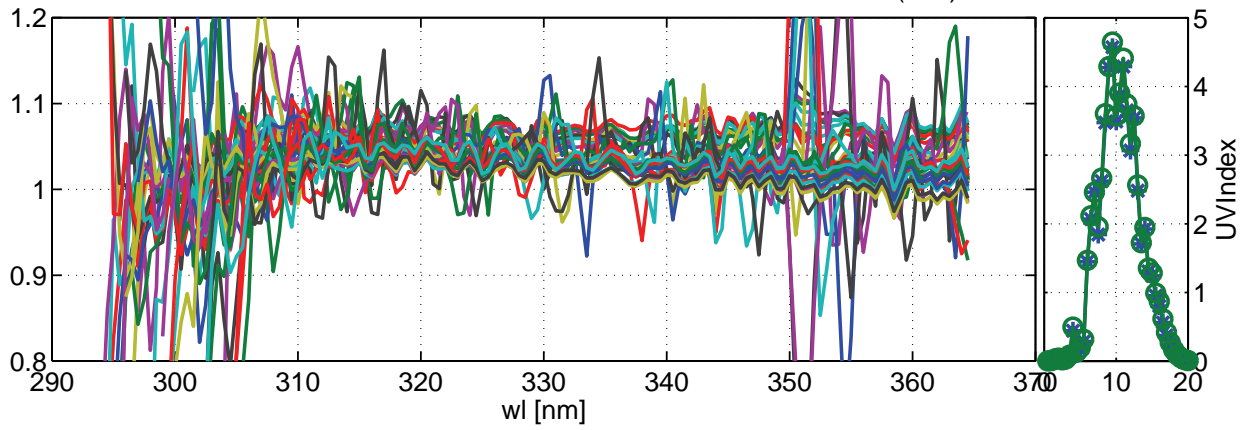
UV Index FMI-Jokioinen 14–20 June 2007



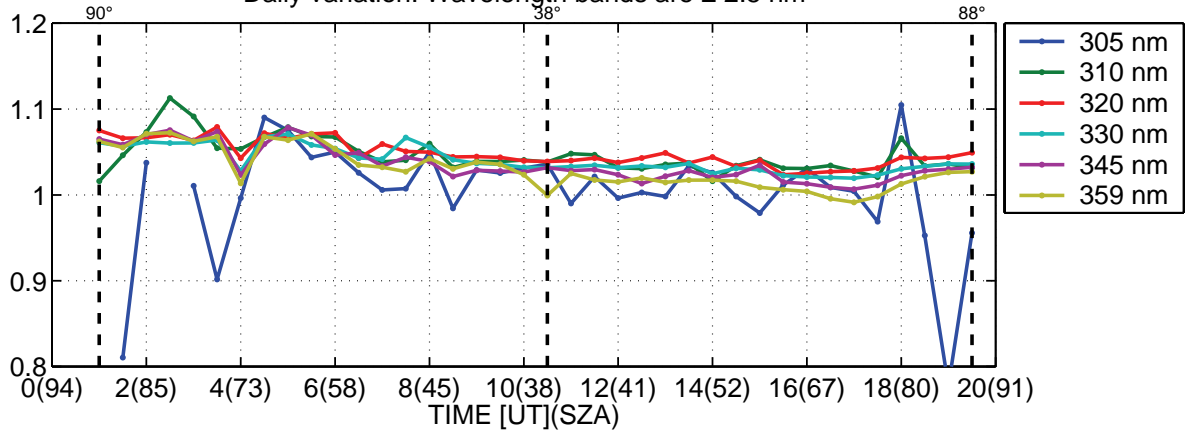
Global irradiance ratios FIJ/QASUME at Jokioinen:15–Jun–2007(166) to 20–Jun–2007(171)



Global irradiance ratios FIJ/QASUME at Jokioinen:15-Jun-2007(166)

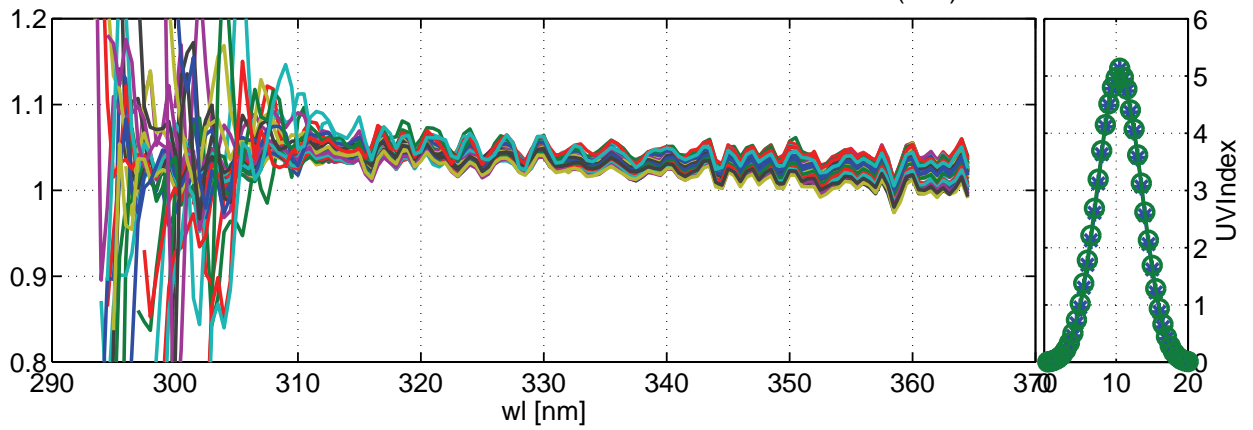


Daily variation. Wavelength bands are ± 2.5 nm

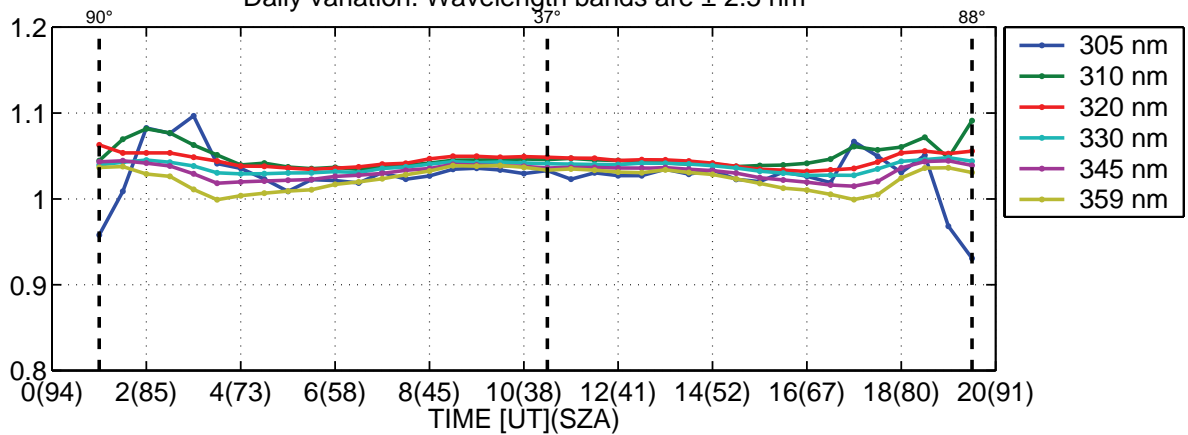


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Global irradiance ratios FIJ/QASUME at Jokioinen:16-Jun-2007(167)

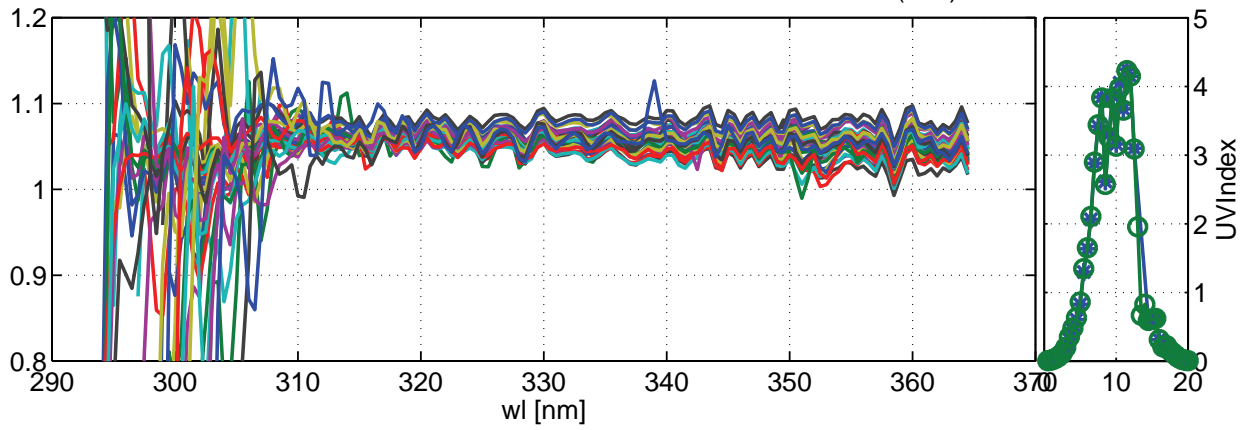


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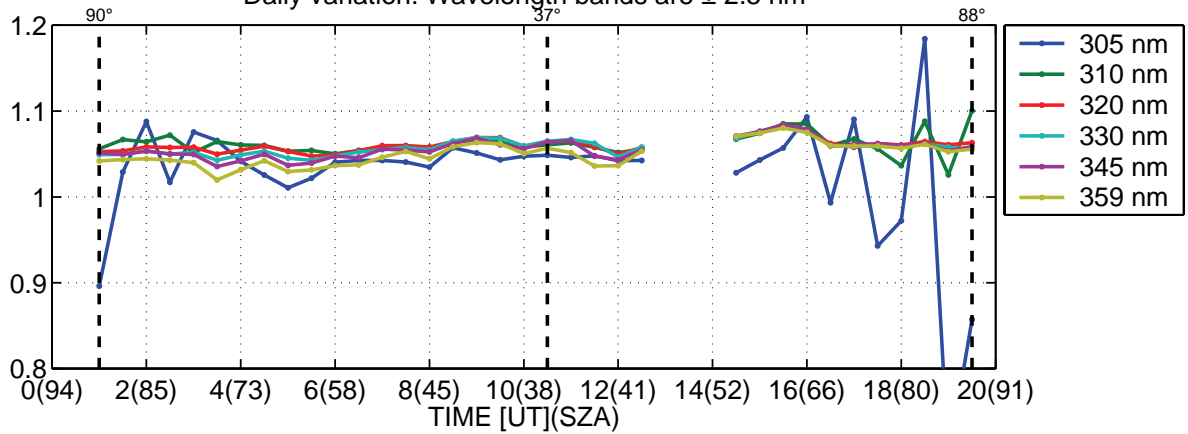


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Global irradiance ratios FIJ/QASUME at Jokioinen:17-Jun-2007(168)

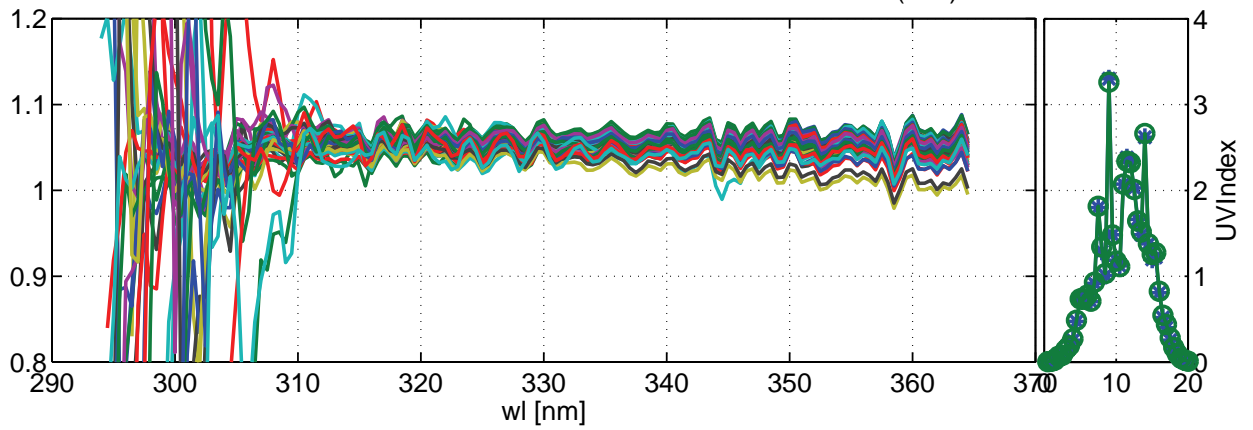


Daily variation. Wavelength bands are ± 2.5 nm

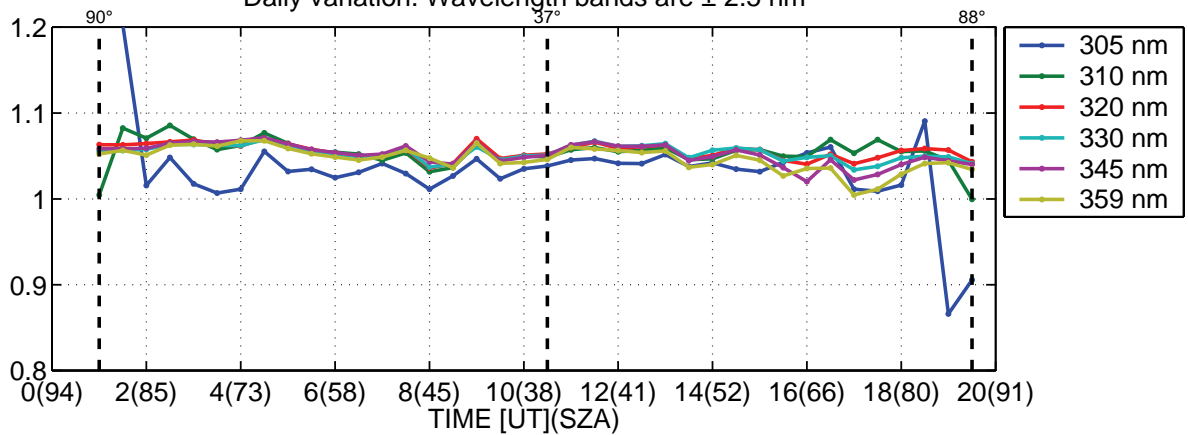


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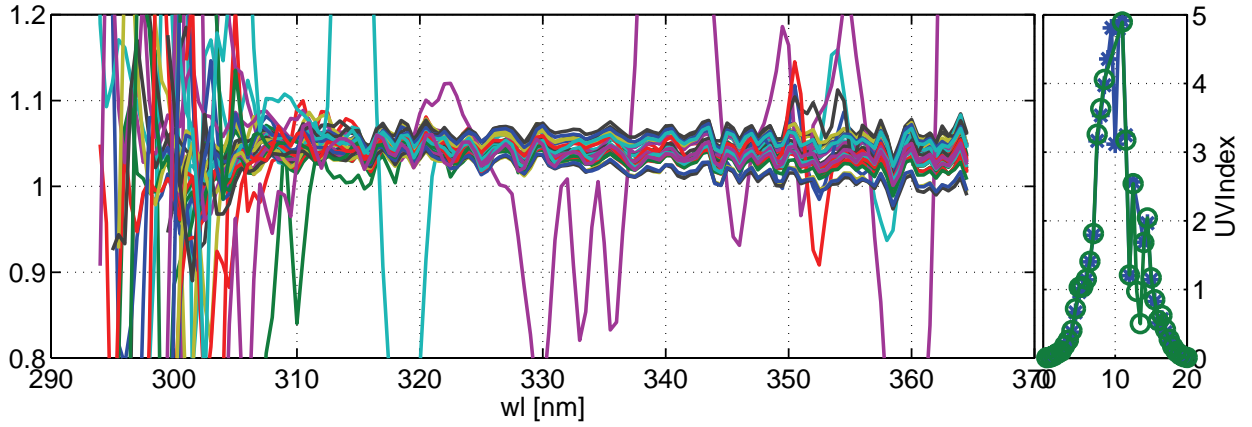


Daily variation. Wavelength bands are ± 2.5 nm

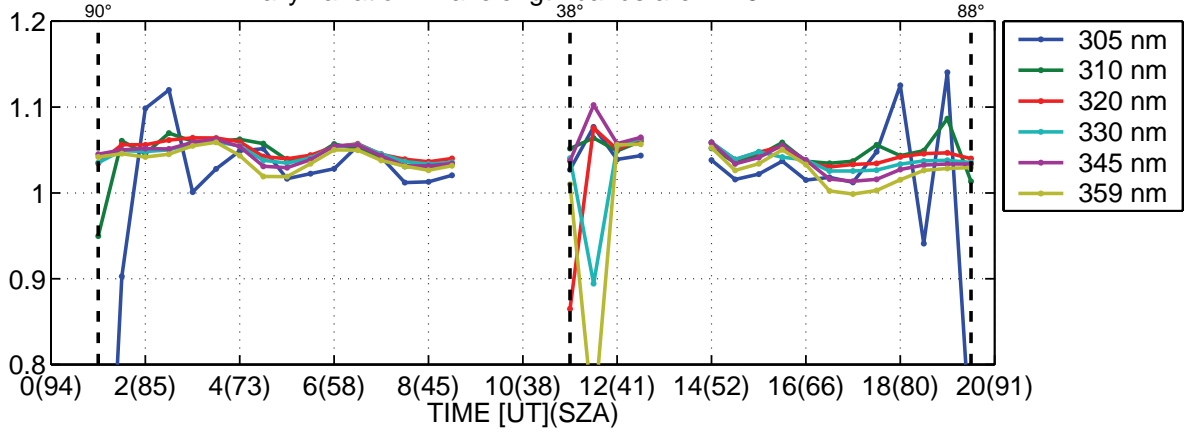


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Global irradiance ratios FIJ/QASUME at Jokioinen:19-Jun-2007(170)

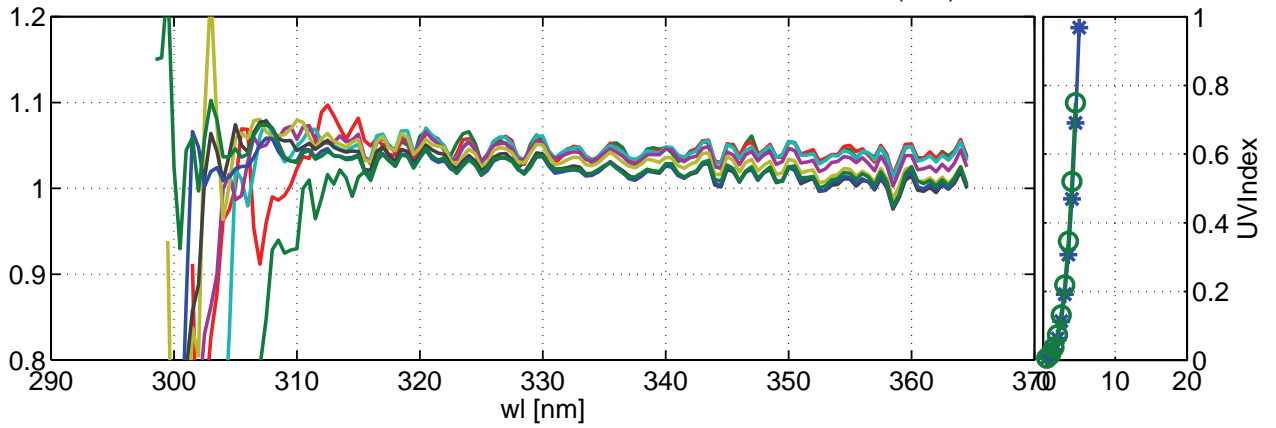


Daily variation. Wavelength bands are ± 2.5 nm

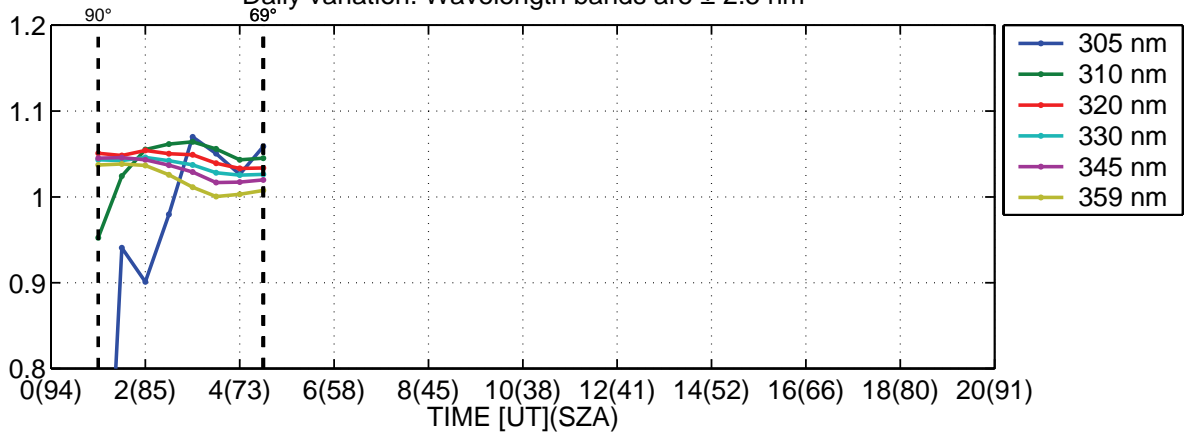


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Global irradiance ratios FIJ/QASUME at Jokioinen:20-Jun-2007(171)

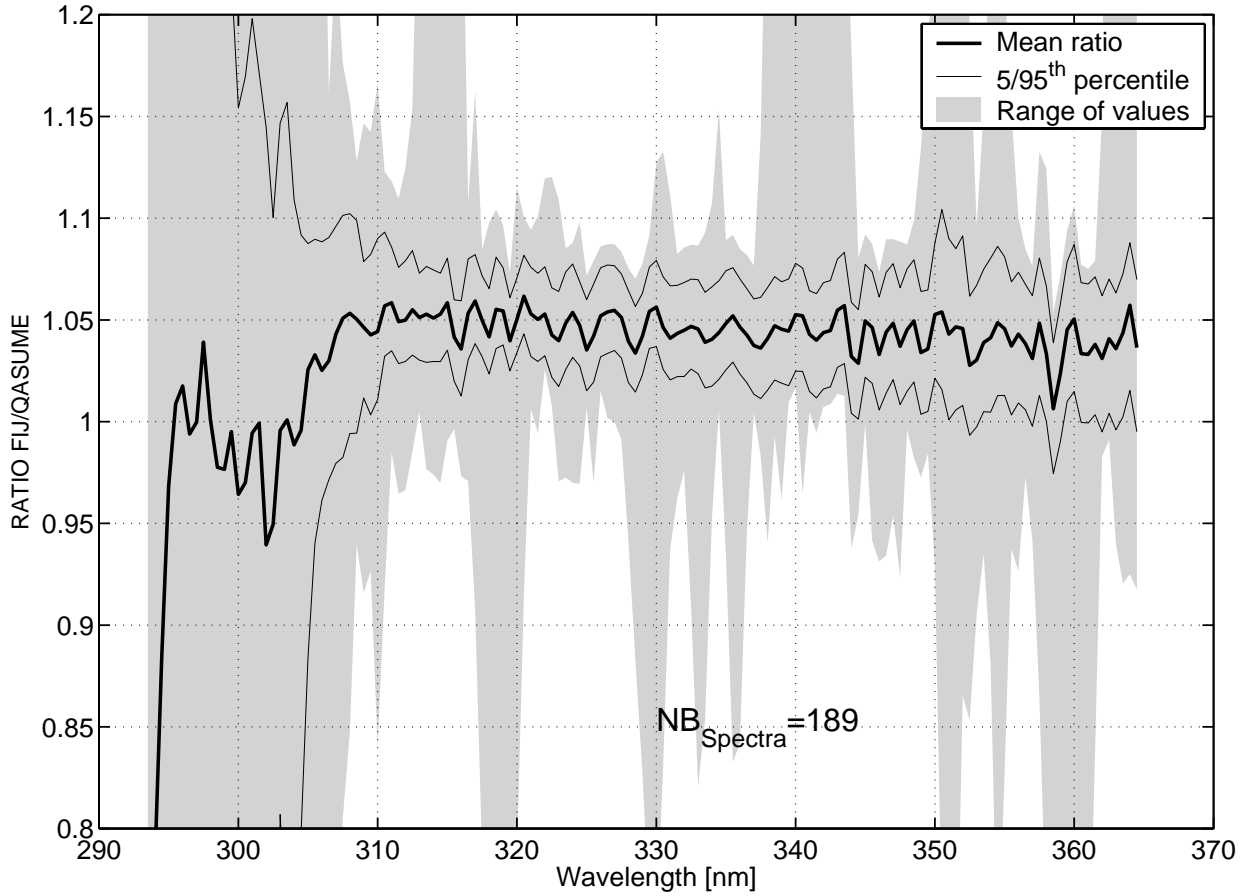


Daily variation. Wavelength bands are ± 2.5 nm

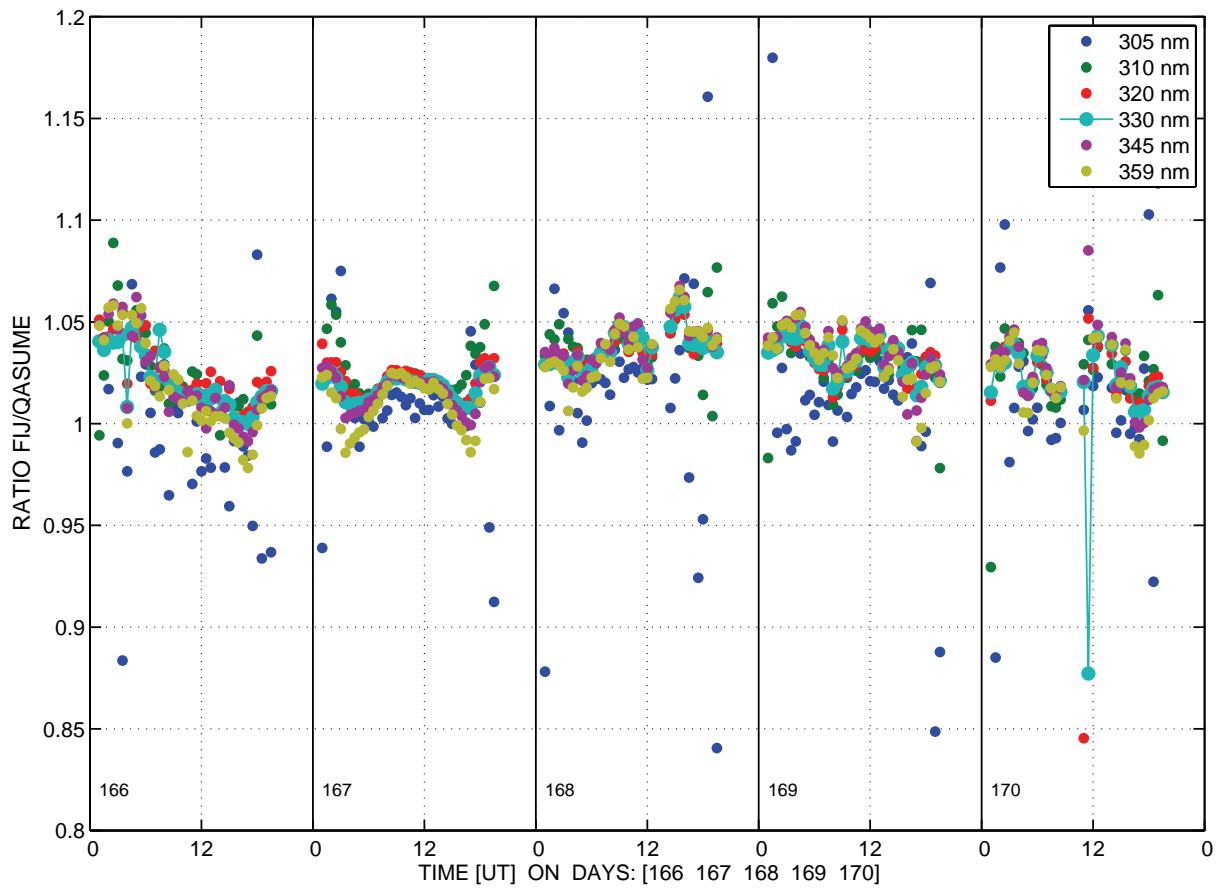


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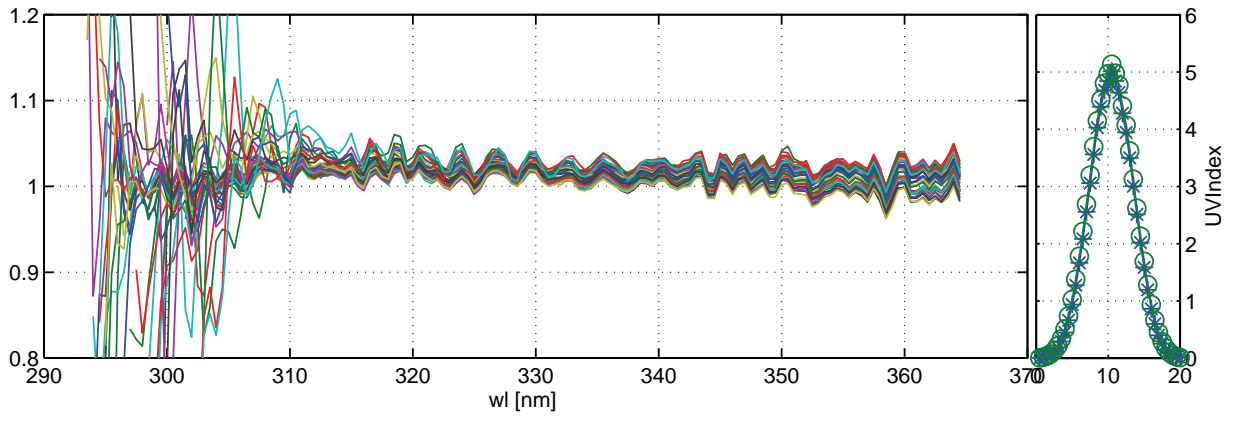
Mean ratio FIJ/QASUME at Jokioinen:15-Jun-2007(166) to 20-Jun-2007(171)



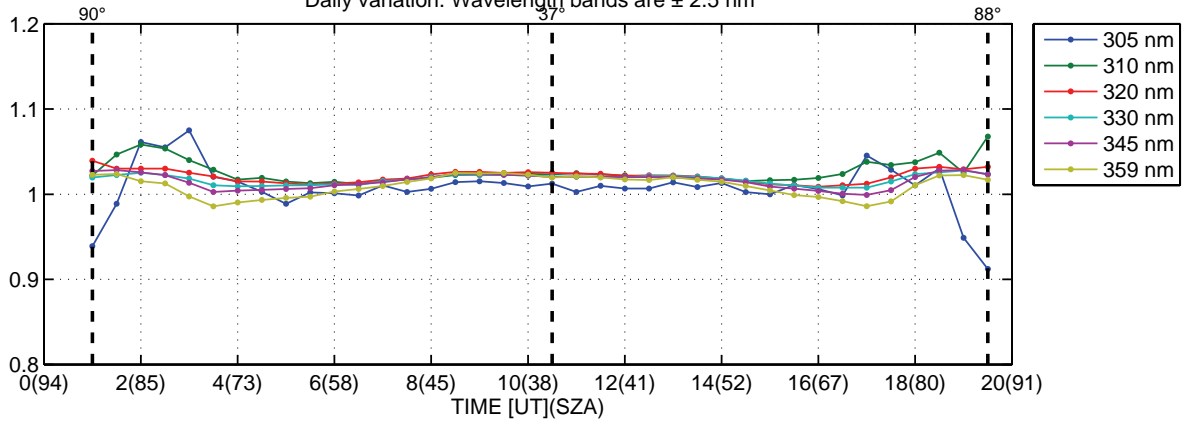
Global irradiance ratios FIJ/QASUME at Jokioinen - Lamp Corrected:15-Jun-2007(166) to 19-Jun-2007(170)



Global irradiance ratios FIJ/QASUME at Jokioine - Lamp Corrected:16-Jun-2007(167)

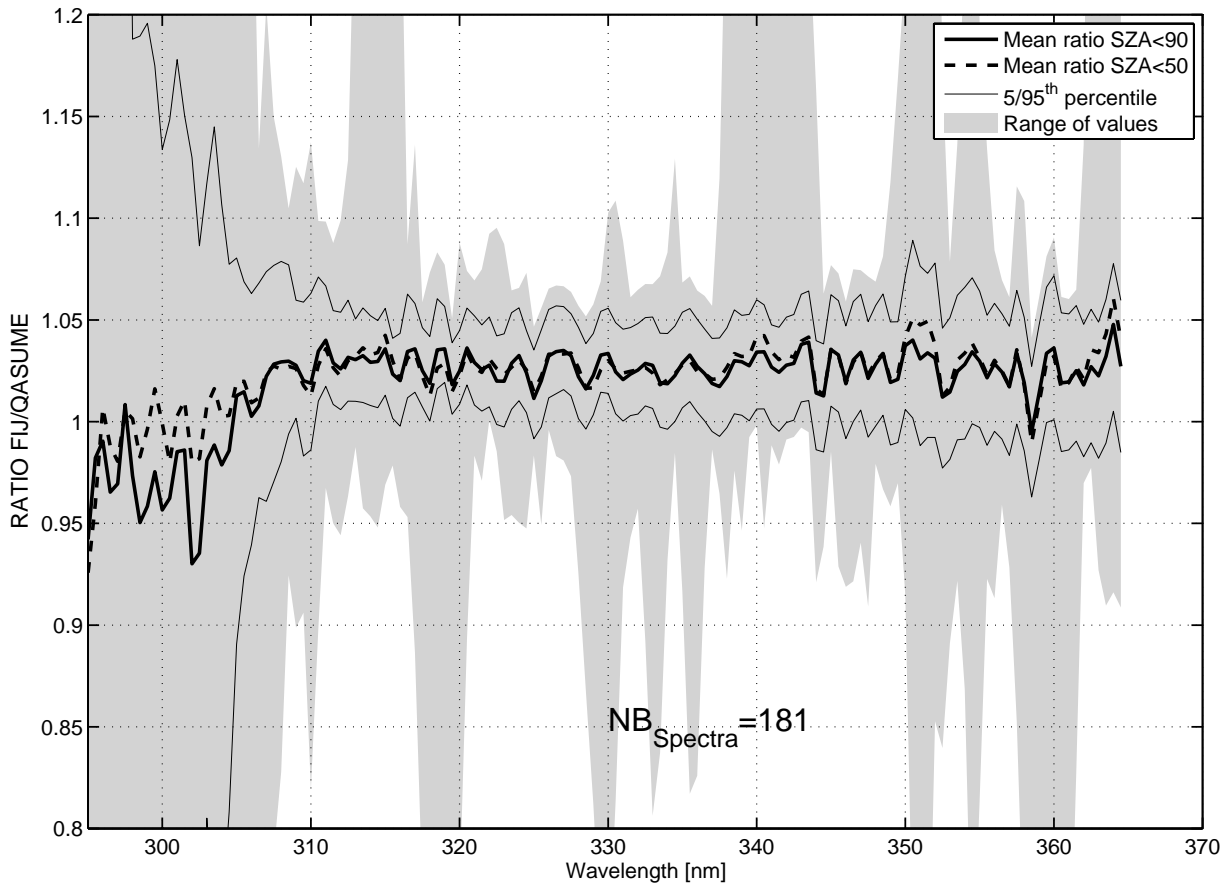


Daily variation. Wavelength bands are ± 2.5 nm

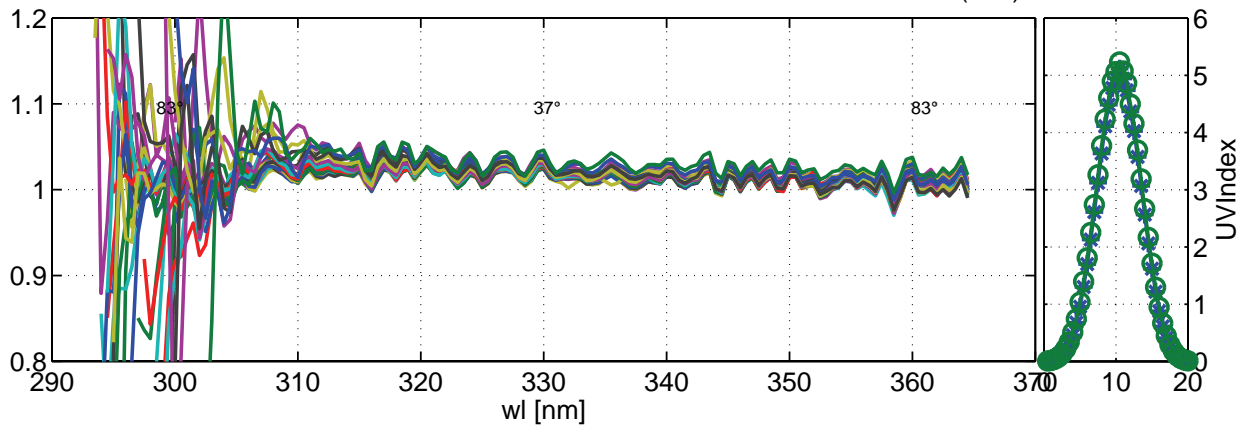


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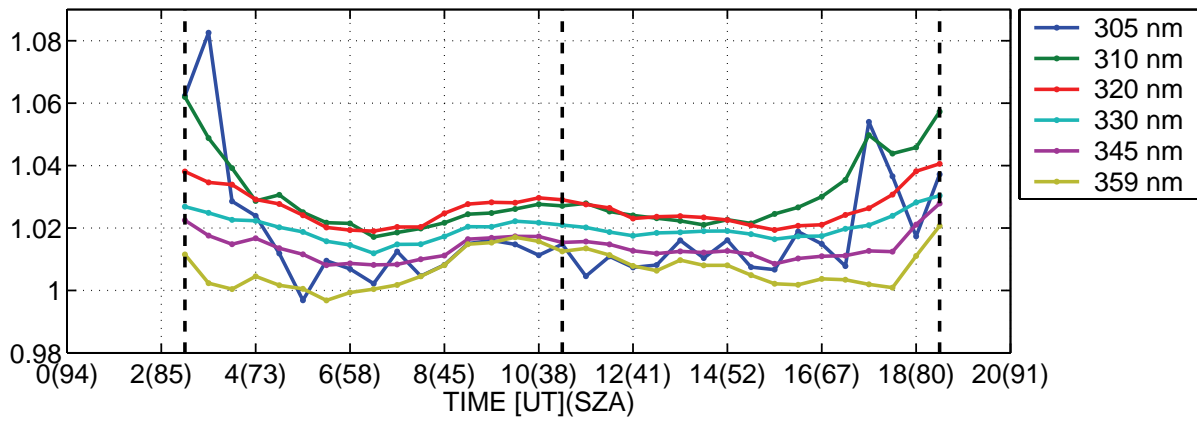
Mean ratio FIJ/QASUME at Jokioinen - Lamp Corrected:15-Jun-2007(166) to 19-Jun-2007(170)



Global irradiance ratios FIJ/QASUME at Jokioinen - coscor:16-Jun-2007(167)

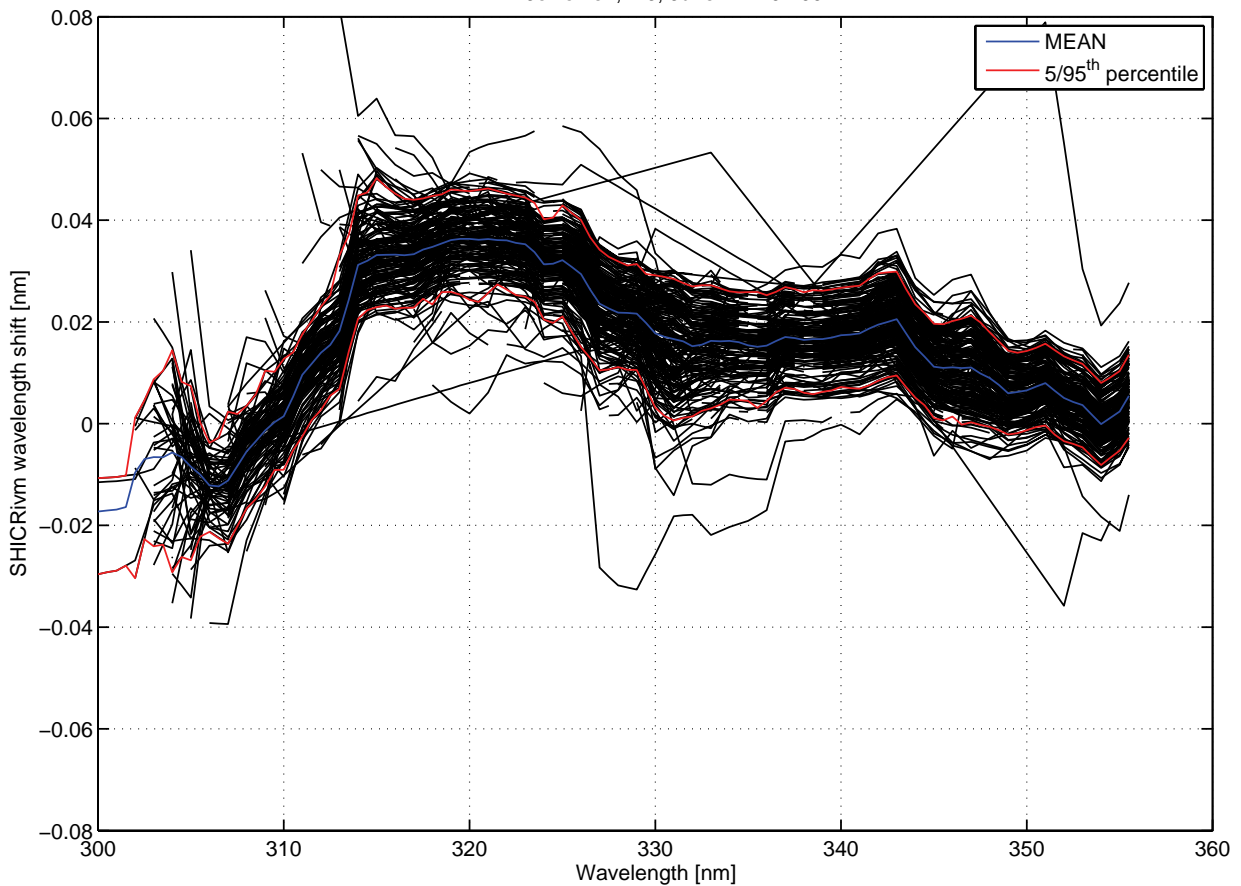


Daily variation. Wavelength bands are ± 2.5 nm

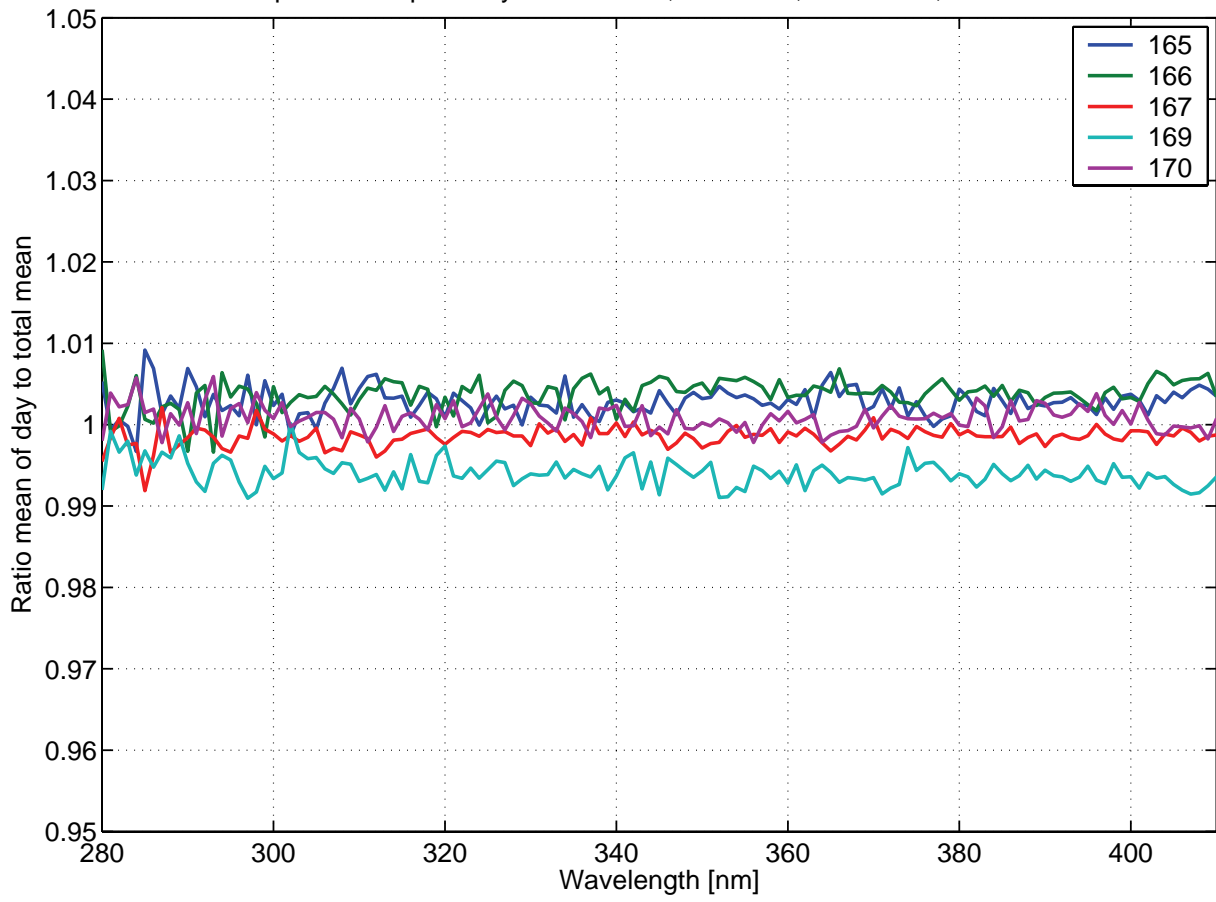


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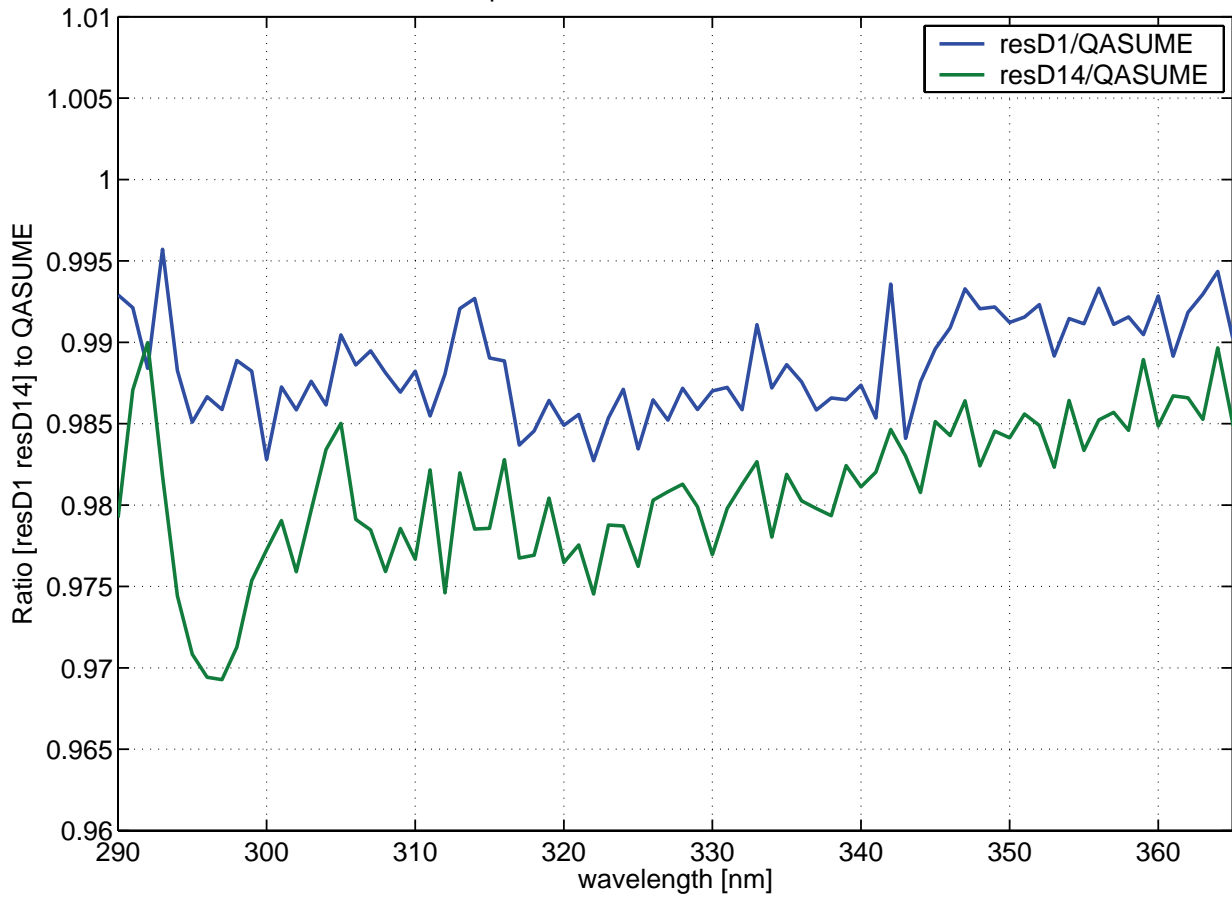
FMI-Jokioinen, FIJ, June 14-20 2007



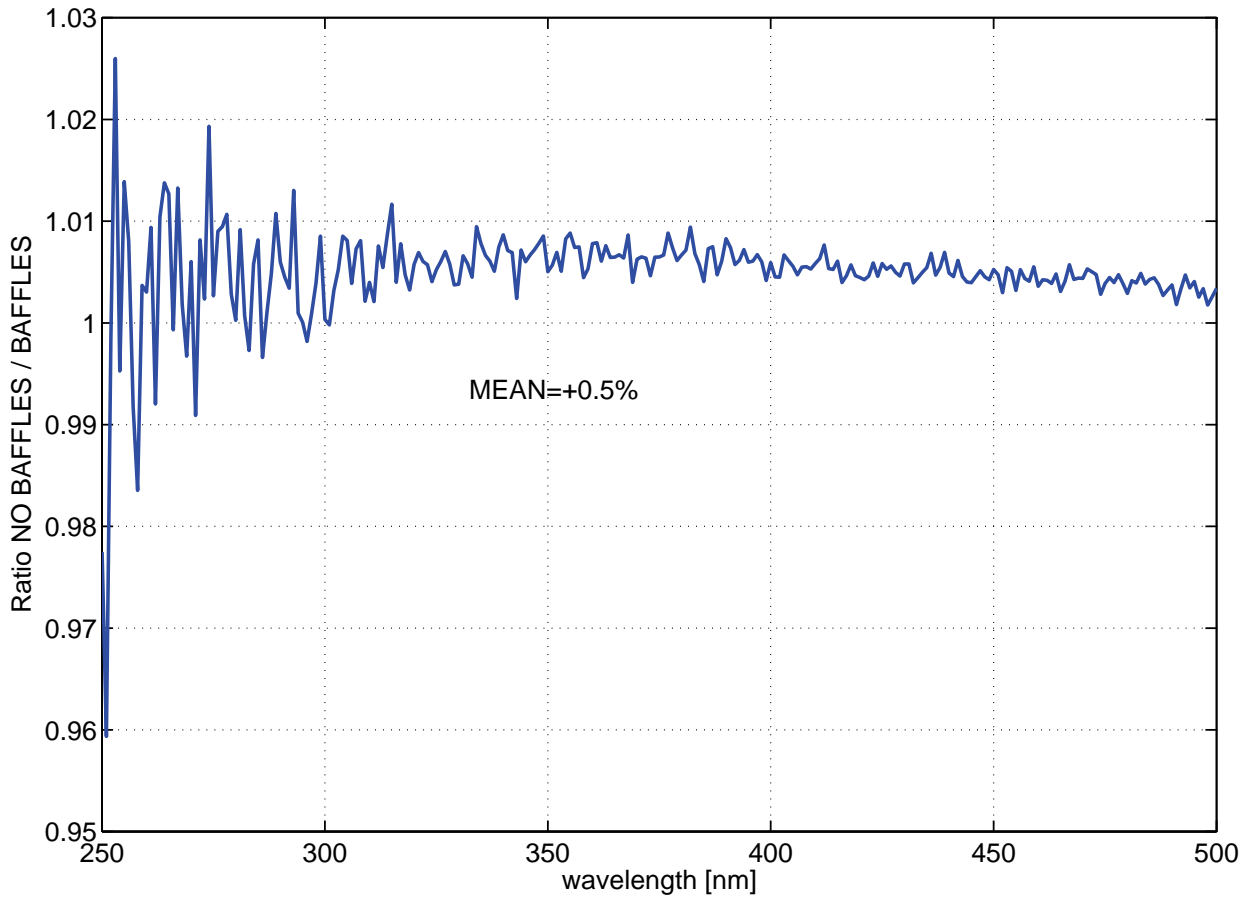
Spectral Responsivity of QASUME, Jokioinen, June 2007, T68522/3



LAMP Comparison D1 & D14 to QASUME UL1712007



D14 UL1712007.b5503 Jokioinen 2007



Ratio of responses from four lamps to the mean of the four.
The mean was used by #107 in the Qasume campaign 2007 at Jokioinen

