Protocol of the intercomparison at the University of Hannover (UHAN), Hannover, Germany, August, 26-31 2002 with the travelling reference spectrometer B5503 from ECUV within the project QASUME

Report prepared by Julian Gröbner

Operator: Julian Gröbner

The purpose of the visit was the comparison of global solar irradiance measurements between the spectrometer operated by UHAN and B5503. The visit at UHAN follows the previous intercomparison at the home site of B5503 at the JRC, Ispra, Italy. The measurement site is located near Ruthe in the south of Hannover and consists of a large grass field. Latitude is 53.242 N, Longitude 9.813 E and altitude is 70 m.a.s.l.
The horizon of the measurement site is free down to about 85 deg SZA in all directions.

B5503 arrived at UHAN in the evening of August 26, 2002. The instrument was installed on the ground, about 1.5 m from the spectrometer of UHAN. The intercomparison between B5503 and the spectrometer from UHAN lasted five days, from morning of August 27 to the afternoon of August 31.

B5503 was calibrated at the beginning, middle, and end of the intercomparison period using a 100 W portable calibration system. Three 100 W 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 August 27 was held from 14:50 to 17:00 UT, the second on August 29 from 08:40 to 10:00 UT, and the last calibration on August 31 from 7:30 to 8:45 UT. The calibration times were chosen to coincide with the calibrations of UHAN so as not to loose any synchronous solar measurements.
The stability of the instrument during the intercomparison is ± 0.5%, based on the 100 W calibration data (see appended graph). The internal temperature of B5503 was 27.5 ± 0.2 °C during the whole period. 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 ± 50pm in the spectral range 310 to 500 nm (see appended graphs).

Protocol:
The measurement protocol was to measure one solar irradiance spectrum every 30 minutes from 290 to 500 nm, every 0.25 nm, and 1.5 seconds between each wavelength increment.

<u>August 26 (238):</u>

Arrival and setup of the instrument in the late afternoon. Left to stabilize over night.

<u>August 27 (239):</u>

Synchronous measurements started at 4:30 UT. Due to mist and humidity, the detector domes stayed humid until 6:00 UT, time of the first scan with dry domes. Synchronous measurements lasted until 12:00, when UHAN started to calibrate. There were no more synchronous measurements on this day due to problems with

the UHAN spectrometer. General conditions were a mix of sun and clouds and light wind. No data from UHAN was submitted for this day.

August 28 (240):

Similar conditions to the previous day. Due to humidity on the detector dome, first reliable measurements started at 7:00 UT. Solar spectra from UHAN were submitted from 12:00 to 16:00 UT.

August 29 (241):

Similar atmospheric conditions to the previous days., Synchronised measurements were submitted from 11:00 to 13:30 UT. UHAN measured the 325 nm laserline from the HeCd Laser during the late afternoon. In the afternoon, B5503 first calibrated relative to its own set of three working lamps, then measured the primary and working standard of UHAN inside their calibrator (100 W).

August 30 (242):

Two simultaneous solar measurements between the UHAN spectrometer and B5503 were available at 8:30 and 9:00 UT. Atmospheric conditions were sunny with high cirrus clouds.

August 31 (243):

UHAN calibrated from 7:30 UT to 8:30 UT. Atmospheric conditions were variable with a mix of sun and clouds with medium wind speeds. UHAN calibrated again at 12:00 until 13:00 UT. No data was submitted on this day.

Results:

The wavelength shifts of the submitted solar spectra of the UHAN spectrometer retrieved through the SHICRivm analysis were stable to within ±70 pm. The wavelength shifts show a spectral periodicity with an amplitude of approx. 50 pm and a period of about 80 nm.

Due to problems with the UHAN spectrometer only 17 simultaneous measurements were submitted to the operator.

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

- Global irradiances measured by UHAN were between 5% lower to 2% higher than those measured by B5503 on the three days. If measurements on August 29 are excluded, measurements of UHAN are 5% lower than B5503.
- Due to the restricted data set, no definite statement on possible diurnal variations can be made.
- The spectral shape of the global irradiance ratios between UHAN and B5503 are spectrally flat to within 2% between 300 and 500 nm with very little structure.
- The certificate of the primary standard of UHAN is 3% lower than the one used by B5503. Some discrepancies were seen between the working and primary standard of UHAN.

Comments from the local operator:
Description of the campaign in August 2002

Description of the instrument

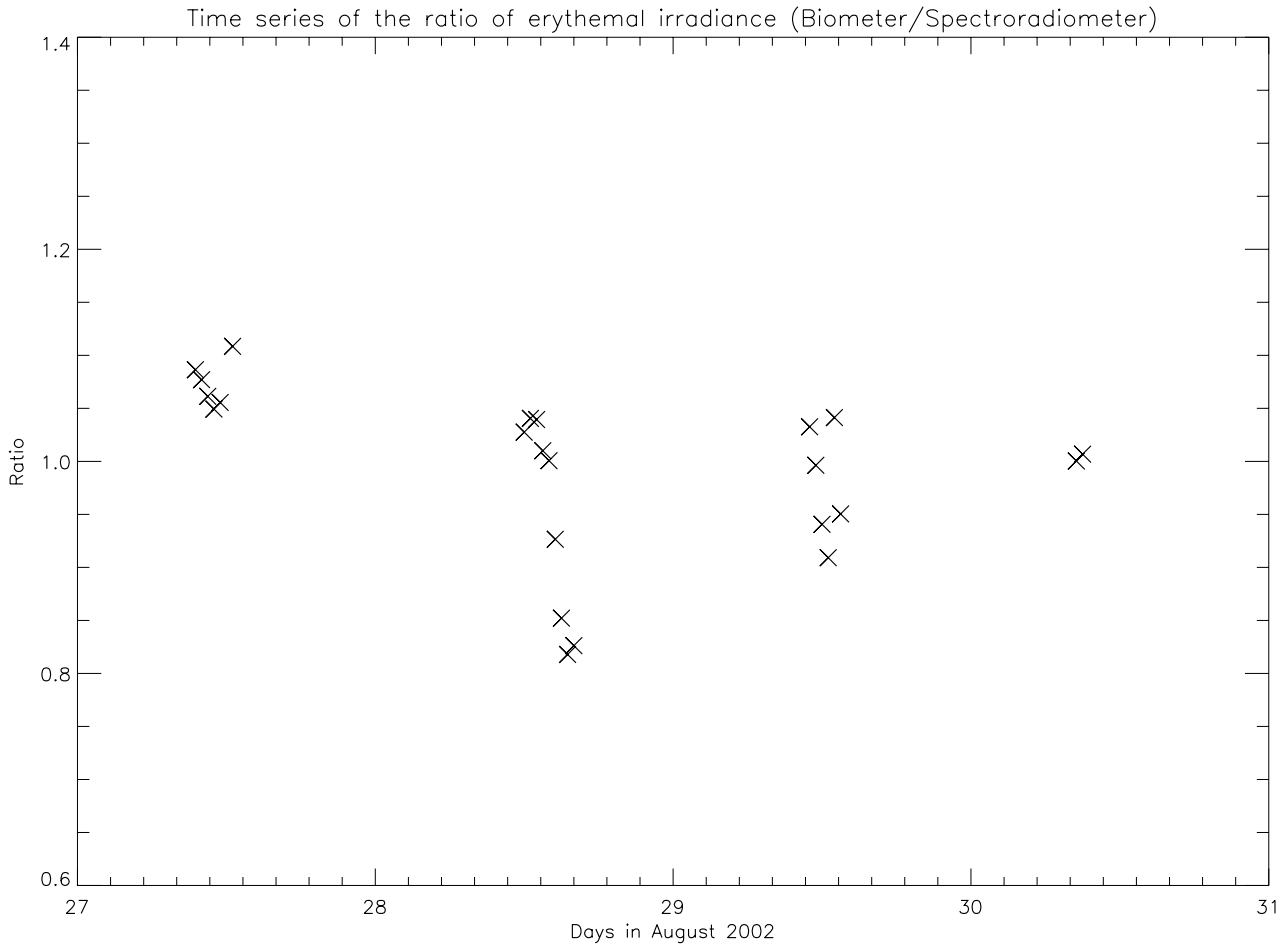
The spectroradiometer contains a double monochromator, modell TMc300, manufactured by Bentham. The instrument has a focal length of 300 mm. To operate the spectroradiometer in a stable way, it is placed it in a temperature controlled box. The temperature inside the box has been 20 °C (± 0.5 °C) during the time of the measurement. The instrument was operated in the same mode as in Ispra: Scans were taken every 30 minutes. Spectra were measured from 290 up to 500 nm in 0.25 nm steps. One wavelength step took 1.5 s resulting in 21 minutes for the complete spectrum.

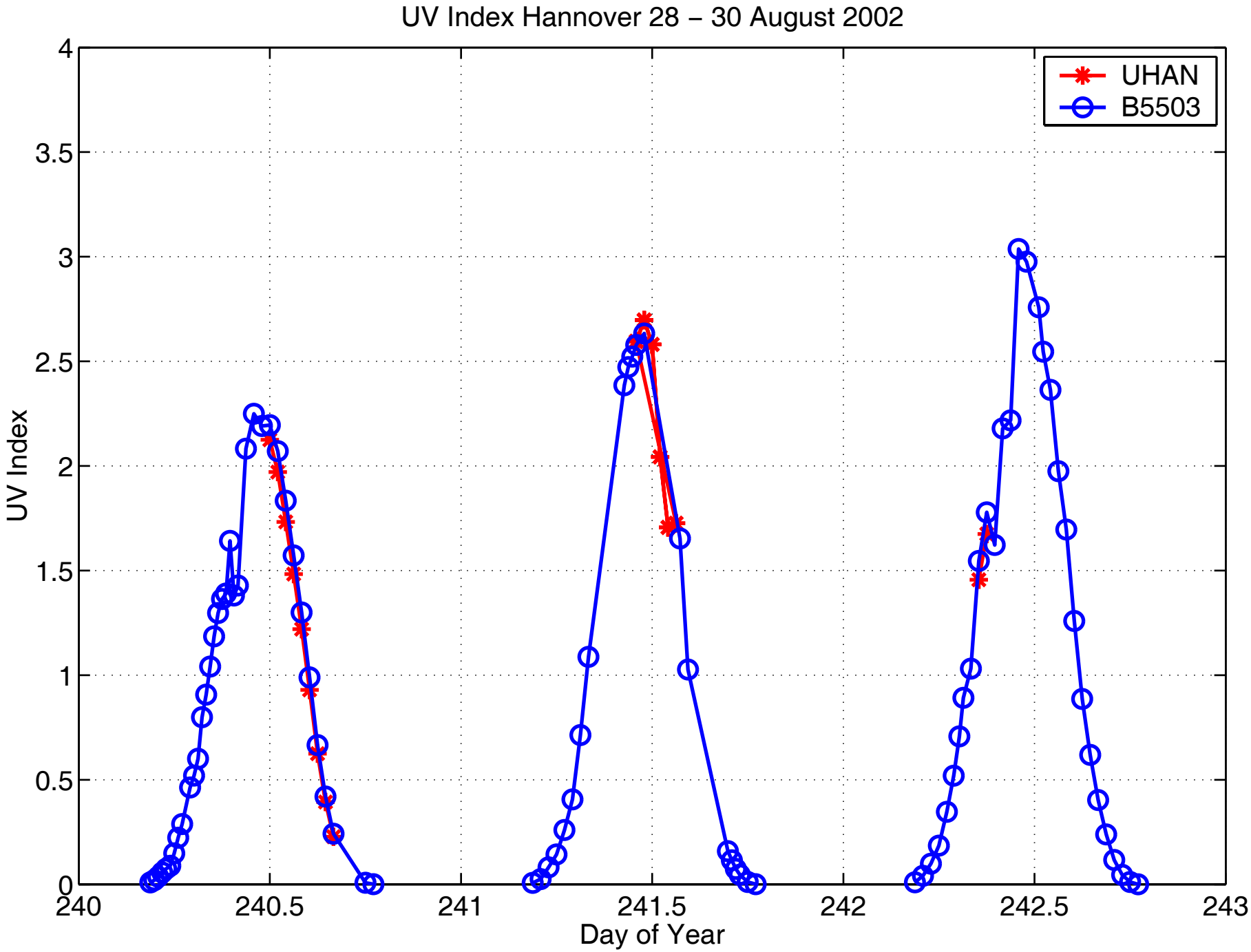
Results of the campaign

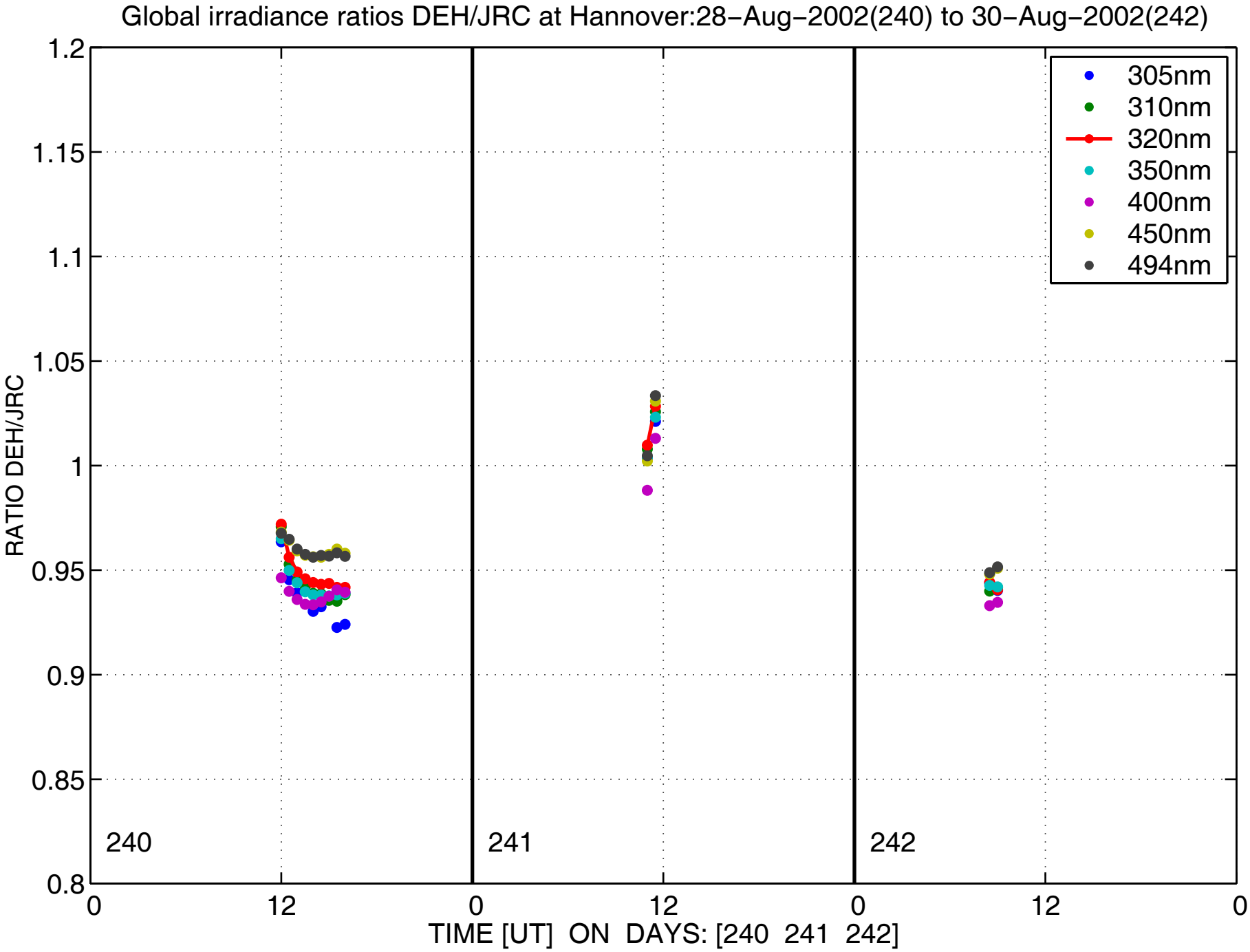
During the qasume campaign in August 2002 the stability of the spectroradiometer was found to be not satisfactory. These problems were detected by stability tests and quality control procedures performed during the campaign by UHAN. At least once a day a 100 W halogen lamp was measured inside our portable calibrator with the same wavelength steps and range as the spectra measuring the sun. On some occasions the lamp measurements deviated by more than 30%. On these days no data were submitted because it was impossible to decide whether the change in stability occured slowly or whether rapid steplike changes in stability occured. The stability problem was especially pronounced when the instrument was parked a few times in a row before taking a lamp scan. Furthermore the stability changes were more pronounced when the wavelengths to be measured and the wavelength steps were altered. Despite these problems there were some times and days where reliable measurements could be submitted. On these occasions the lamp measurements showed a reproducable behaviour. In addition the stability was cross-checked with measurements with a Solar Light Biometer (see attached graph).

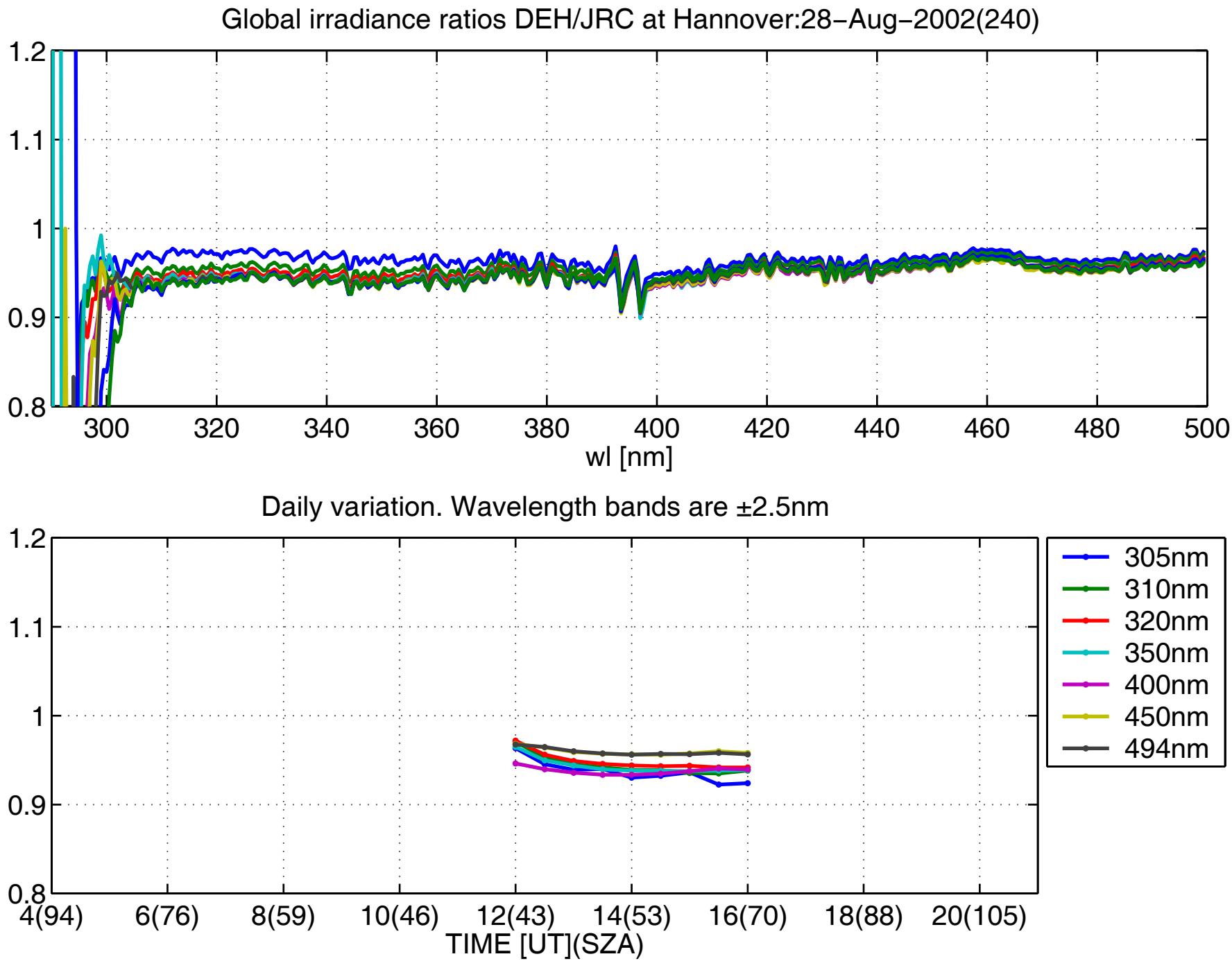
Conclusions

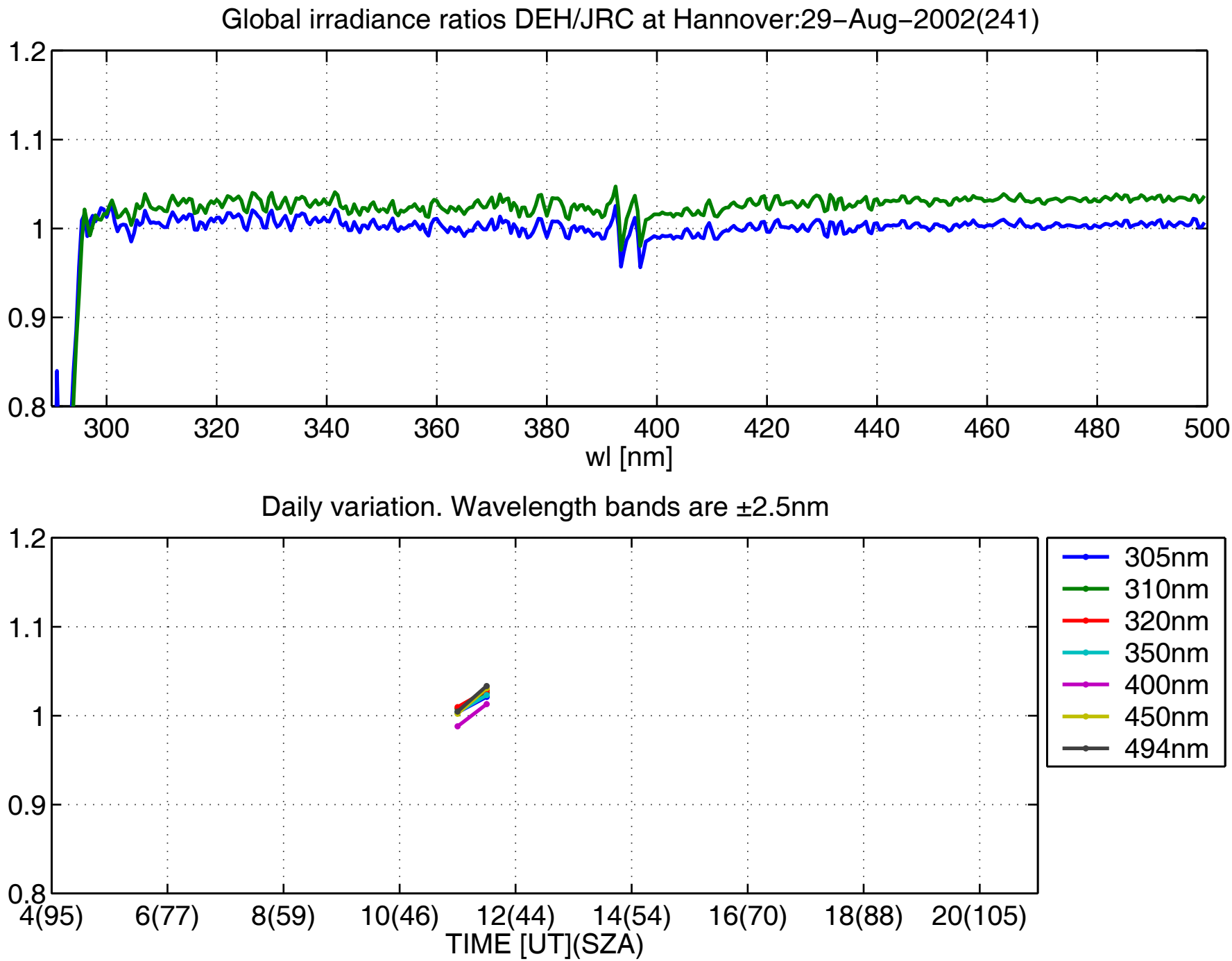
It is concluded that many measurements must be excluded from submission due to a mechanical problem of the monochromator. Fortunately some measurements can be considered satisfactory. It can presently not be said when the instrument is behaving well and when measurements have to be excluded (e.g. in Ispra no measurements had to be excluded for this reason). It is planned to repair the instrument after the calibration of the 1000 W lamps.

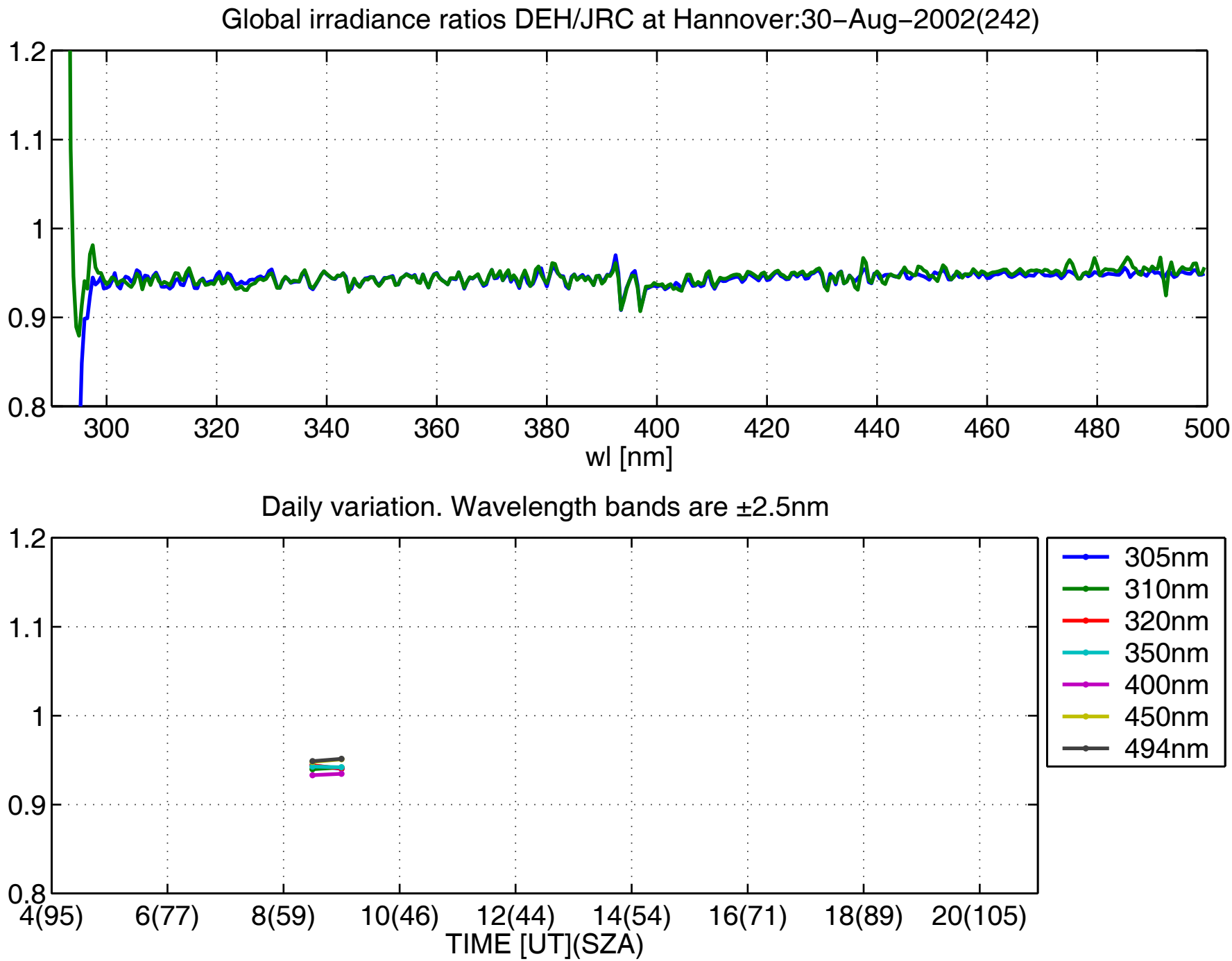

Time series of the ratio of erythemal irradiance (Biometer/Spectroradiometer)
Ratio
1.4
1.2
1.0
0.8
0.6
27
28
29
30
31
Days in August 2002

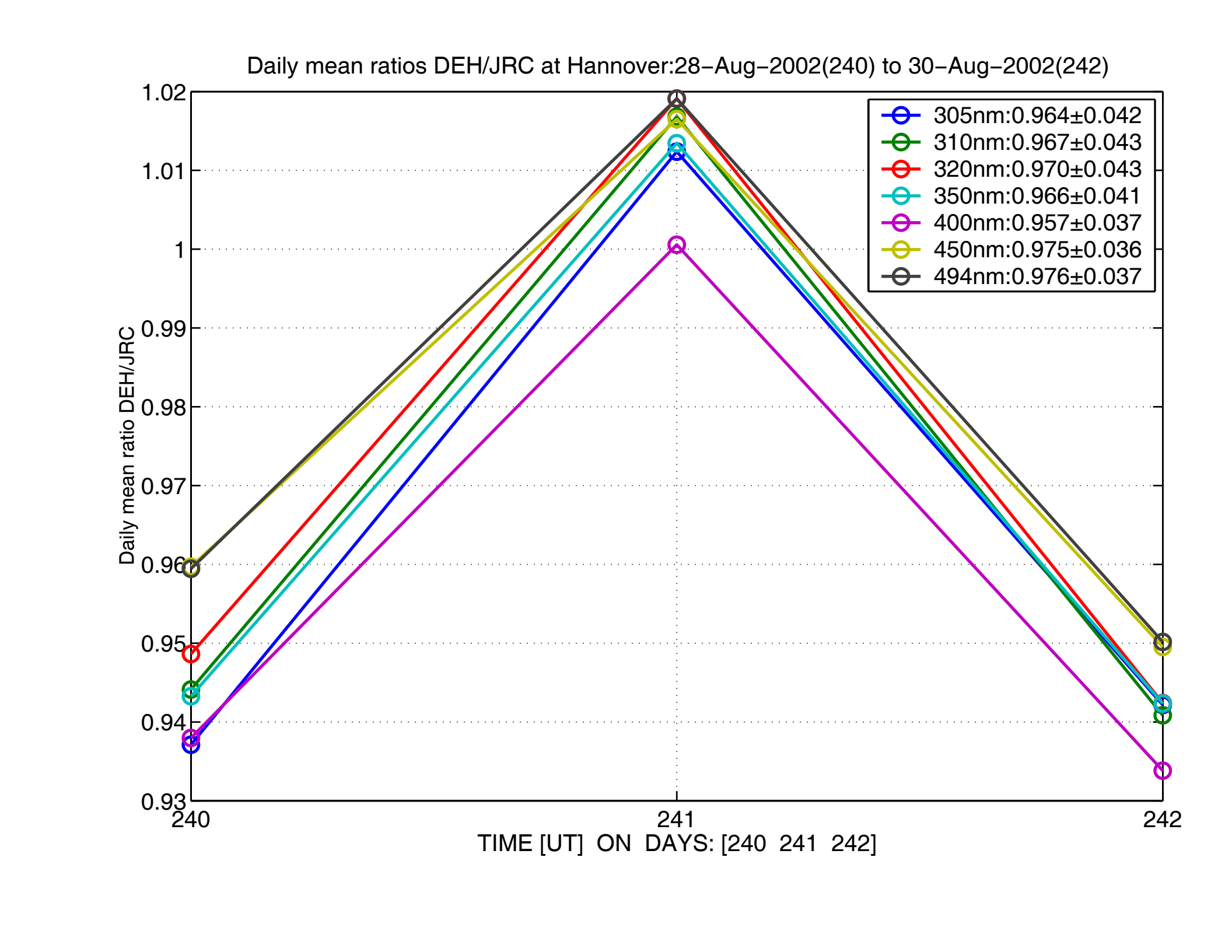

UV Index Hannover 28 – 30 August 2002
UHAN
B5503
UV Index
Day of Year
0
0.5
1
1.5
2
2.5
3
3.5
4
240
240.5
241
241.5
242
242.5
243

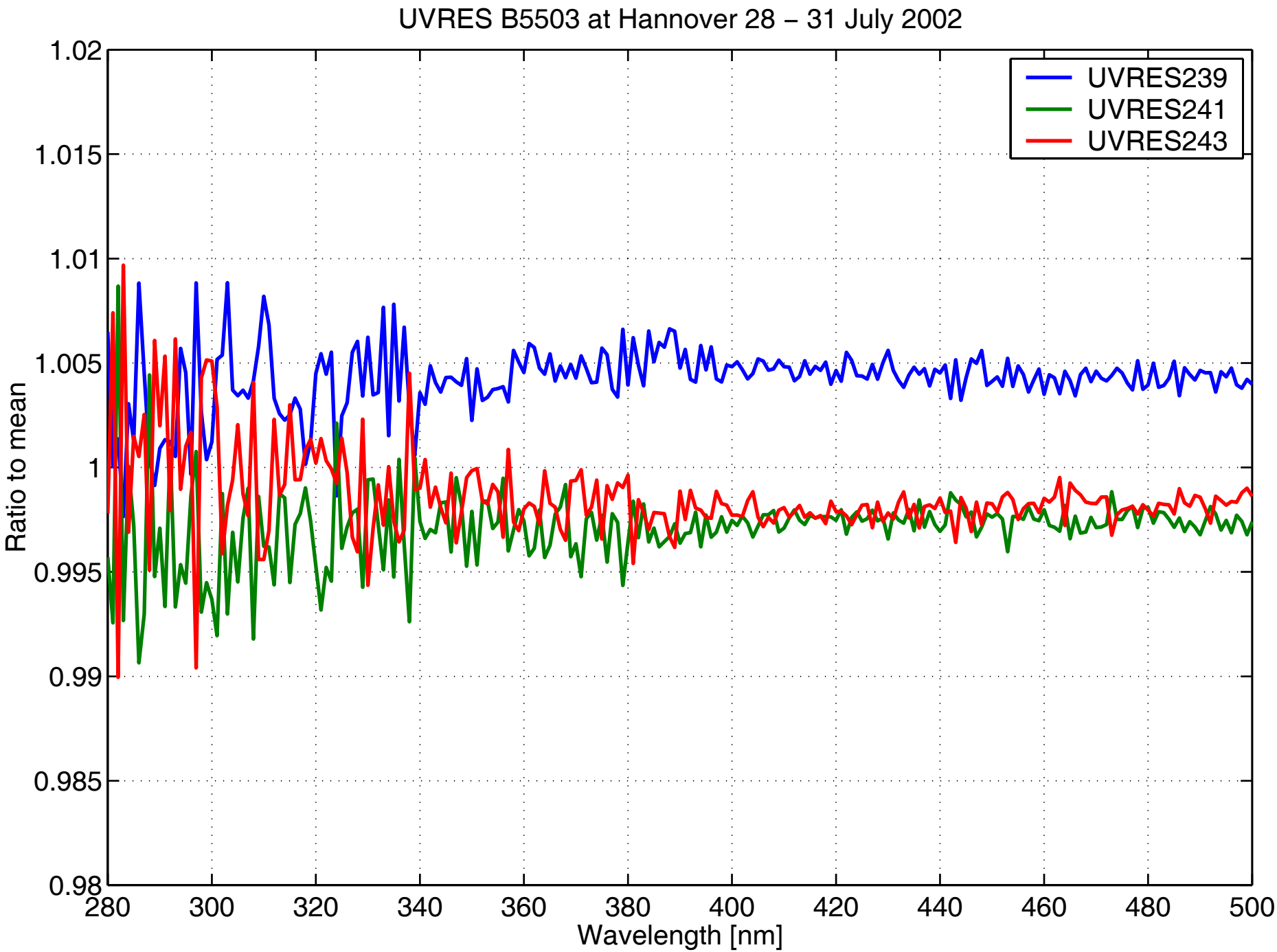

Global irradiance ratios DEH/JRC at Hannover:28−Aug−2002(240) to 30−Aug−2002(242)
RATIO DEH/JRC
TIME [UT] ON DAYS: [240 241 242]
305nm
310nm
320nm
350nm
400nm
450nm
494nm
240
241
242
1.2
1.15
1.1
1.05
1
0.95
0.9
0.85
0.8
0
12
0
12
0
12
0

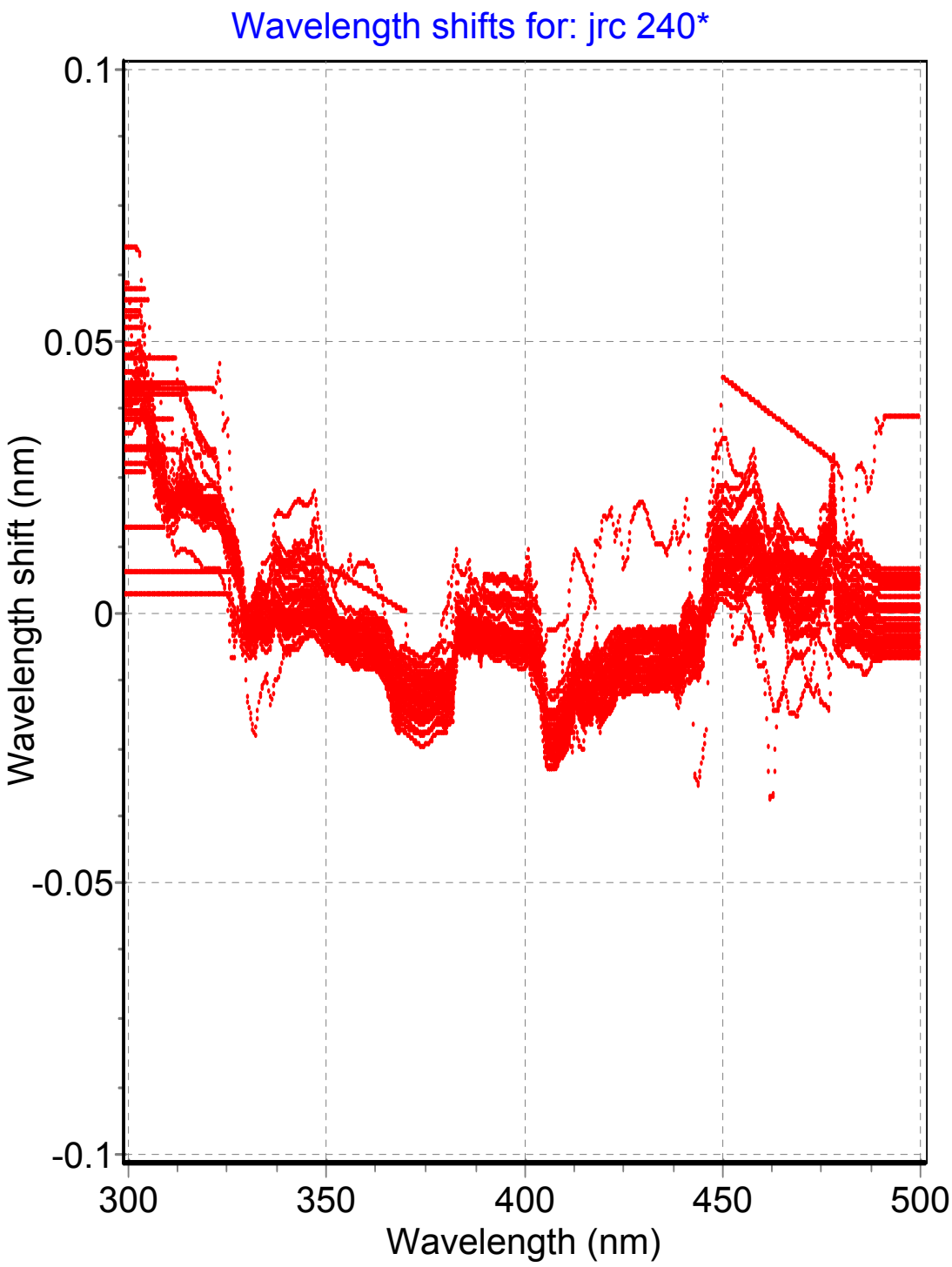

Global irradiance ratios DEH/JRC at Hannover:28−Aug−2002(240)
1.2
1.1
1
0.9
0.8
300
320
340
360
380
400
420
440
460
480
500
wl [nm]
Daily variation. Wavelength bands are ±2.5nm
1.2
1.1
1
0.9
0.8
4(94)
6(76)
8(59)
10(46)
12(43)
14(53)
16(70)
18(88)
20(105)
TIME [UT](SZA)
305nm
310nm
320nm
350nm
400nm
450nm
494nm

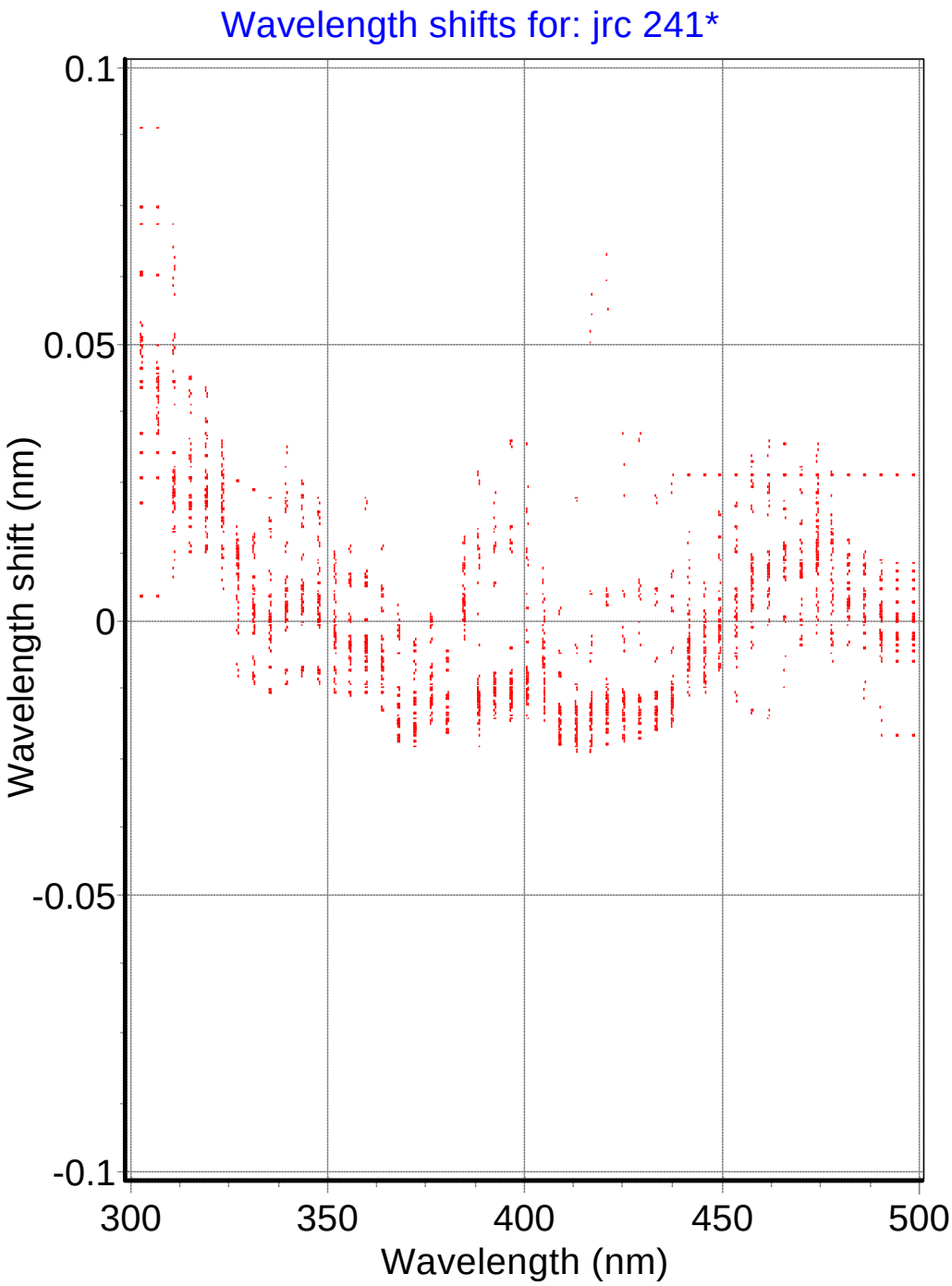

Global irradiance ratios DEH/JRC at Hannover:29−Aug−2002(241)
1.2
1.1
1
0.9
0.8
300
320
340
360
380
400
420
440
460
480
500
wl [nm]
Daily variation. Wavelength bands are ±2.5nm
1.2
1.1
1
0.9
0.8
4(95)
6(77)
8(59)
10(46)
12(44)
14(54)
16(70)
18(88)
20(105)
TIME [UT](SZA)
305nm
310nm
320nm
350nm
400nm
450nm
494nm

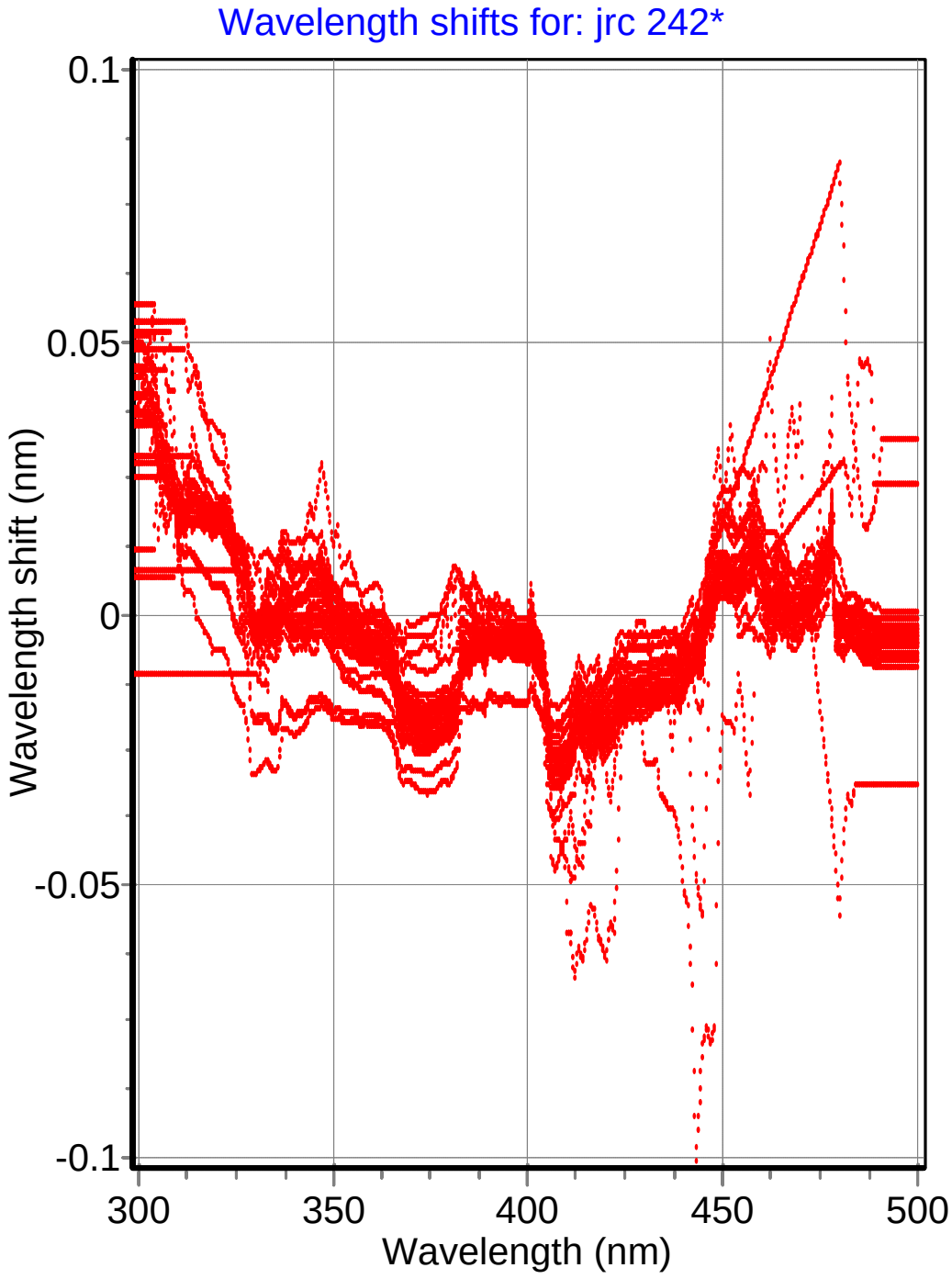

Global irradiance ratios DEH/JRC at Hannover:30−Aug−2002(242)
1.2
1.1
1
0.9
0.8
300
320
340
360
380
400
420
440
460
480
500
wl [nm]
Daily variation. Wavelength bands are ±2.5nm
1.2
1.1
1
0.9
0.8
4(95)
6(77)
8(59)
10(46)
12(44)
14(54)
16(71)
18(89)
20(105)
TIME [UT](SZA)
305nm
310nm
320nm
350nm
400nm
450nm
494nm

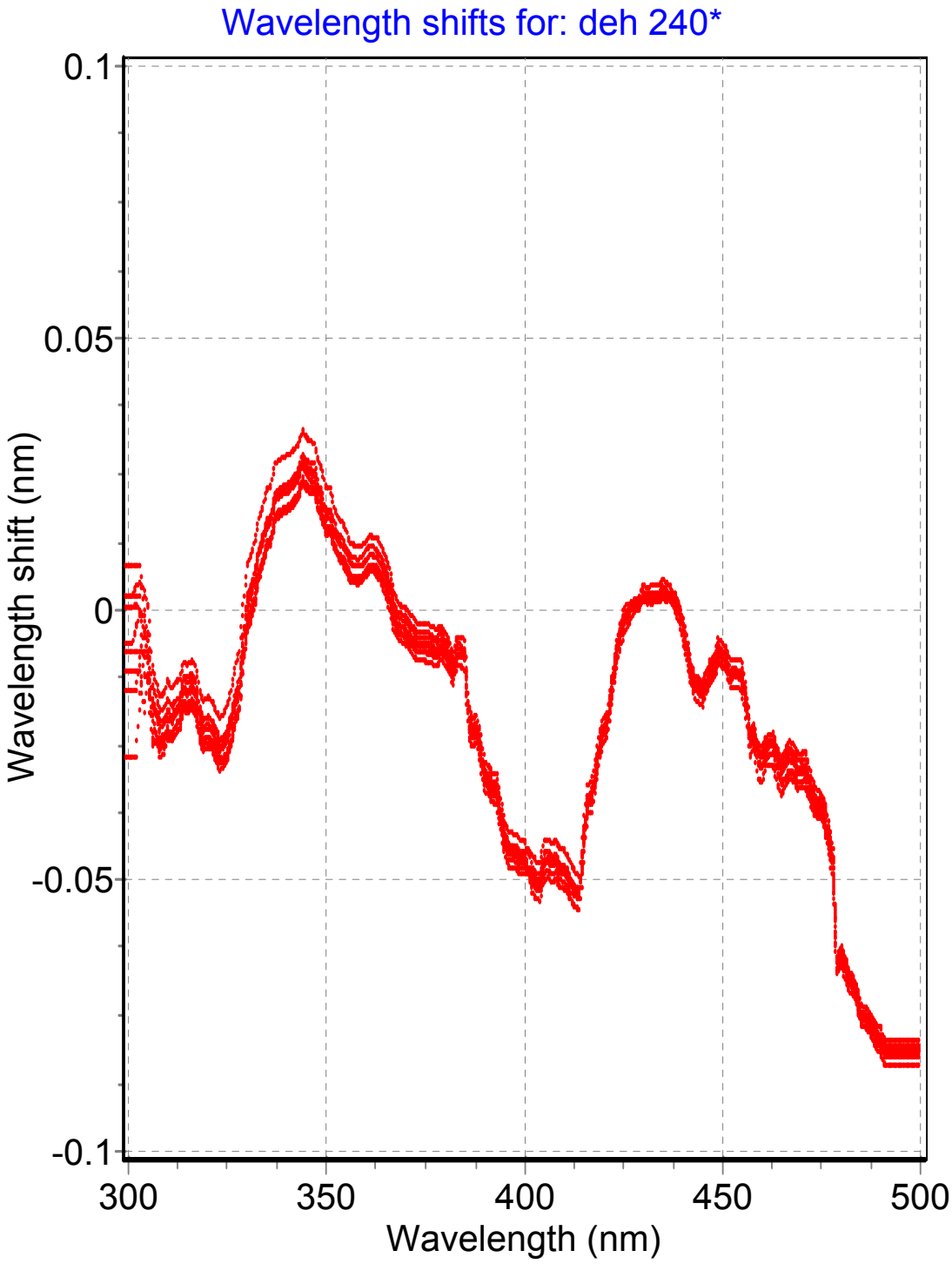

Daily mean ratios DEH/JRC at Hannover:28−Aug−2002(240) to 30−Aug−2002(242)
305nm:0.964±0.042
310nm:0.967±0.043
320nm:0.970±0.043
350nm:0.966±0.041
400nm:0.957±0.037
450nm:0.975±0.036
494nm:0.976±0.037
Daily mean ratio DEH/JRC
1.02
1.01
1
0.99
0.98
0.97
0.96
0.95
0.94
0.93
240
241
242
TIME [UT] ON DAYS: [240 241 242]

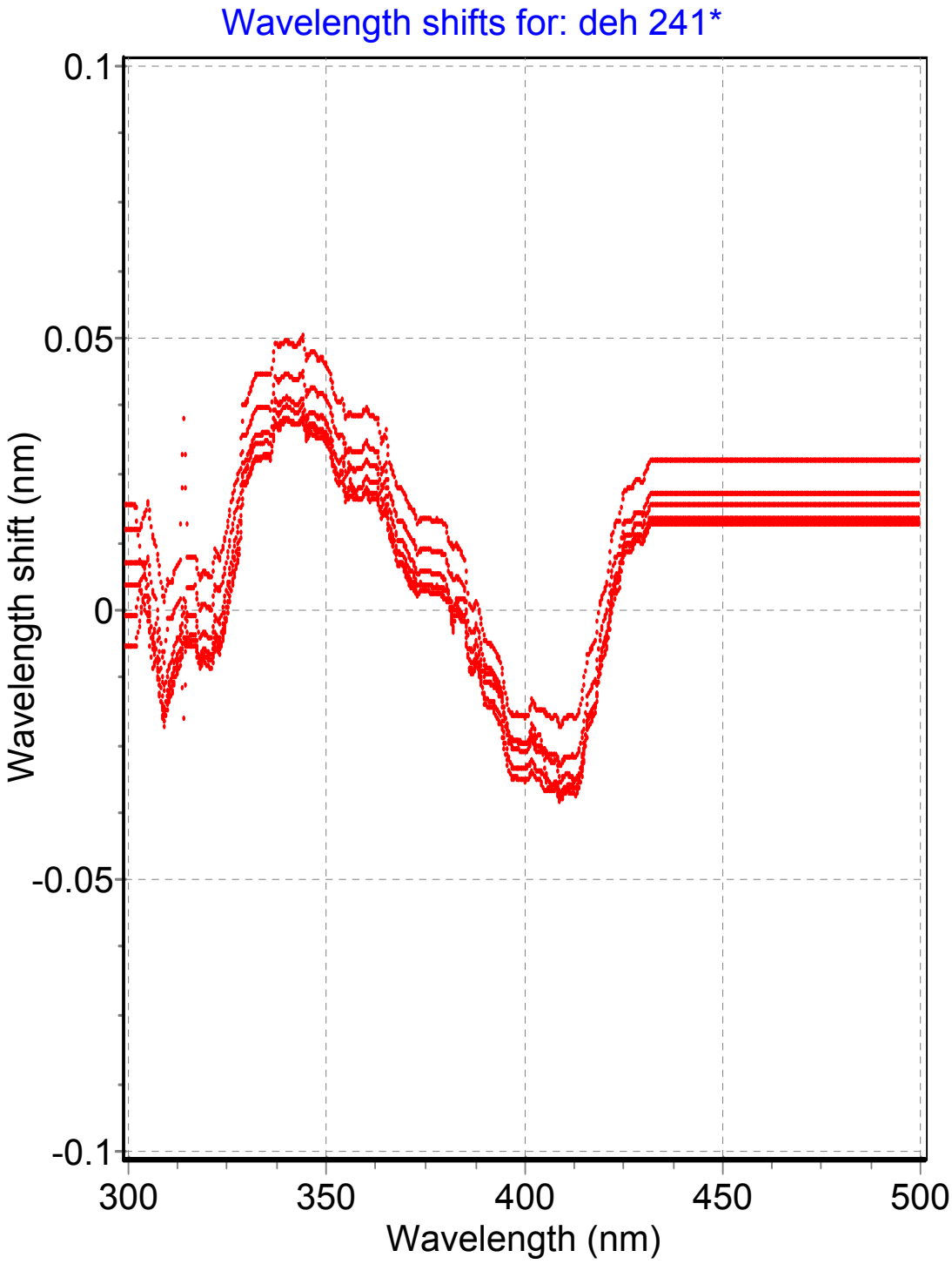

UVRES B5503 at Hannover 28 – 31 July 2002
UVRES239
UVRES241
UVRES243
Ratio to mean
Wavelength [nm]
1.02
1.015
1.01
1.005
1
0.995
0.99
0.985
0.98
280
300
320
340
360
380
400
420
440
460
480
500


Wavelength shifts for: jrc 240*
0.1
0.05
0
-0.05
-0.1
Wavelength shift (nm)
300
350
400
450
500
Wavelength (nm)


Wavelength shifts for: jrc 241*
0.1
0.05
0
-0.05
-0.1
Wavelength shift (nm)
300
350
400
450
500
Wavelength (nm)


Wavelength shifts for: jrc 242*
0.1
0.05
0
-0.05
-0.1
Wavelength shift (nm)
300
350
400
450
500
Wavelength (nm)


Wavelength shifts for: deh 240*
0.1
0.05
0
-0.05
-0.1
Wavelength shift (nm)
300
350
400
450
500
Wavelength (nm)


Wavelength shifts for: deh 241*
0.1
0.05
0
-0.05
-0.1
Wavelength shift (nm)
300
350
400
450
500
Wavelength (nm)

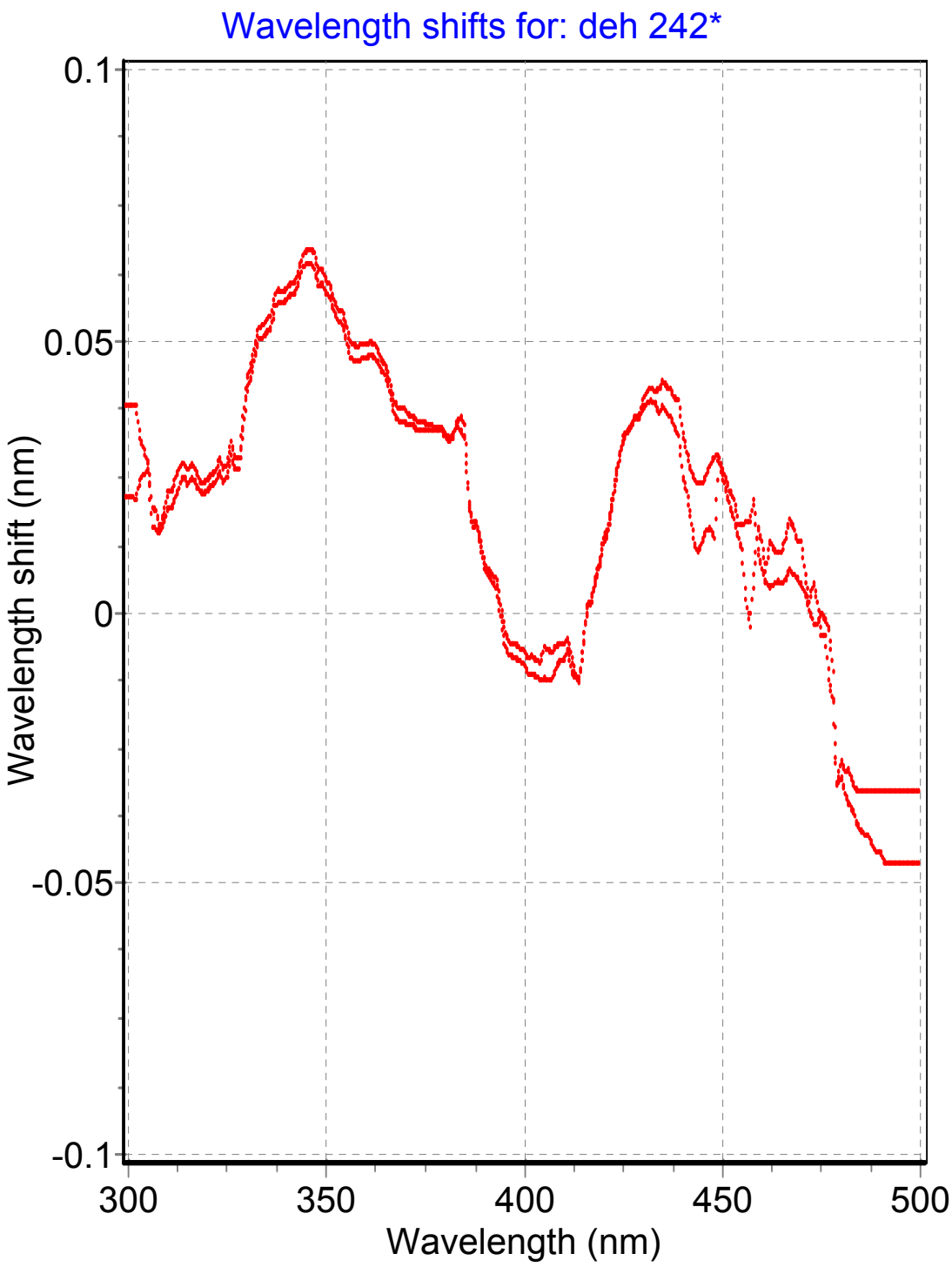

Wavelength shifts for: deh 242*
0.1
0.05
0
-0.05
-0.1
Wavelength shift (nm)
300
350
400
450
500
Wavelength (nm)

Figure 1 Measurement location at Heisede, Hannover. 27 August 2002 at 14:57 UT. Looking NORTH.

Figure 2 Measurement location at Heisede, Hannover. 27 August 2002 at 14:59 UT. Looking SOUTH.

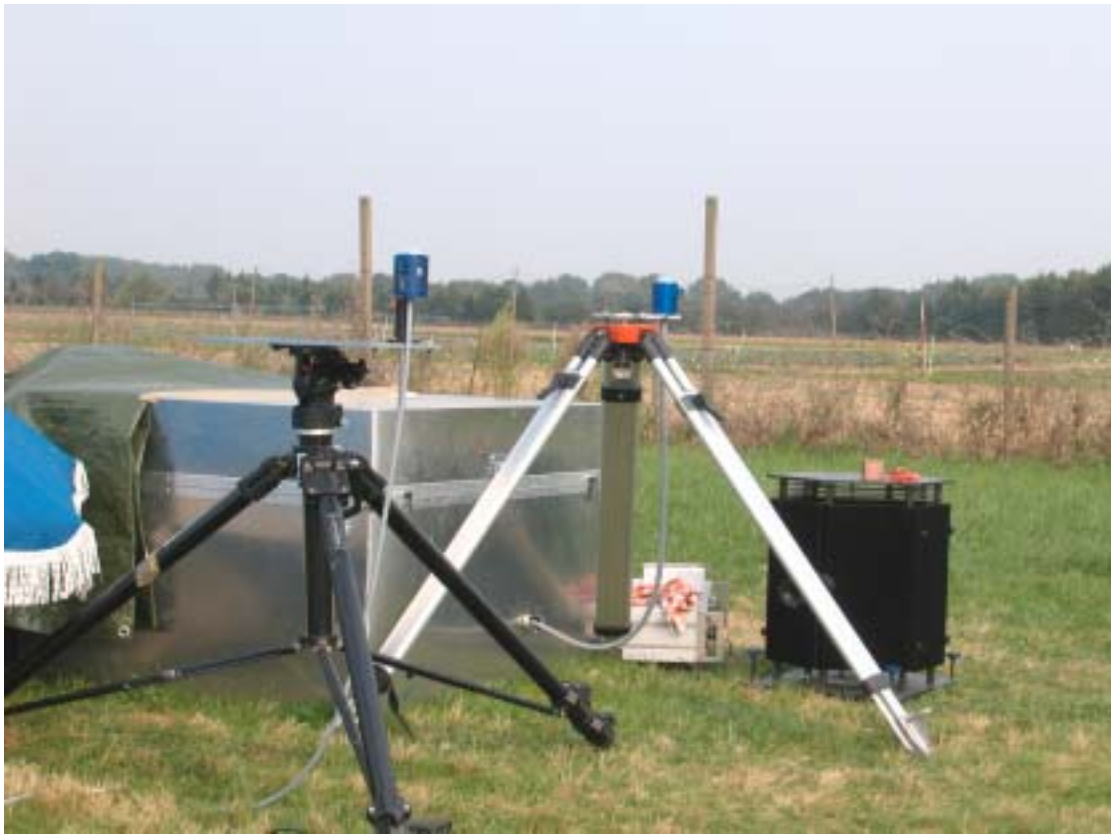


Figure 3 Measurement setup. B5503 is to the left in the picture.