

Protocol of the intercomparison at FMI, Observatory of Jokioinen, Finland  
July 6-11, 2002 with the travelling reference spectrometer B5503 from  
ECUV within the project QASUME

Report prepared by Julian Gröbner

Operators: Stelios Kazadzis and Joseph Schreder

The purpose of the visit was the comparison of global solar irradiance measurements between the spectrometer operated by FMI and B5503. The visit at Jokioinen follows the previous intercomparison at the home site of B5503 at the JRC, Ispra, Italy. The measurement site is located on the roof of a building 10 meters above ground. Latitude is 60.814 and longitude 23.499E, altitude is 104 m.a.s.l. The horizon of the measurement site is free down to about 85 deg SZA. Higher obstructions are located in the West and South-West.

B5503 arrived at Jokioinen in the evening of July, 6, 2002. The instrument was installed on the roof of the building 1.5m away from the spectrometer operated by FMI and left to stabilize over night.

The intercomparison between B5503 and FIJ lasted four days from July 7 to July 10, 2002. The local operator (Tapani Koskela) arrived at noon of July 8.

B5503 was calibrated at the beginning and end of the intercomparison period using a 100W portable calibration system. Three 100W lamps were used to obtain an absolute spectral calibration traceable to the primary reference (F330) held at ECUV and traceable to PTB. The first calibration on July 6 was held from 08:00 to 10:00 UT, and the second on July 11 from 07:00 to 09:00 UT. The first calibration showed a spectrally flat offset of 1 to 1.5% relative to the second calibration. The experience gained with B5503 during this and other measurement campaigns has shown that the instrument requires stabilisation times of up to 24 hours after transportation. Thus, for the final data analysis, the first calibration was only used for the measurement day of July 7 and the subsequent measurements on July 8 to 10 were based on the second calibration obtained at the end of the campaign. The internal temperature of B5503 was constant at  $27.35 \pm 0.1^\circ\text{C}$ . No information is available on possible temperature gradients within the instrument. The wavelength shifts relative to an extraterrestrial spectrum as retrieved from the SHICRivm analysis were between  $\pm 50\text{pm}$  in the spectral range 300 to 400 nm (see appended graphs).

Protocol:

Synchronous measurements started on July 7 at 10:30 UT. Global irradiance measurements were performed every 30 min in the range 290 to 365 nm with an increment of 0.5 nm every 3 sec. Measurements on this day were performed under cloudy conditions with light rain after 18:00 UT. Last measurement was at 20:00 UT (90 deg).

Measurements on July 8 were quality controlled from 4 to 19:30 UT. Sunrise was at 01:12 UT and sunset was at 19:48 UT. The minimum solar zenith angle was 38 deg.

Measurements were performed under scattered cloud conditions from 4 till 14 UT with partly sunshine. From 14:00 to 19:30 UT very few cumulus clouds were present with the sun being visible in most of the measurements periods. B5503 missed one measurement at 05:30 UT.

July 9 was characterized by broken clouds in the morning (01:30 to 04:30 UT) few-scatter clouds from 04:30 UT to 12:00 UT and few clouds during the remaining day. The sun was visible during most of the measurements and slow moving clouds were present during some of the measurements. Data were quality controlled from 01:30 (domes cleaned) till 19:30 UT.

On July 10 measurements were quality controlled from 01:30 to 19:30 UT (domes were cleaned before the first measurement). Scattered cirrus clouds were present from 01:30 to 5:00 UT and afterwards all measurements were performed under clear sky conditions. FIJ missed the 09:30 and 10:00 UT measurements.

On July 11 the calibration of B5503 took place from 7 to 9 UT. From 14 till 18 UT the slit function of FIJ was measured at 325 nm with the HeCd Laser in the laboratory.

#### Results:

After a preliminary comparison between the two data sets of B5503 and FIJ at Jokioinen, the local operator of FIJ decided to submit a completely revised data set for the whole measurement campaign. The revised data set was submitted about two months after the campaign. A description of the changes between the original and revised data set has been provided by the local operator and is attached to this document.

The data from FIJ were processed with the SHICRivm algorithm. The wavelength shifts of FIJ were within  $\pm 50$  pm during the whole measurement period.

The intercomparison of the global irradiance measured by the two instruments can be summarized as follows:

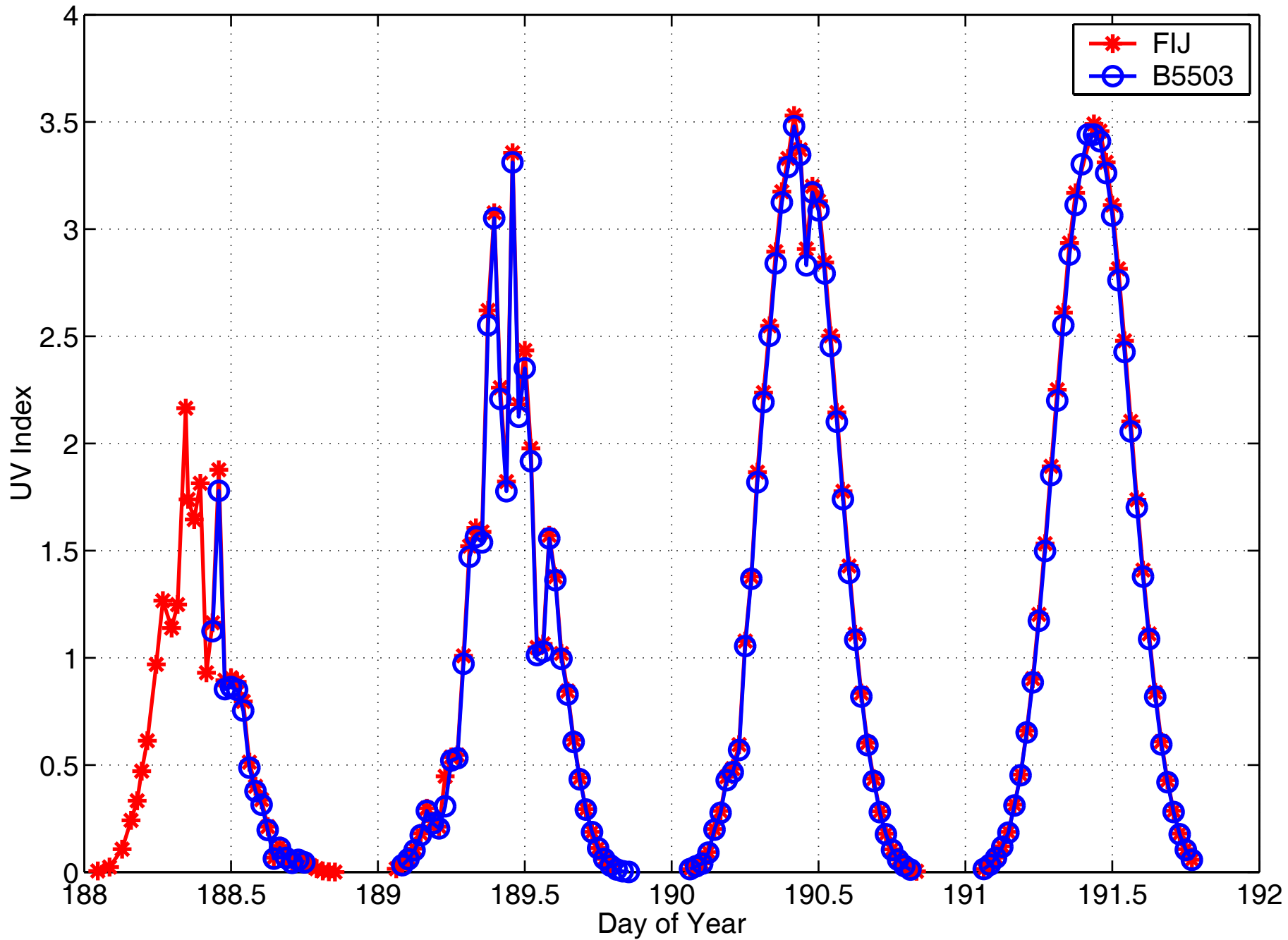
- The ratios between FIJ and B5503 are spectrally flat.
- Measurements of FIJ are about 5 to 6% higher than B5503 on July 7 and 1 to 3% higher on the subsequent days 8, 9 and 10 July. It is possible that this change observed between the first measurement day and the later ones can be attributed to B5503 being not fully operational and requiring some more settling time.
- Diurnal variations between the two instruments are  $\pm 2\%$  over the whole day. On 9 and 10 July this diurnal variation seems correlated to the solar zenith angle. Some possible explanations are: a) an azimuthal dependence of the input optic of B5503. This will be investigated in the laboratory on the return of B5503 to JRC, b) limitations in the “cosine correction” of the global irradiance measurements of FIJ

Comments from the local operator:

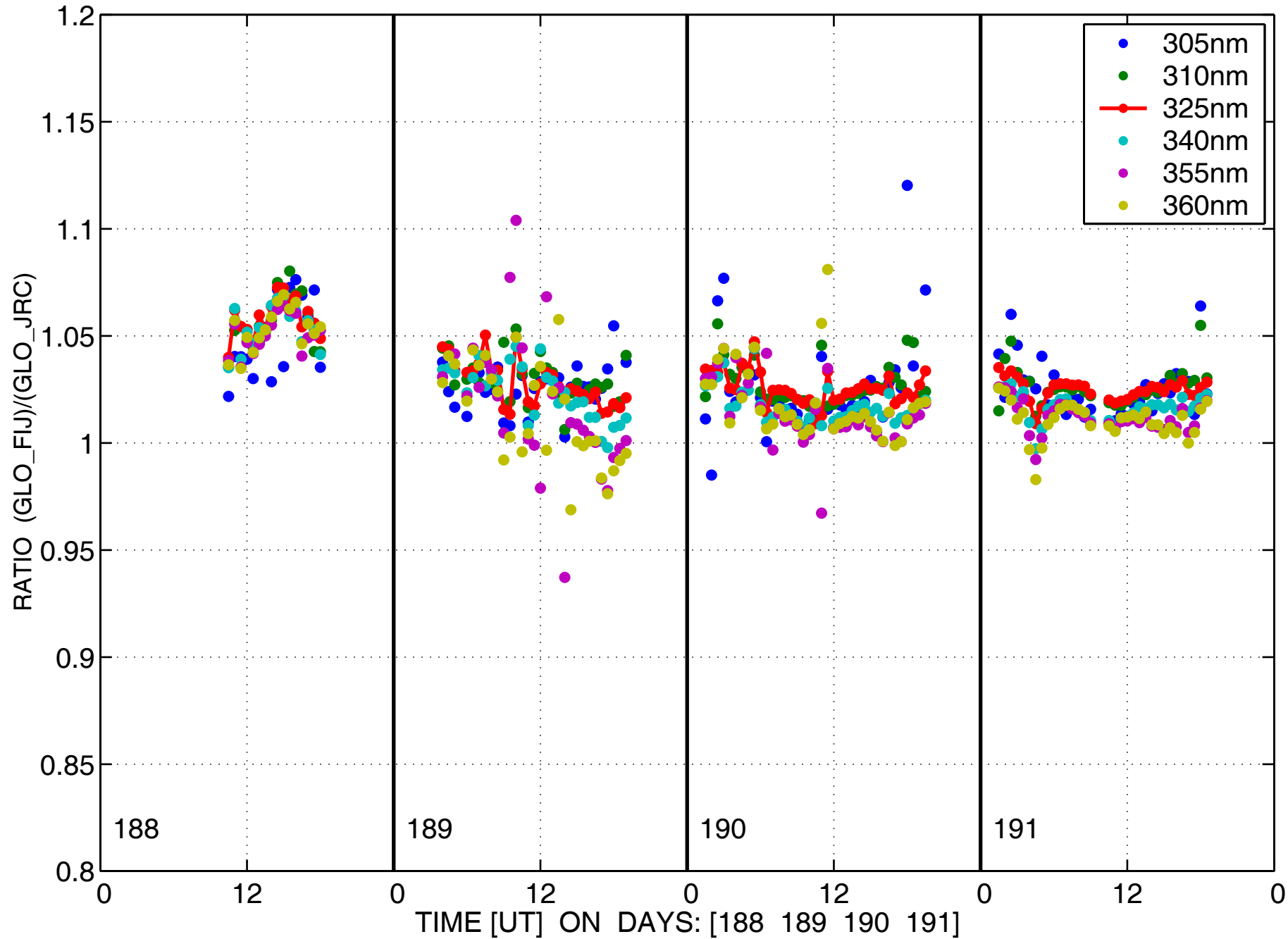
The instrument is a Brewer double spectrophotometer #107 with a flat Teflon diffuser.

The revision included an improved method in processing the ancillary broadband UV data used for estimating the cloud optical depth. It was found necessary to correct the broadband data for cosine and spectral errors, too. This has a great influence at large SZAs. No changes in the calibration of the instrument was made as a result of an analysis of the lamp time series. The fact that the problem in the processing software was observed now clearly demonstrates the necessity of frequent comparisons with other instruments, even with one. It also suggests that comparisons should include different weather situations.

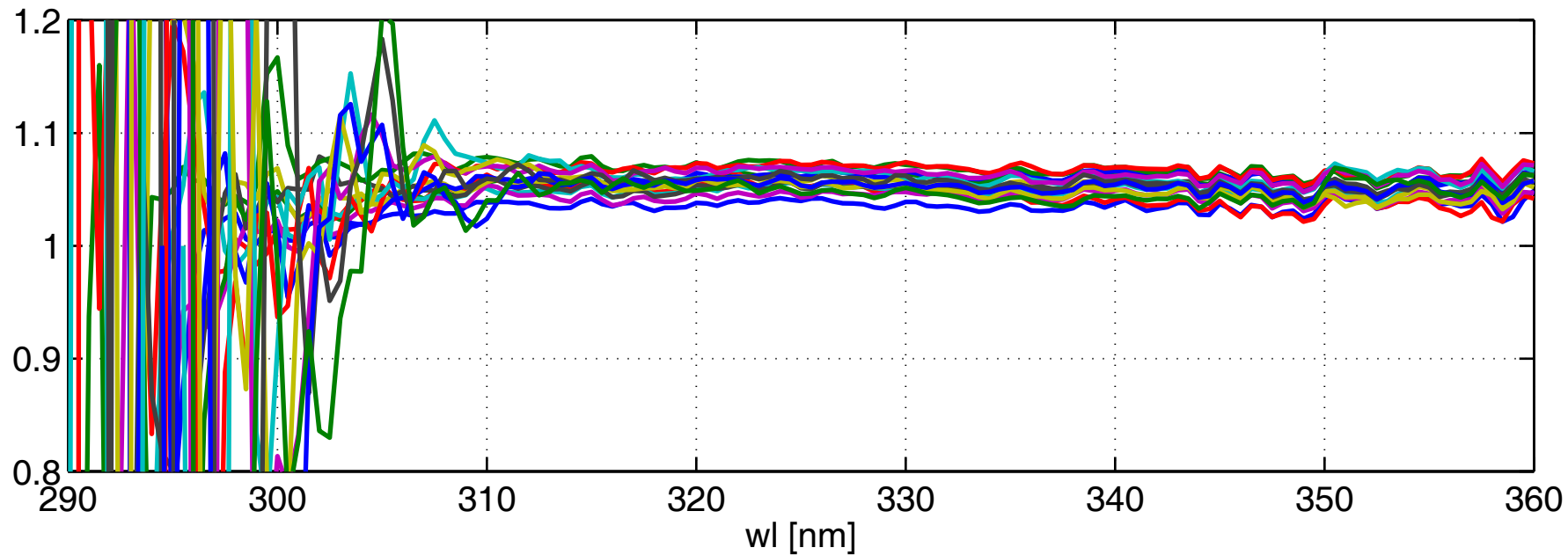
UV Index JOKIOINEN 7 – 10 July 2002



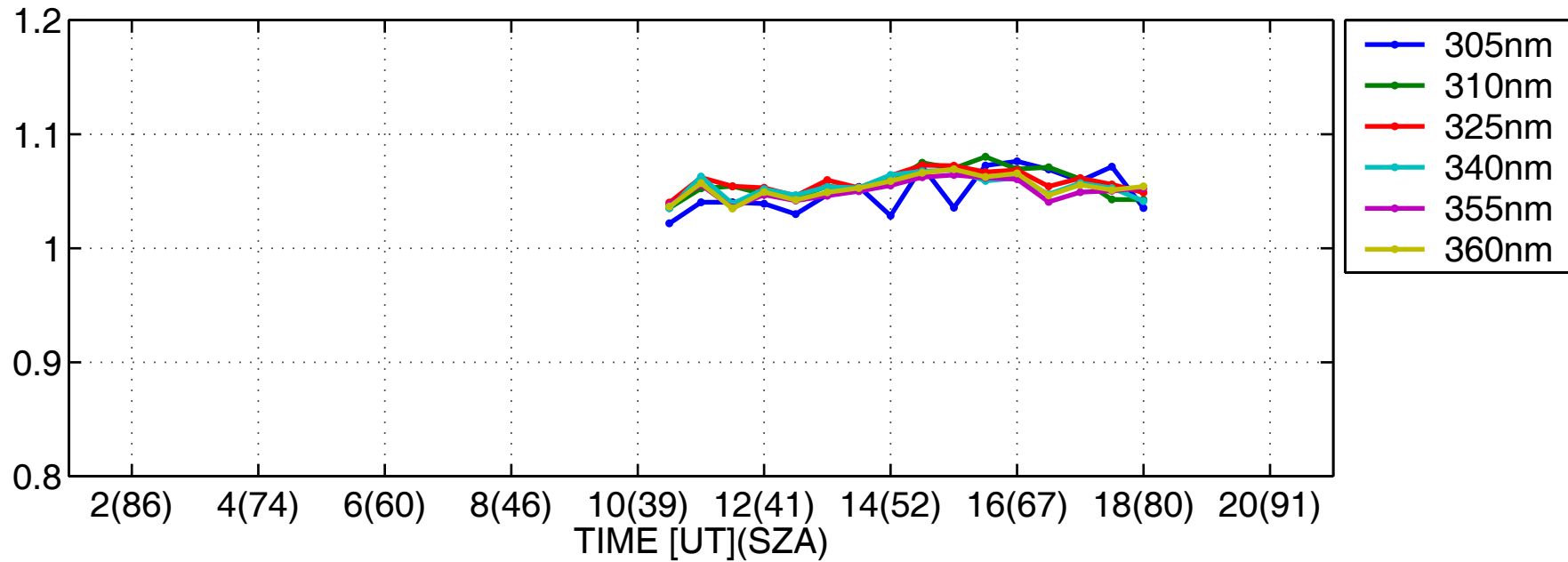
Global irradiance ratios FIJ/JRC at Jokioinen:07-Jul-2002(188) to 10-Jul-2002(191)



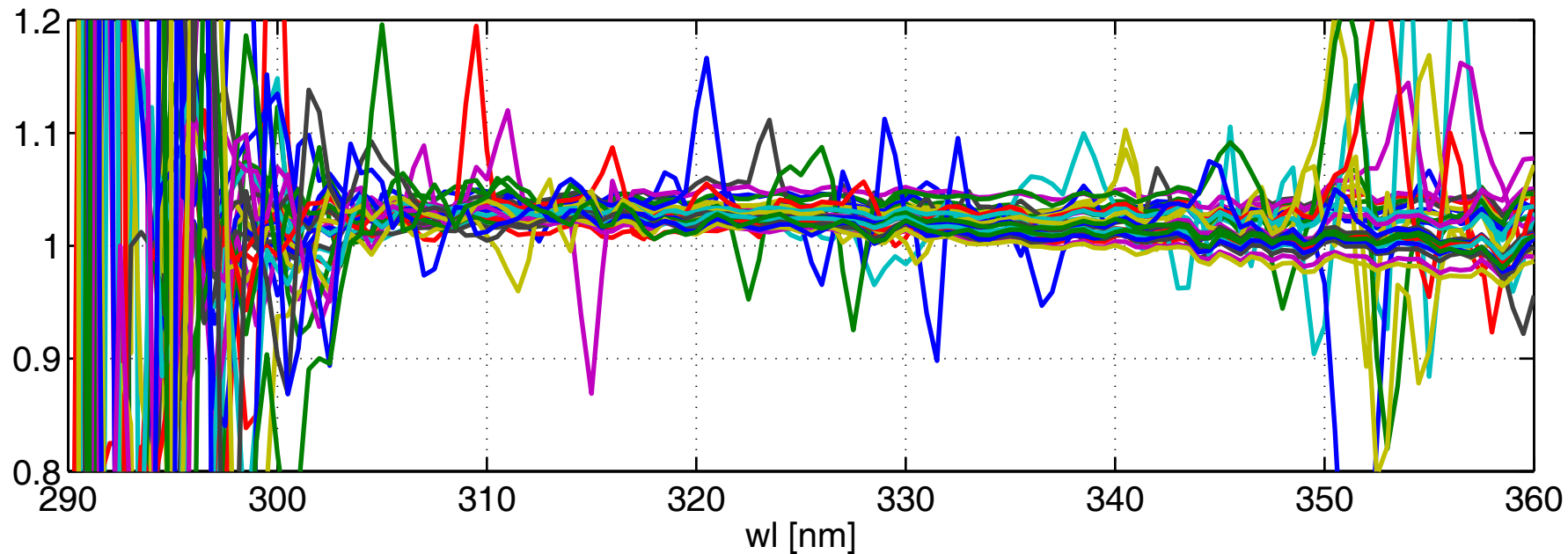
Global irradiance ratios FIJ/JRC at Jokioinen:07-Jul-2002(188)



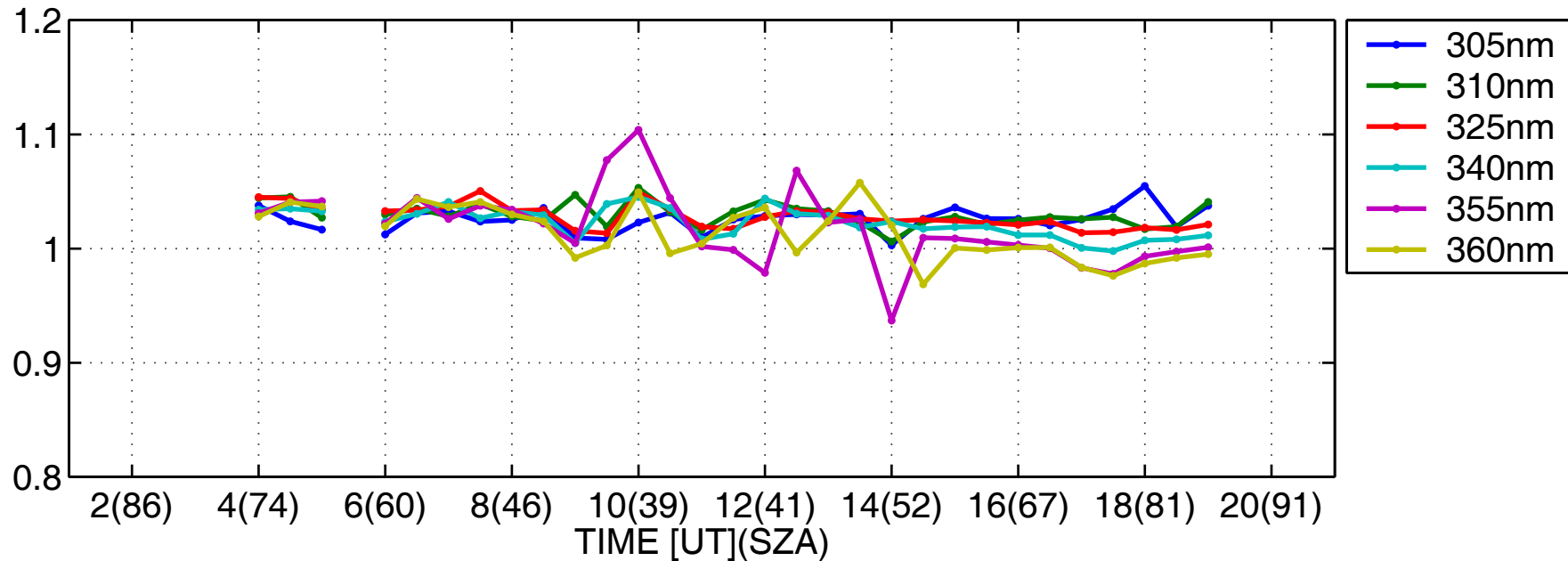
Daily variation. Wavelength bands are  $\pm 2.5$ nm



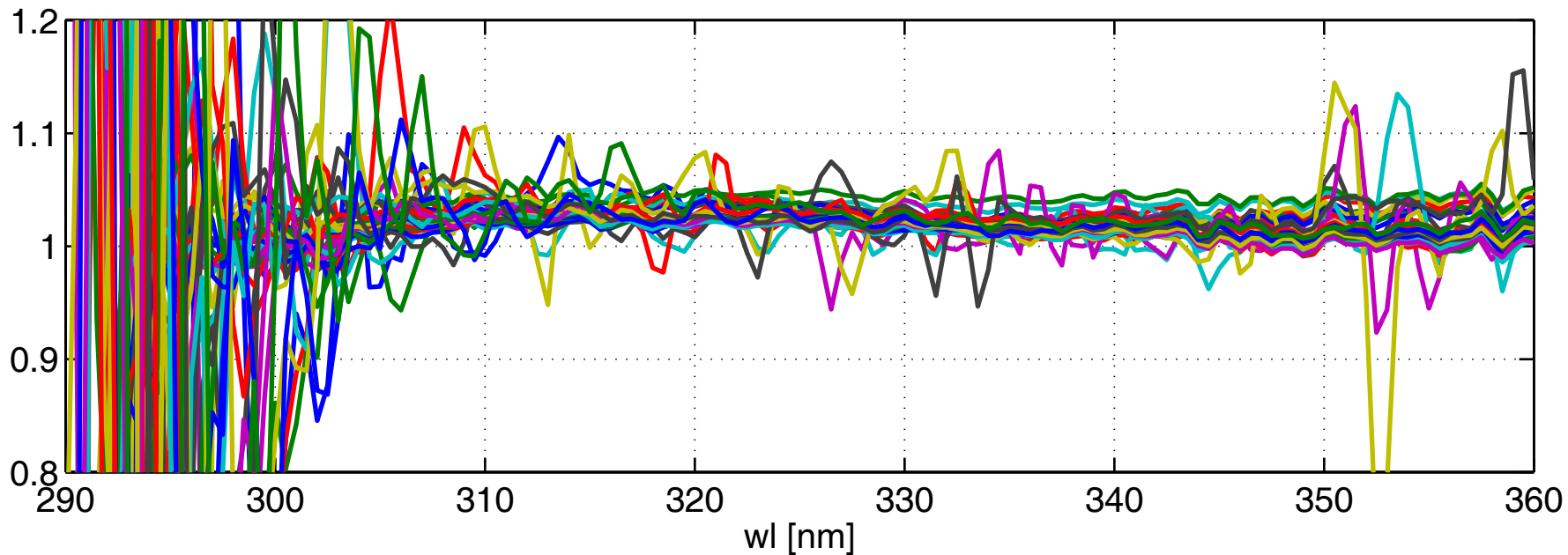
Global irradiance ratios FIJ/JRC at Jokioinen:08-Jul-2002(189)



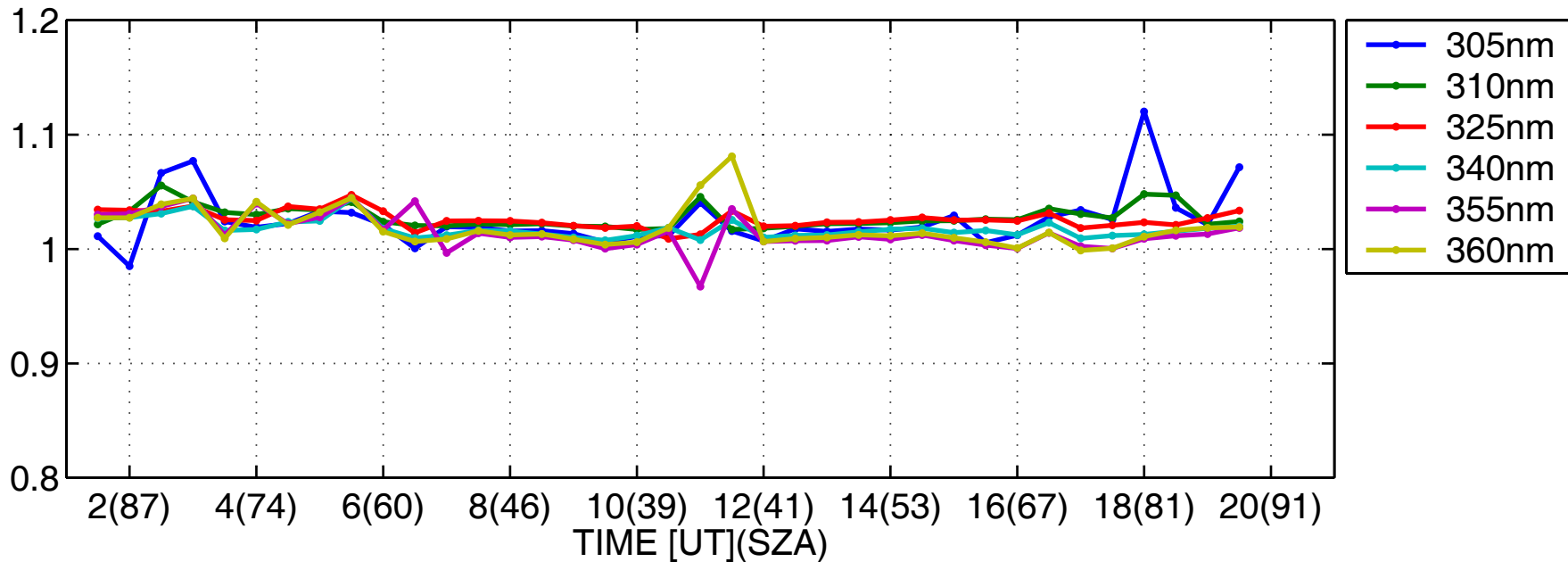
Daily variation. Wavelength bands are  $\pm 2.5$ nm



Global irradiance ratios FIJ/JRC at Jokioinen:09-Jul-2002(190)

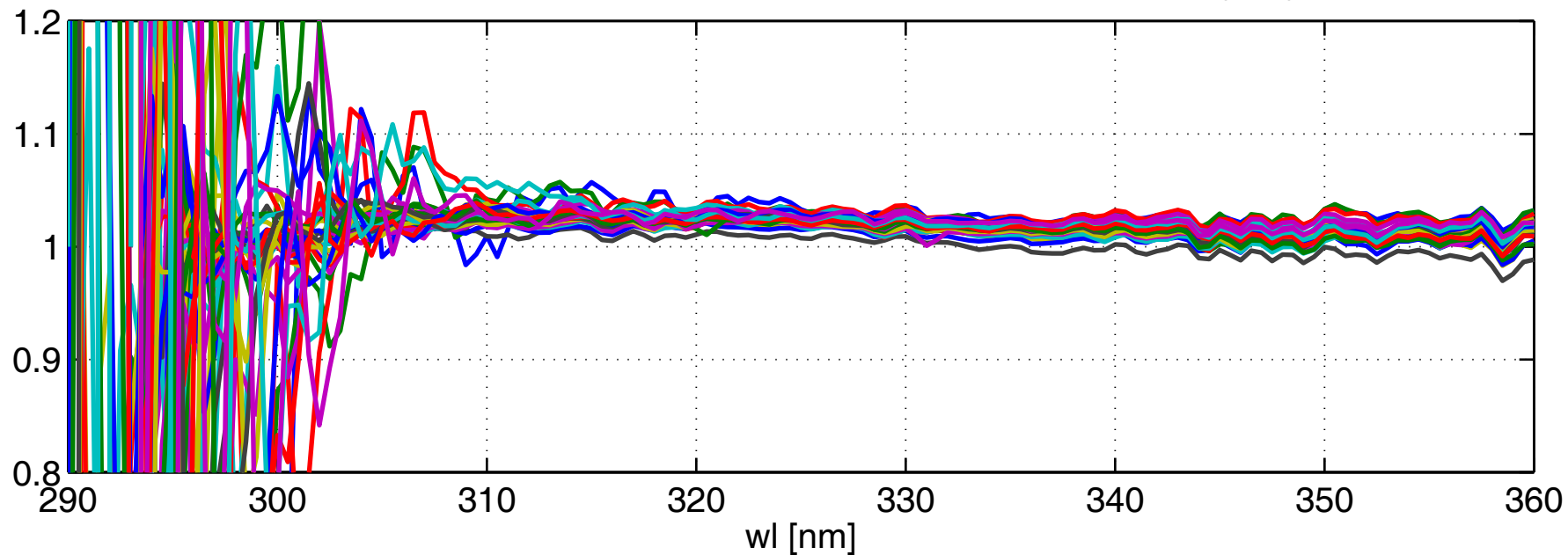


Daily variation. Wavelength bands are  $\pm 2.5$ nm

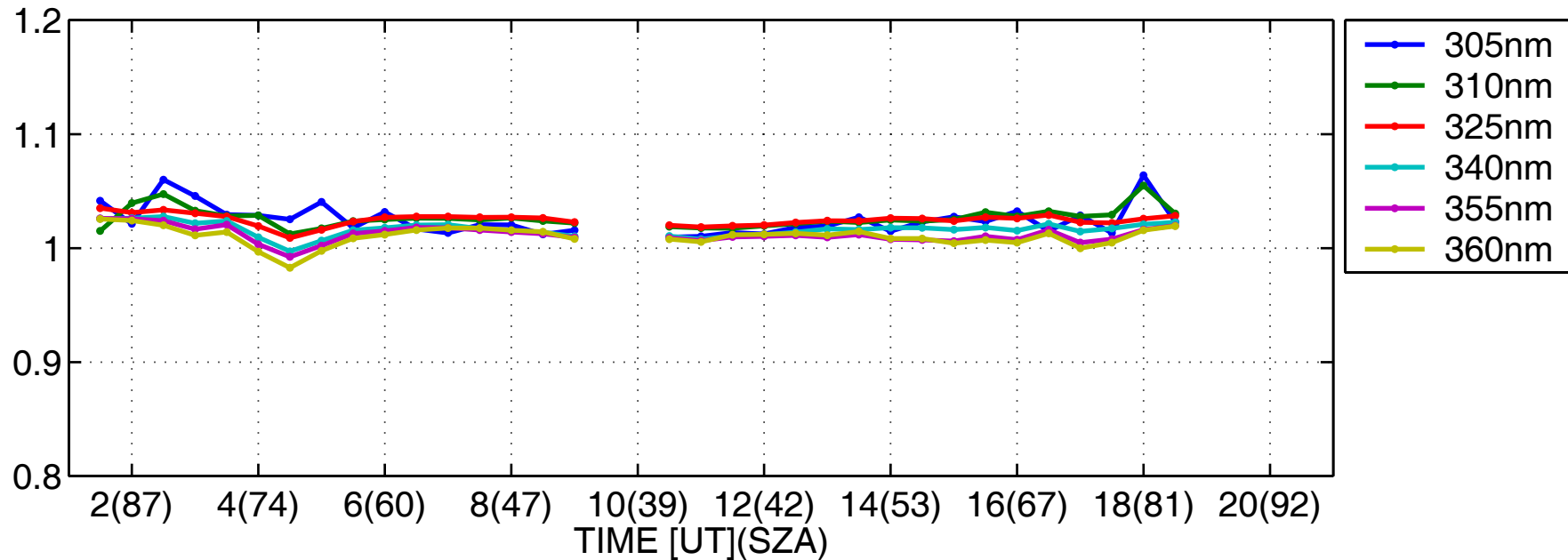




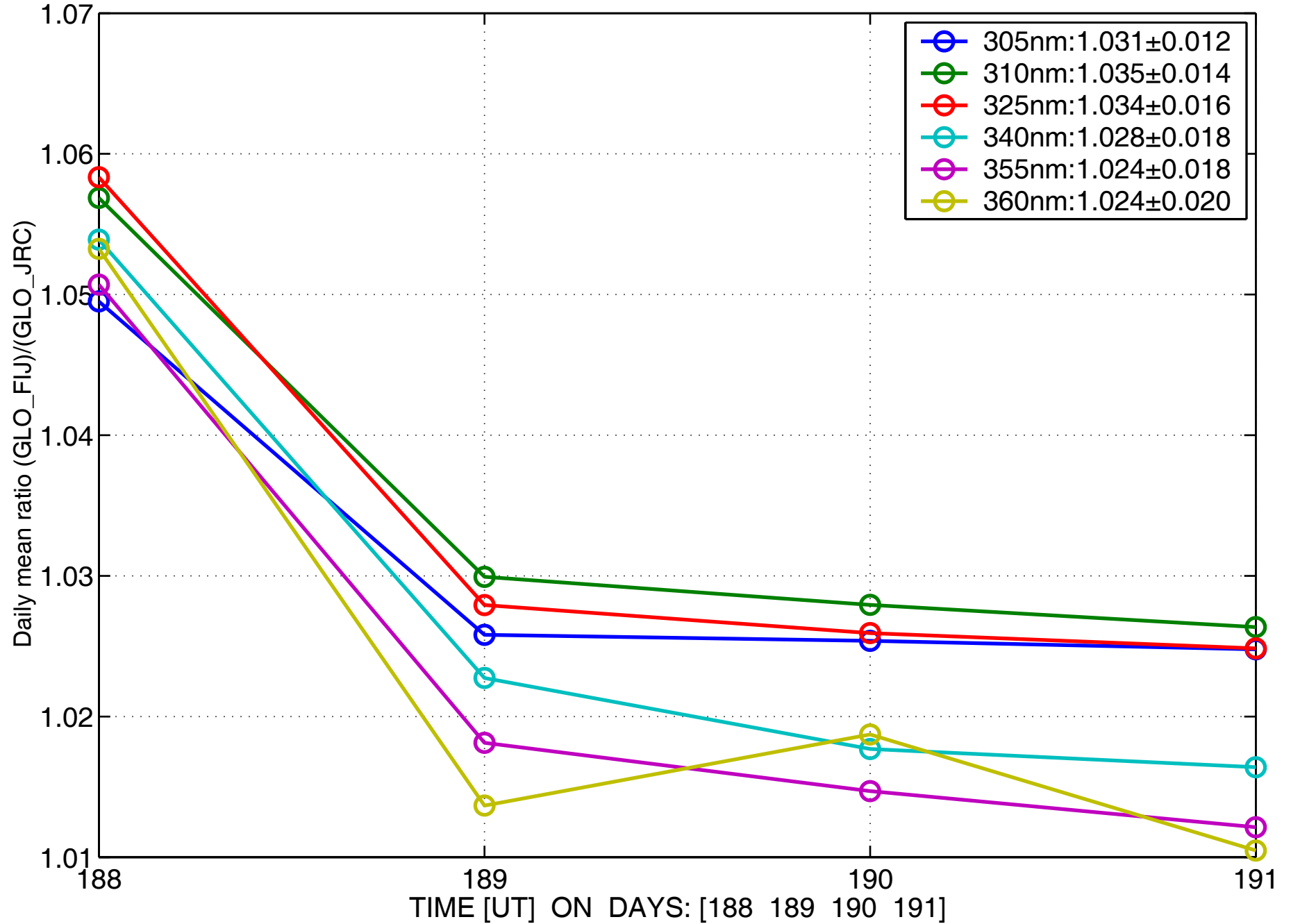
Global irradiance ratios FIJ/JRC at Jokioinen:10-Jul-2002(191)



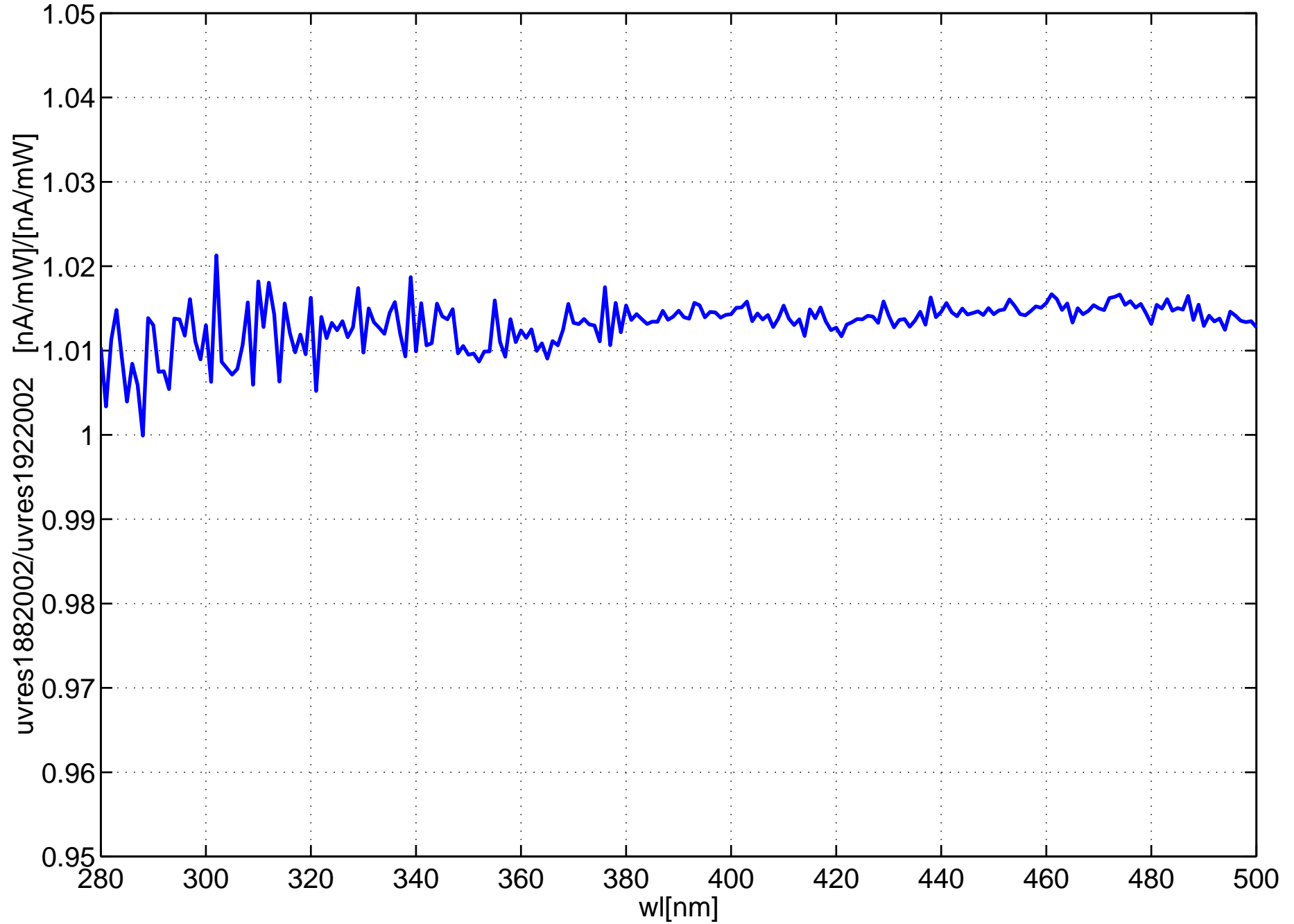
Daily variation. Wavelength bands are  $\pm 2.5$ nm



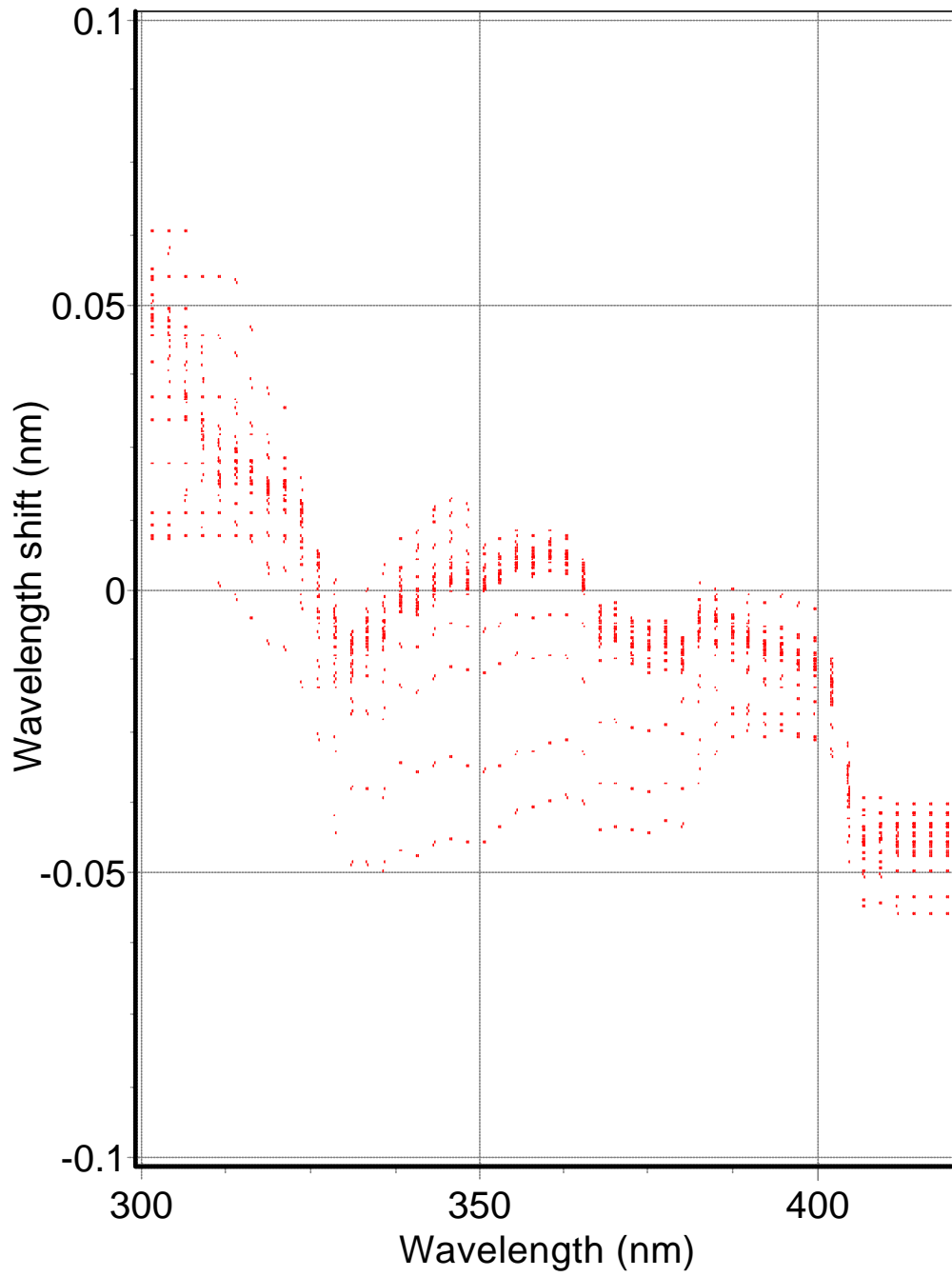
Daily mean ratios FIJ/JRC at Jokioinen:07-Jul-2002(188) to 10-Jul-2002(191)



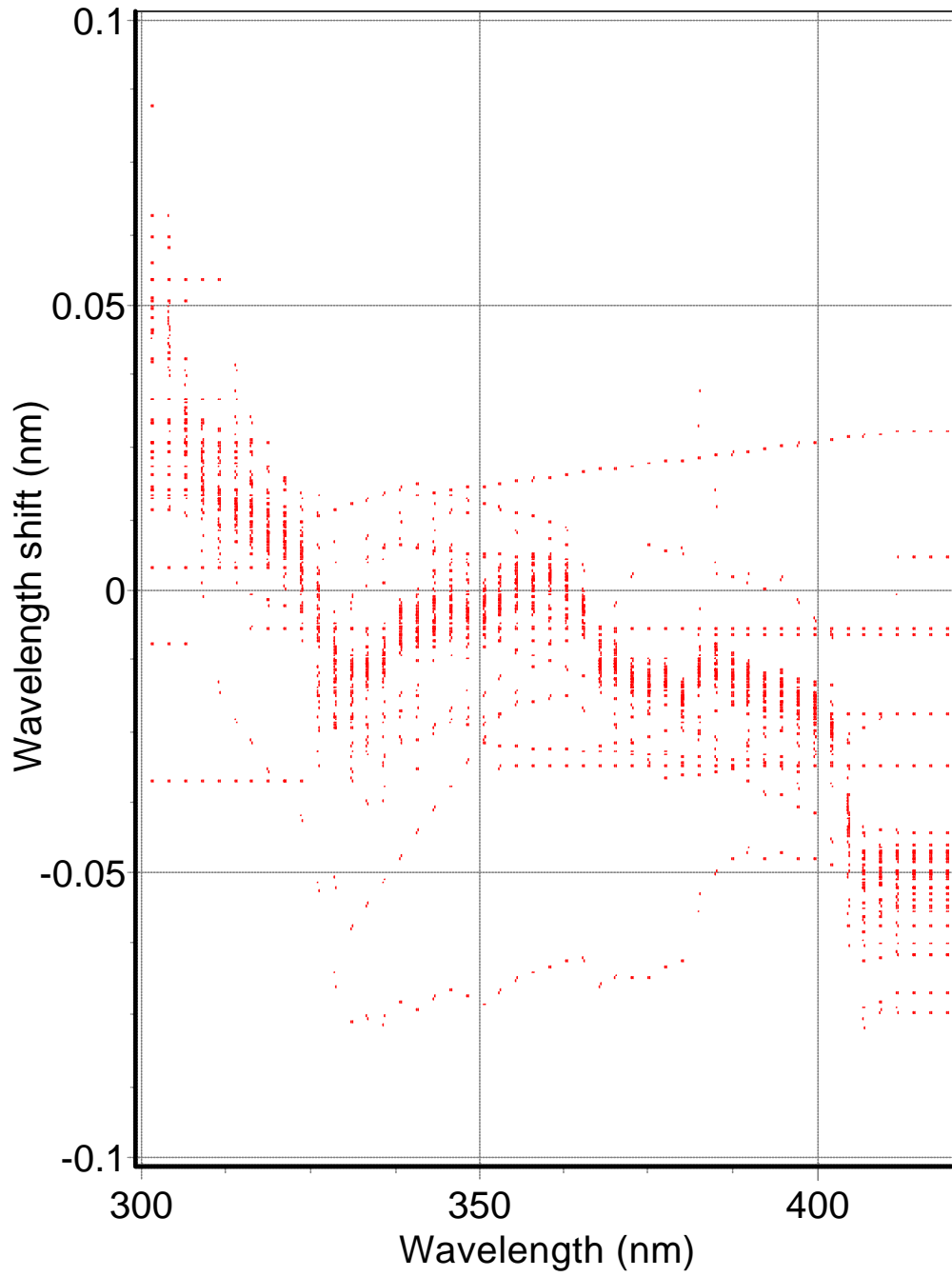
UV calib B5503 at FMI 2002, FMI before and after campaign



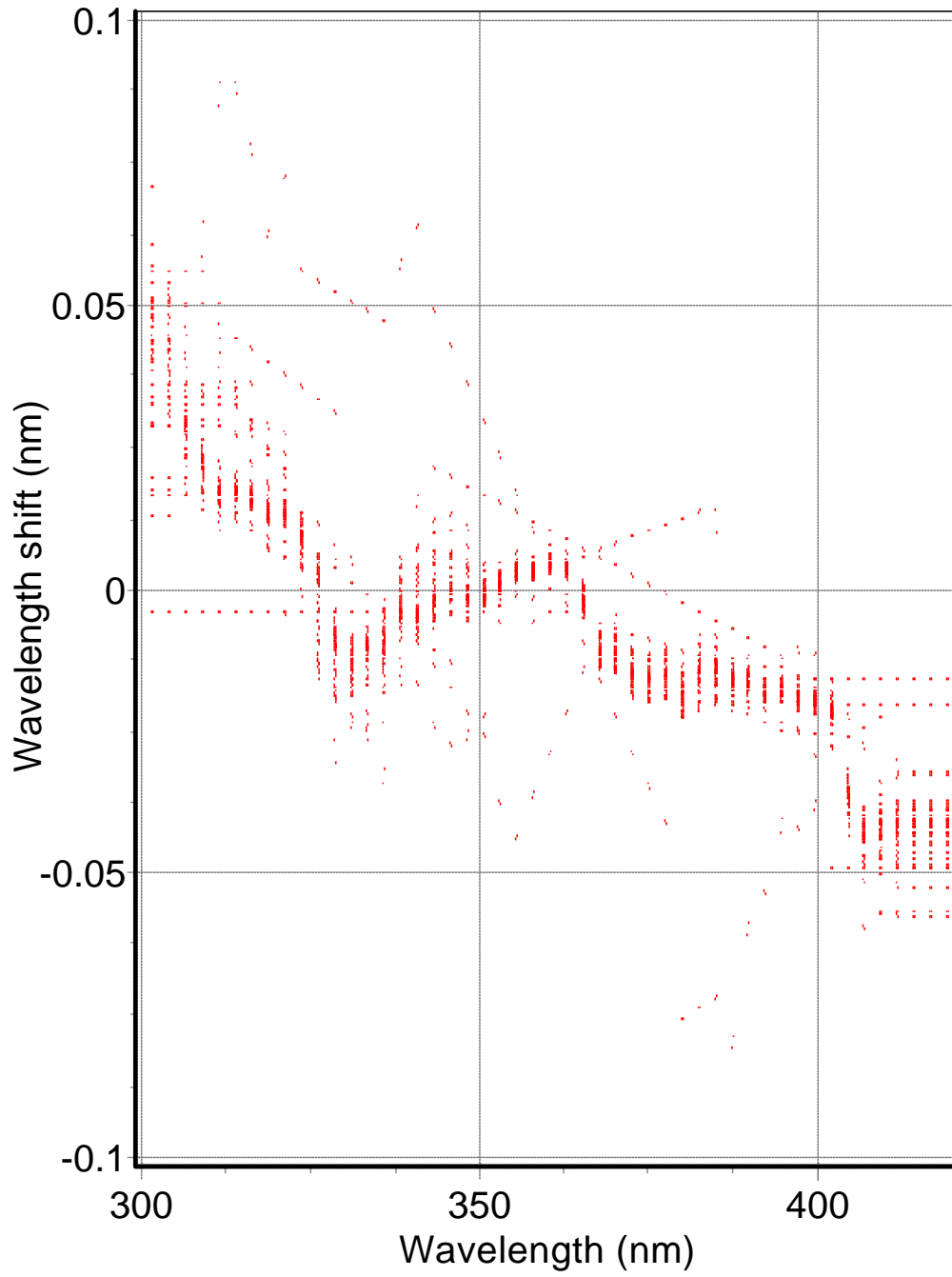
Wavelength shifts for: jrc 188\*



Wavelength shifts for: jrc 189\*



Wavelength shifts for: jrc 190\*

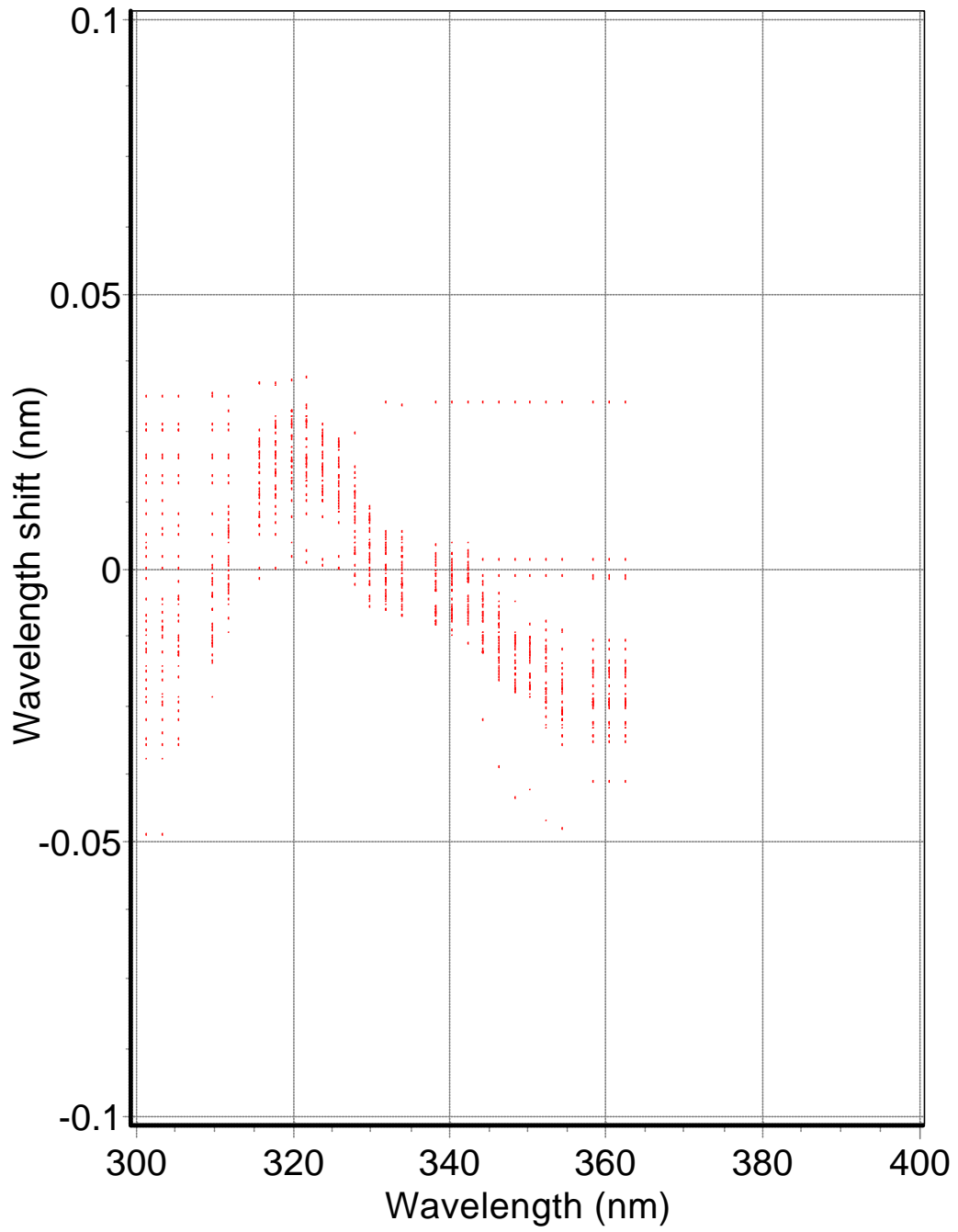




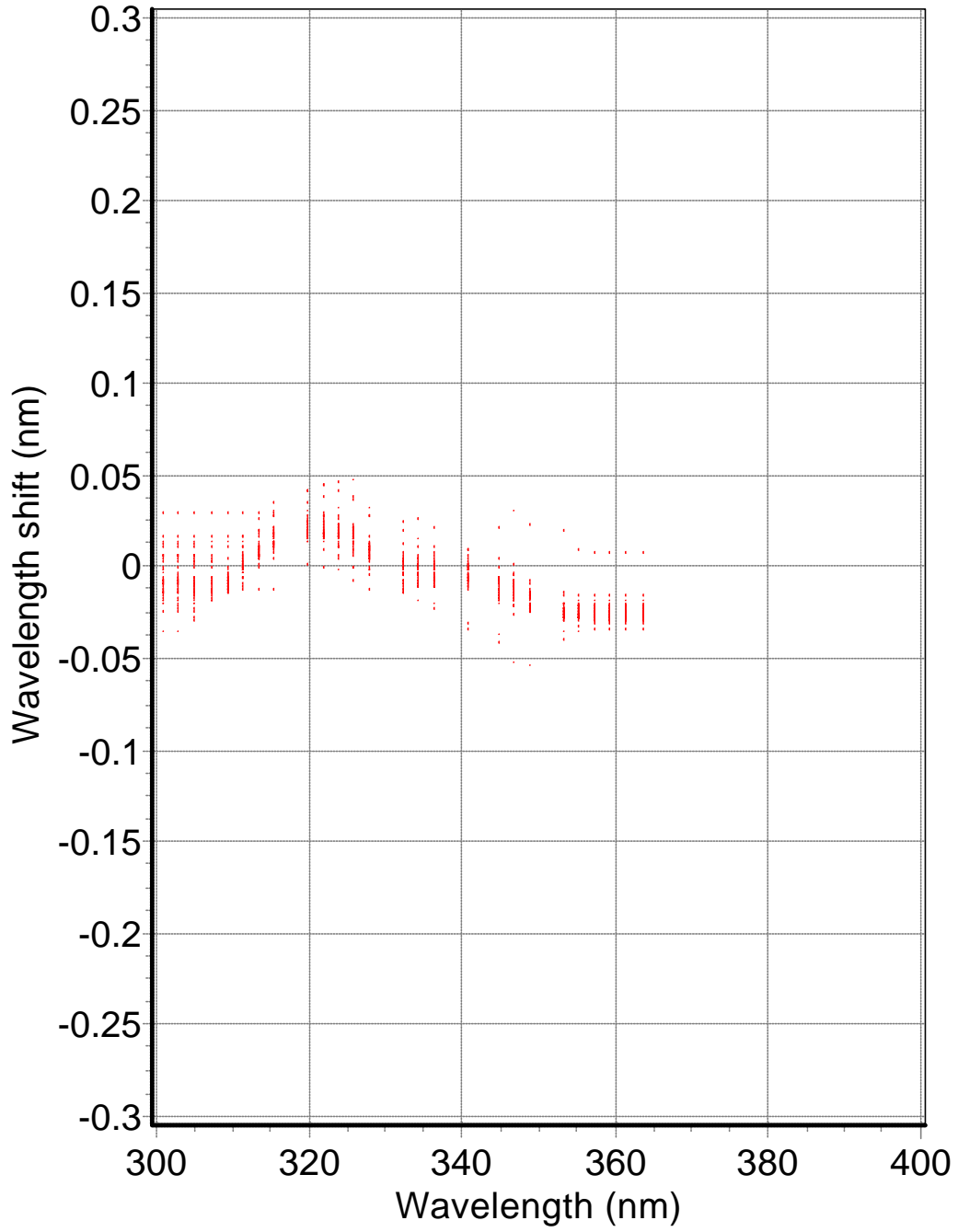




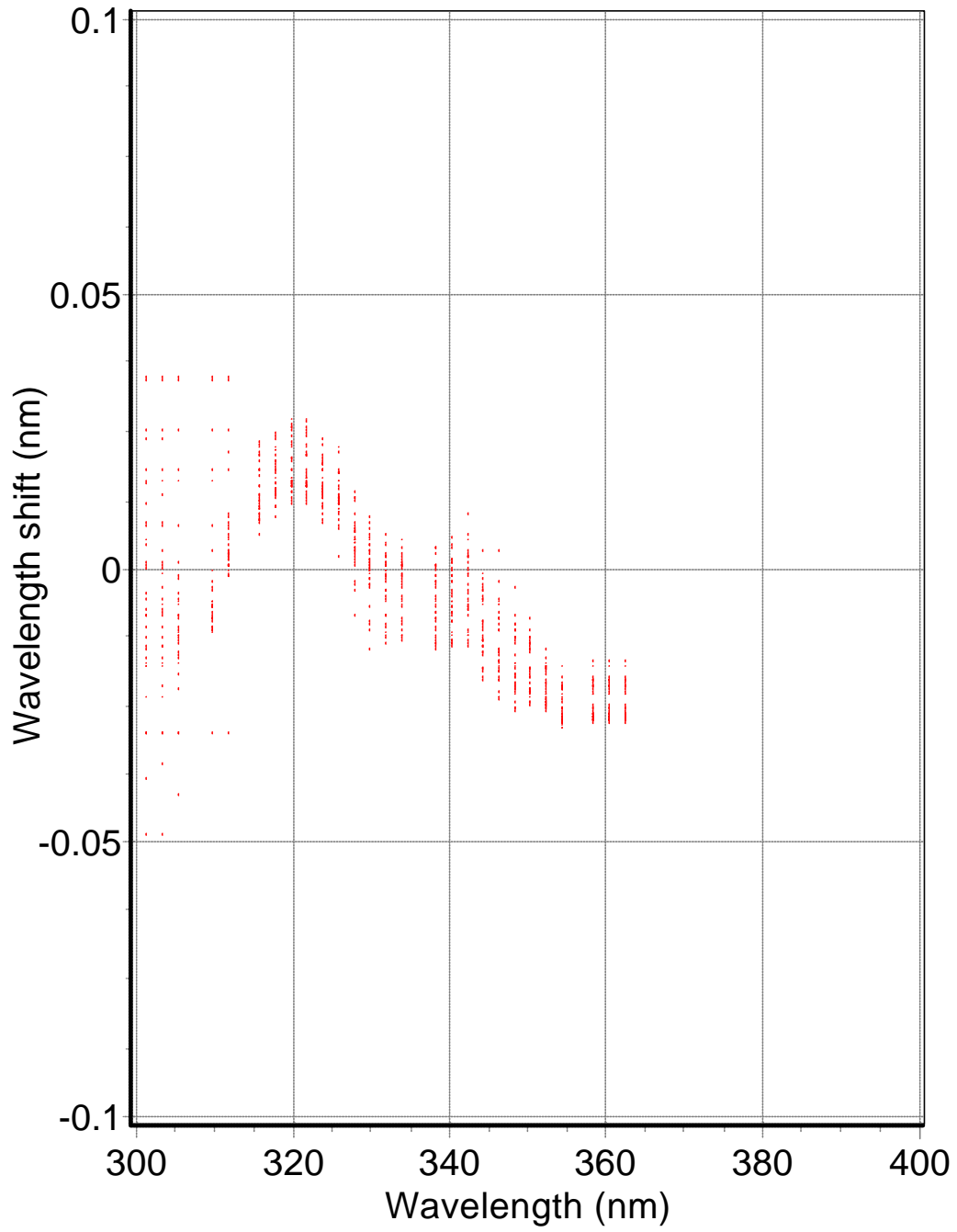
Wavelength shifts for: fij 189\*



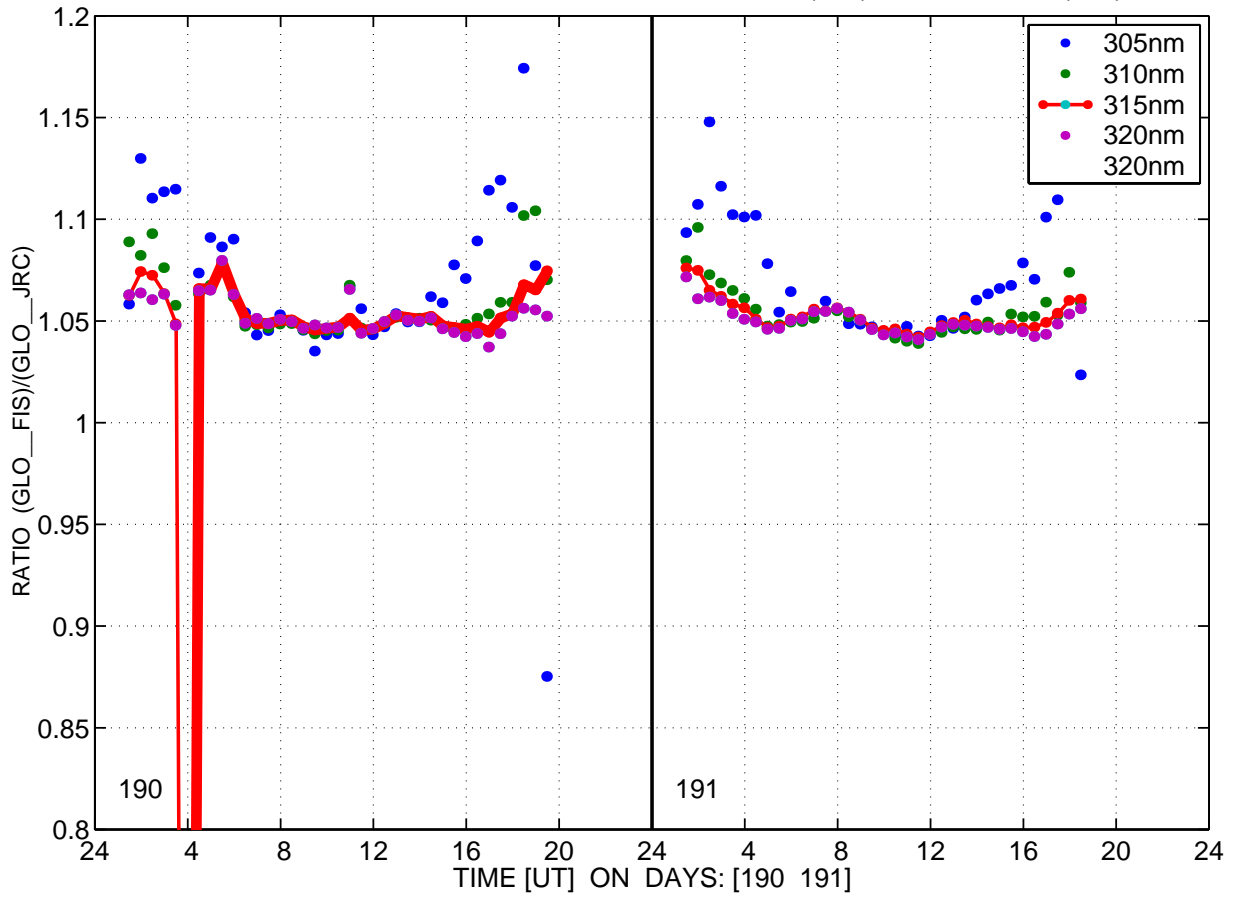
Wavelength shifts for: fij 190\*



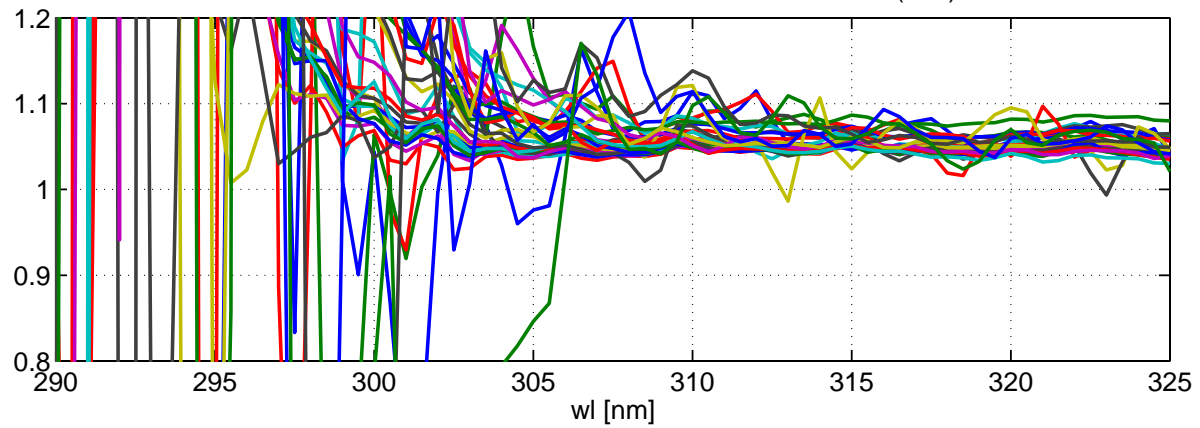
Wavelength shifts for: fij 191\*



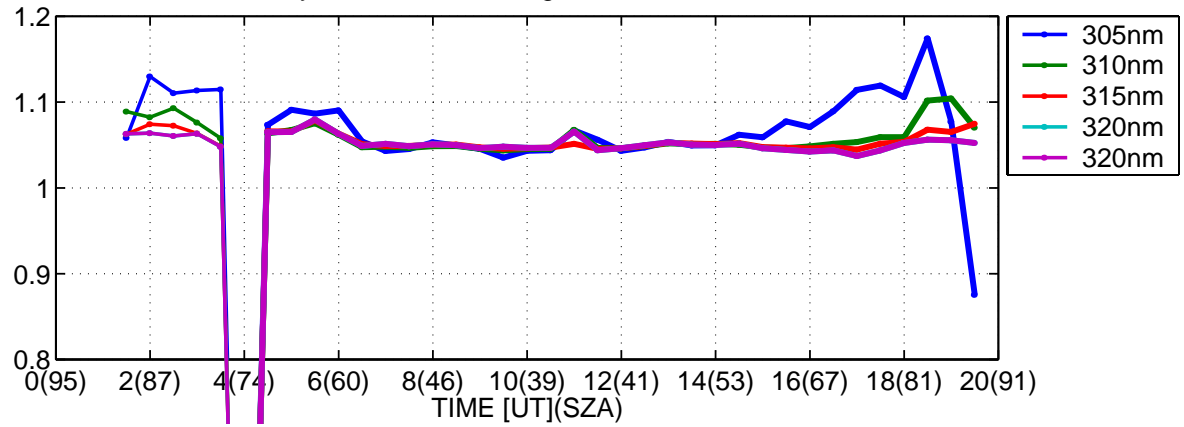
Global irradiance ratios FIS/JRC at FIS:09-Jul-2002(190) to 10-Jul-2002(191)



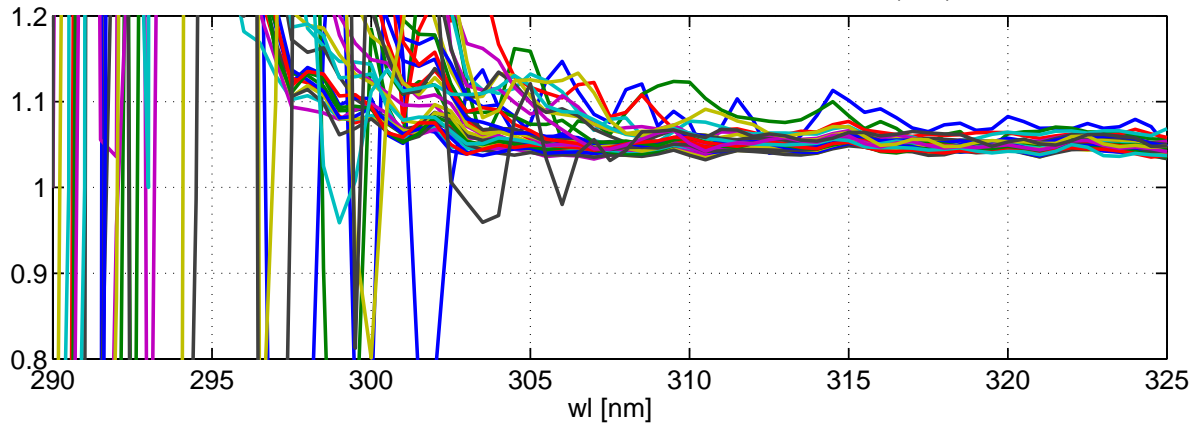
Global irradiance ratios FIS/JRC at FIS:09-Jul-2002(190)



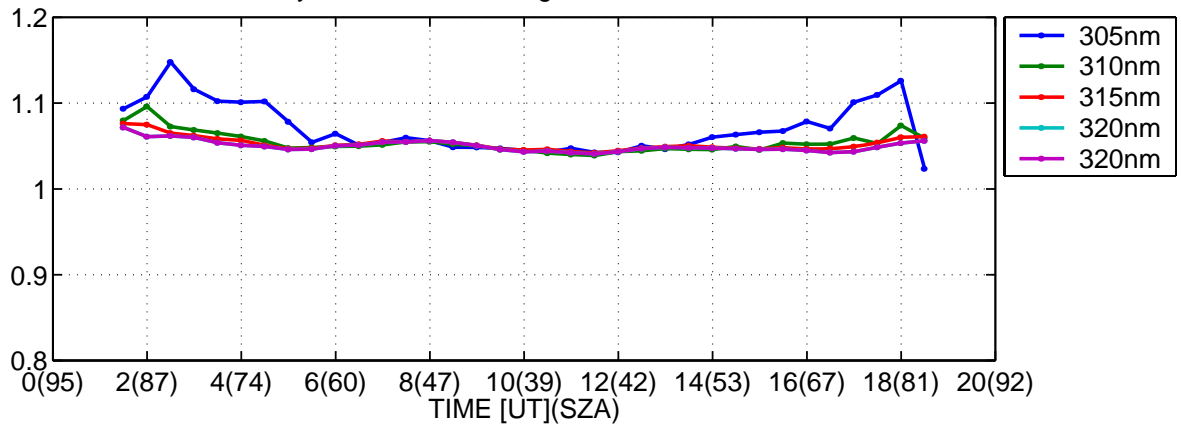
Daily variation. Wavelength bands are  $\pm 2.5$ nm



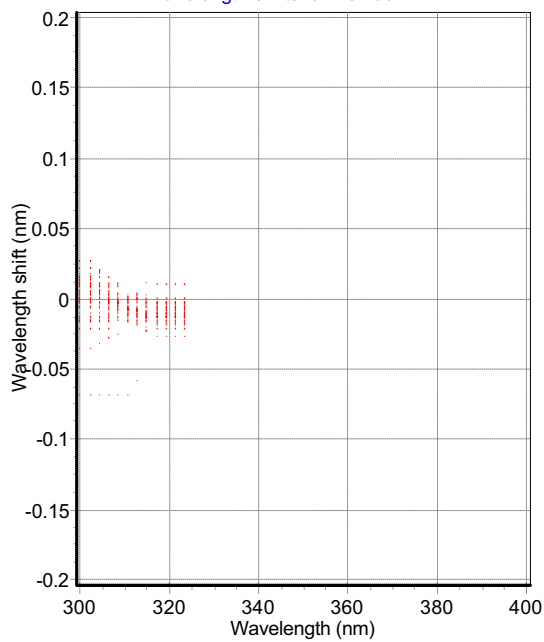
Global irradiance ratios FIS/JRC at FIS:10-Jul-2002(191)



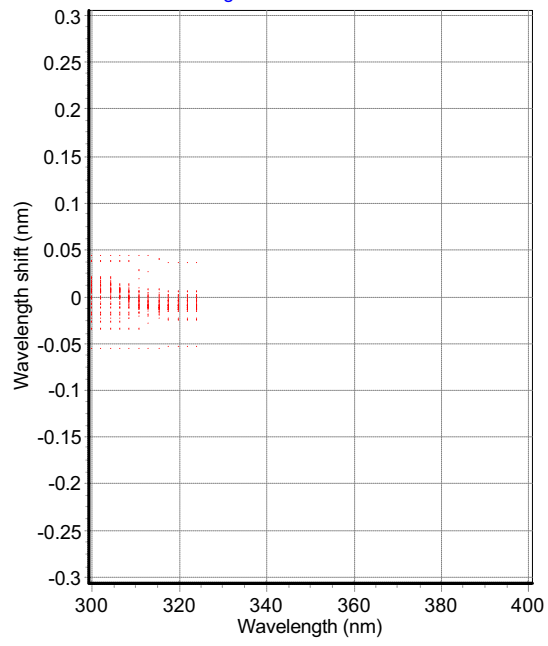
Daily variation. Wavelength bands are  $\pm 2.5$ nm



Wavelength shifts for: fis 190\*



Wavelength shifts for: fis 191\*



The visible horizon at Brewer #107 (FIJ) at Jokioinen as recorded in summer 1994. Since then wood has been cut in the south and in the west, thus improving the horizon by a few degrees. Also the path of the Sun on days 1 to 180 is shown.

