Protocol of the intercomparison at the Bundesamt für Strahlenschutz (BFS), Neuherberg, Germany, August, 23-27 2004 with the travelling standard spectroradiometer B5503 from ECUV within the project QASUME

Report prepared by Julian Gröbner and Josef Schreder

Operator: Josef Schreder

The purpose of the visit was the comparison of global solar irradiance measurements between the spectroradiometer operated by BFS and B5503 within the project QASUME. The measurement site is located at Neuherberg; Latitude 48.221 N, Longitude 11.59 E and altitude 493 m.a.s.l.
The horizon of the measurement site is free in all directions.

B5503 arrived at Neuherberg in the morning of August 23, 2004. The spectroradiometer was installed on the roof of the BFS. The spectroradiometer in use at BfS is a Bentham DM150 double monochromator (DHB). The intercomparison between B5503 and the local spectroradiometer lasted 4 days, from the morning of August 24 to midday of August 27.

B5503 was calibrated several times during the intercomparison period using a portable calibration system. Two lamps were used to obtain an absolute spectral calibration traceable to the primary reference held at ECUV which is traceable to PTB: T57825 (100 W) and T61251 (250 W). The responsivity of the instrument based on these calibrations increased by 1.5% during the intercomparison. The internal temperature of B5503 was 27.1°C and varied by less than 0.4 °C. The diffuser head was heated to a temperature of about 25±3°C.
The wavelength shifts relative to an extraterrestrial spectrum as retrieved from the SHICRivm analysis were between ± 50pm in the spectral range 310 to 400 nm.

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 from 290 to 400 nm. Some spectra were measured at 15 min intervals. The NHB instrument was operated manually during the intercomparison, so synchronised measurements of NHB stopped at 15:30 UTC due to the departure of the local operator.

<u>Aug 23 (236):</u>

Arrival and setup of the instrument in the late morning. After the instrument stabilised, measurements were initiated at 10:00 UT. Weather conditions were broken clouds.
Temperature stabilisation started at 16° C.

Aug 24 (237):

Synchronised measurements are available from 8:00 to 14:15 UT. Weather conditions from the beginning till 10:00 are overcast by cirrus clouds. Then intermittent slight rain. The whole day slight windy. Measurements were disturbed by 2 fire alarms.

B5503 calibrated from 10:37 to 11:15 UT.

Aug 25 (238):

Synchronised measurements are available from 8:00 to 14:15 UT. BFS made a calibration of the system before 08:00. Weather conditions were a mix of sun and clouds, no rain.

Aug 26 (239):

Synchronised measurements are available from 6:15 to 15:30 UT.

Weather conditions until 7:15 rain, then overcast. Rain also from 11:00 to 11:45 UT.

B5503 calibrated from 12:07 to 13:20 UT.

Aug 27 (240):

Synchronised measurements are available from 5:30 to 11:00 UT.

Weather conditions were overcast by cirrus clouds.

Results:

59 synchronised scans are available from the measurement period.

The wavelength shifts of the submitted solar spectra of the BFS spectroradiometer retrieved through the SHICRivm analysis varied from –0.08 nm at 305 nm to +0.08 nm at 390 nm. The mean wavelength shift over the wavelength range 300 to 400 nm was 0.02 nm.

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

- Global solar irradiances measured by NHB were between 10% lower to 10% higher than those measured by B5503 for wavelengths between 300 and 400 nm.
- The spectral ratios between NBH and B5503 show a systematic decrease of about 6% between 345 nm and 360 nm. The average ratio of NBH to B5503 is about 1.04 between 300 and 345 nm, and 0.98 between 360 nm and 400 nm.
- Due to the rainy periods it is difficult to assess the diurnal variation of NHB. However the instrument seems to be stable at the 5% level for most of the measurement period. On August 27 a distinct increase of 10% is seen in the ratios NHB to B5503 from 6:00 UT to 10:00 UT, independent of wavelength.

Conclusion:

On average, the global solar irradiance spectra measured by the NHB spectroradiometer are between 5% higher to 3% lower than those measured by B5503 between 300 and 400 nm. Between 345 and 360 nm the spectral ratios decrease by about 6%. The variability between NHB

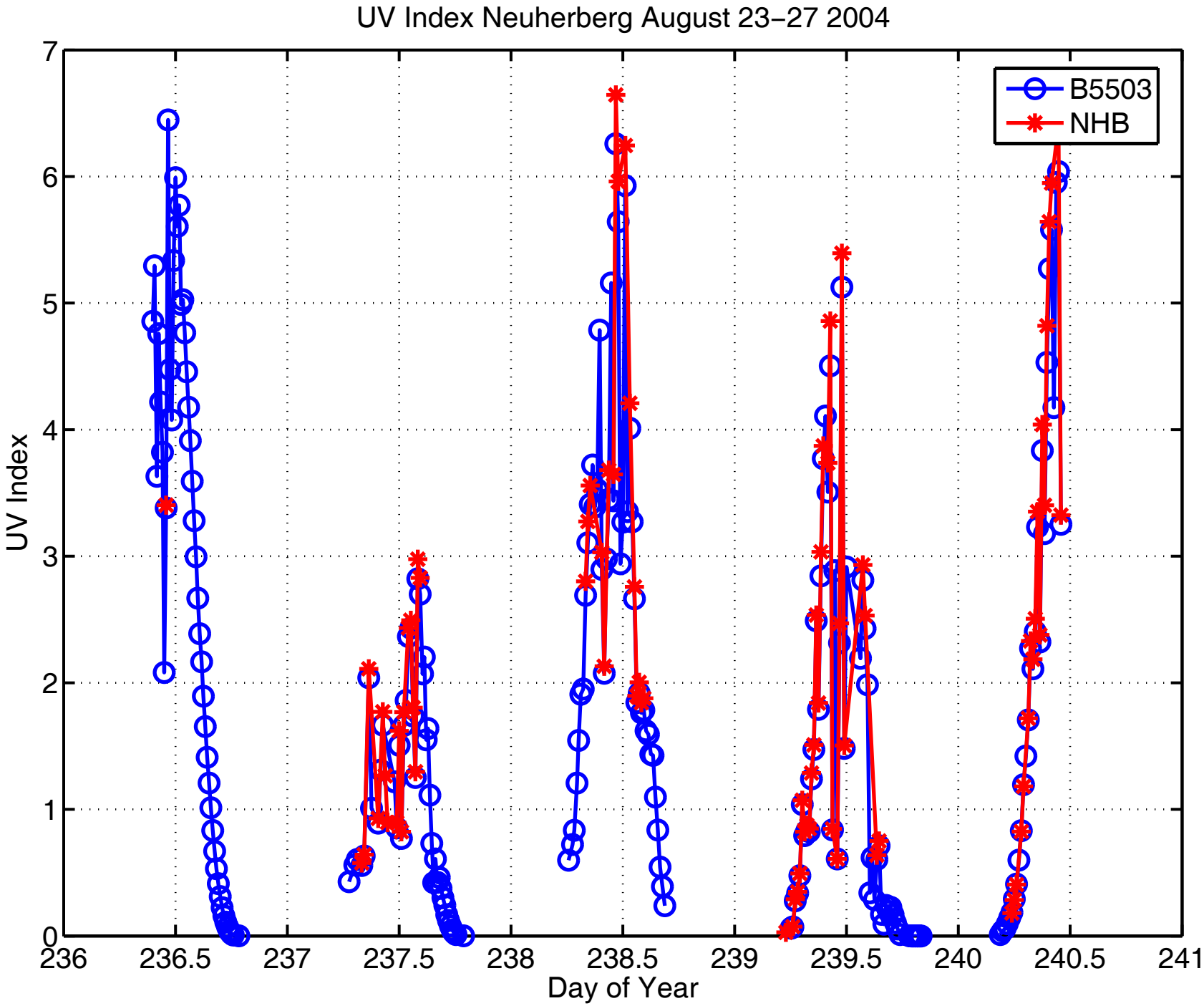
and B5503 is of the order of 10%. This variability might be in part due to problems with the synchronisation of NHB which was partly manual.

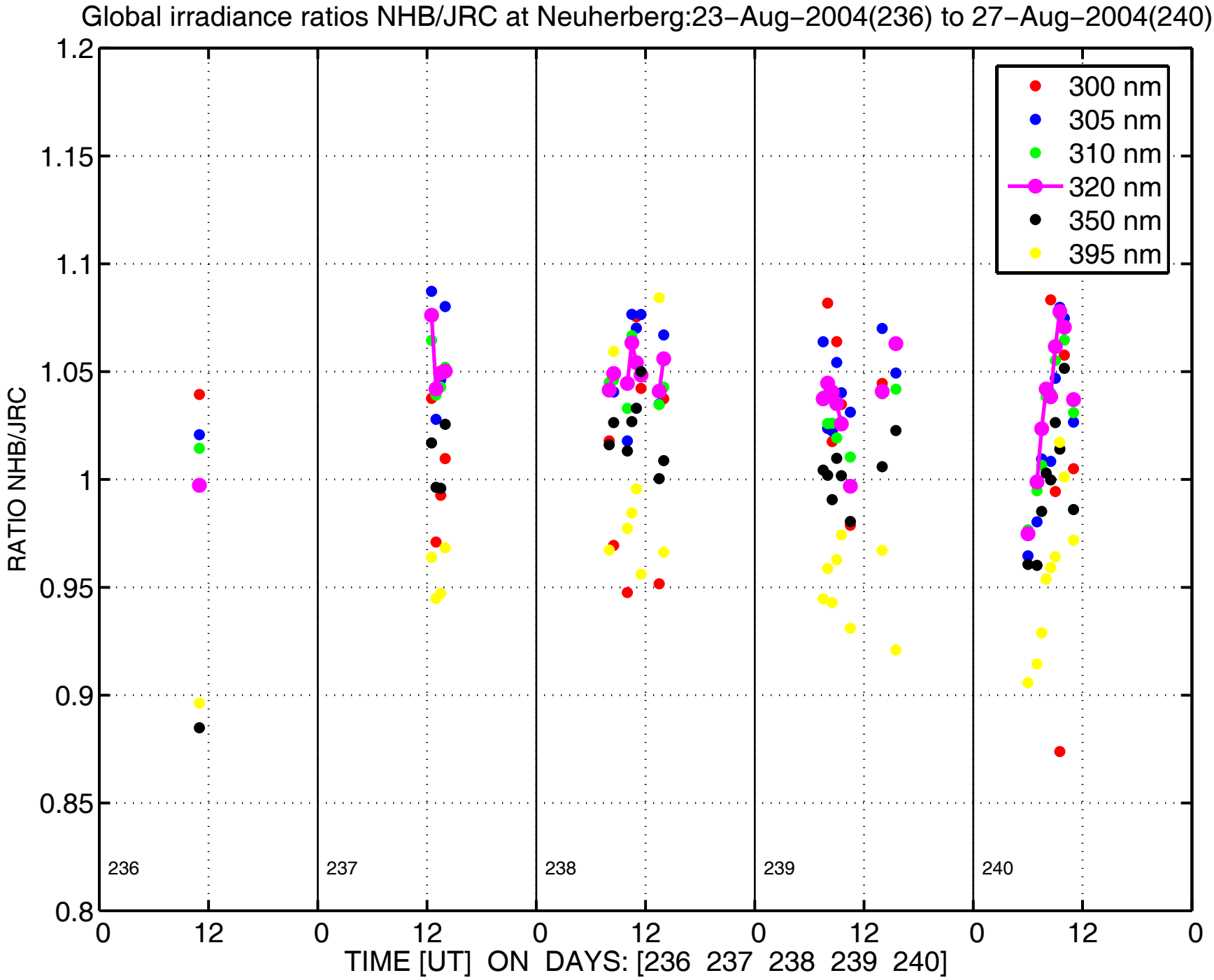
Comments from the local operator:

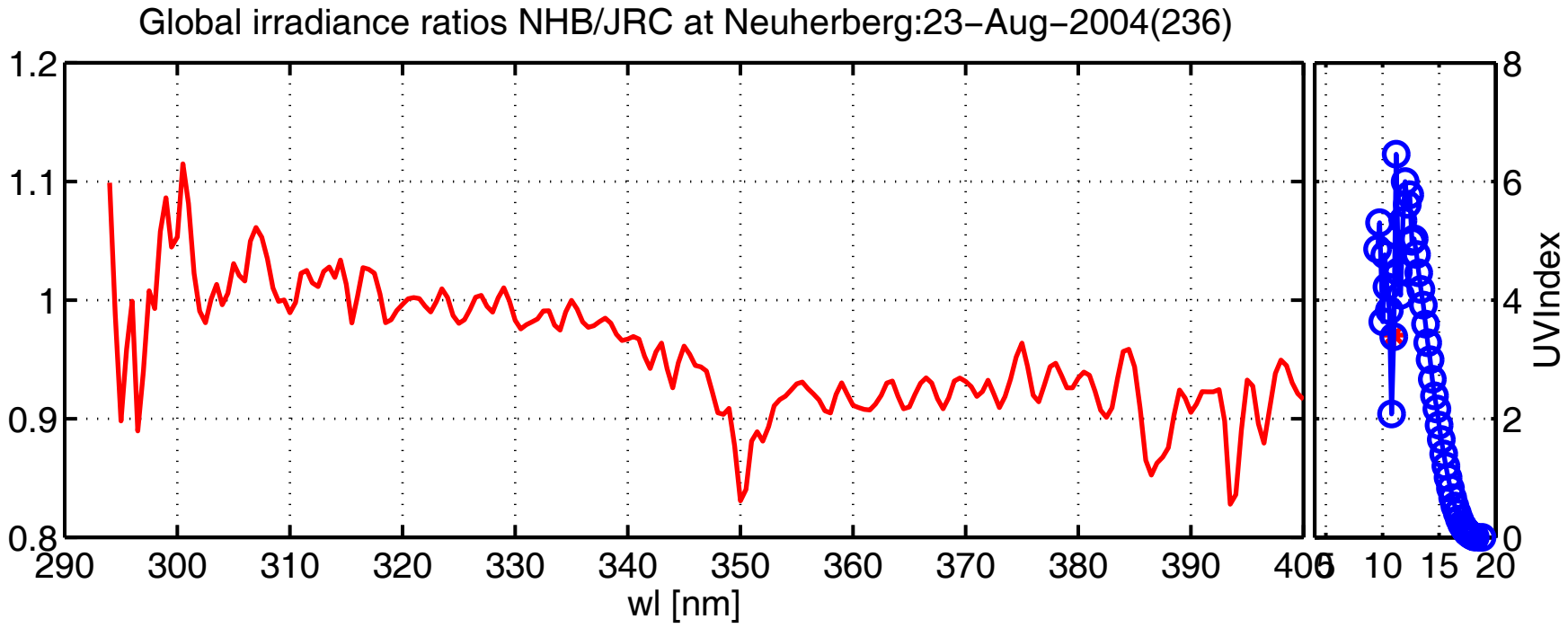
The BfS spectroradiometer NHB was calibrated with our working standard (1000W) on 19.4.04 and checked on 3.8.04 and 25.8.04. The BfS working standards are traceable to a PTB traceable transfer standard. Daily checks of the system sensitivity (integration of the erythemal weighted spectrum from 290nm to 400nm) are done with our 30W auxiliary lamp. Within the time period April to September only a slight decrease of 1.5% were registered. The internal temperature of the device was held within 27°C ± 0.1°C. Wavelength stability was controlled by monitoring the Fraunhofer line at 393.36nm in each measured solar spectrum.

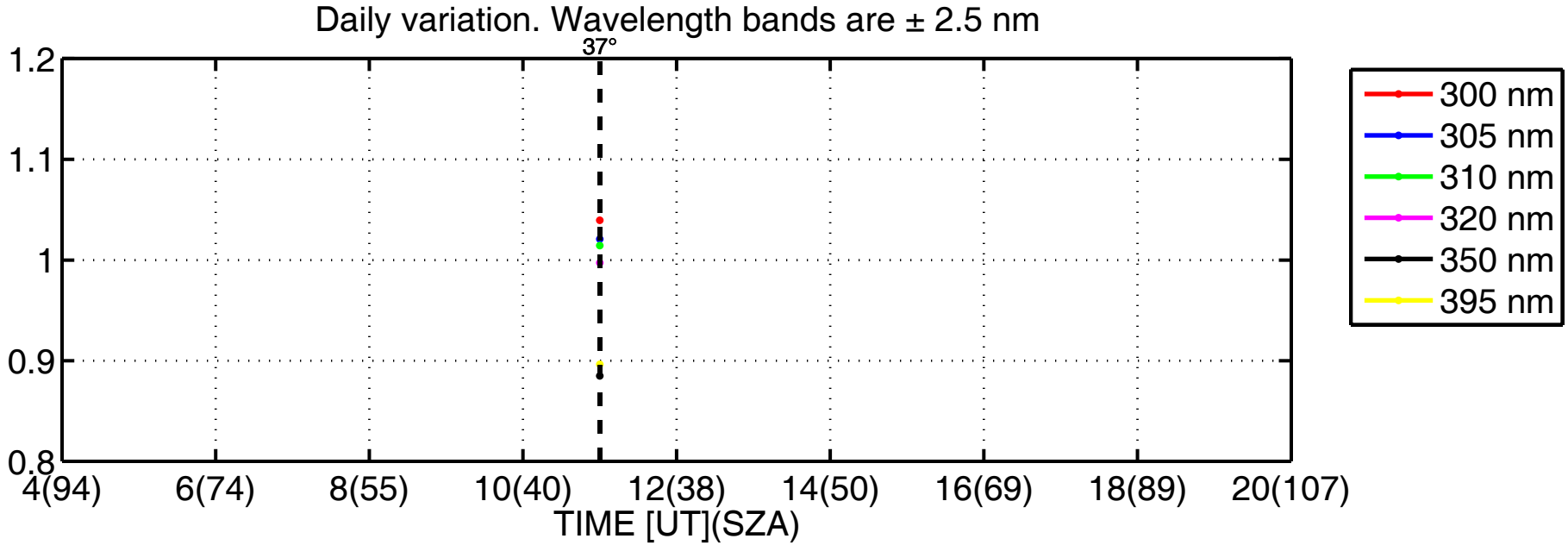
From our point of view measured data were especially influenced by two issues:

1. Due to the failing time synchronisation of starting the spectra (up to 2 seconds) the temporary very quick changes in cloudiness might have influenced measuring data at individual wavelengths. Because of a time-variable system check of ca. 24-26 s before each measuring procedure, the NHB system couldn't be synchronised exactly with the automatically running QASUME reference system.
2. Different geometry of the calibration lamps and the entrance optics didn't allow a comparison of the irradiance scales of both systems. Therefore, a comparison between lamp data and global irradiance data was not possible. Furthermore, the quantitative influence of different directional responsivities of the two instruments on the measured global irradiance could not be determined. When interpreting the results one must also take into consideration:
   - The aim of the intercomparison was to compare the travelling reference spectroradiometer QASUME with the Neuherberg NHB system in-situ (the system works daily within the solar UV – Monitoring net). Therefore NHB was calibrated only with a working standard accepting a calibration deviation of about ±4%.
   - During an internal comparison of the NHB system and a laboratory system a solar zenith angle dependent difference was also found. Between 6:00 and 11:00 UTC at 13.8.2003, the two systems deviated between 3-6% within the whole wavelength region in accordance with the measurements described here. Both devices were calibrated with the same working standard. So, differences in the data were matched by differences in the directional responses of both diffusers. This result let us decide to use optimised entrance optics offered by CMS-Ing. Dr. Schreder (http:\\www.schreder-cms.com). Til spring 2005 all BfS/UBA systems will be equipped with such an optic.

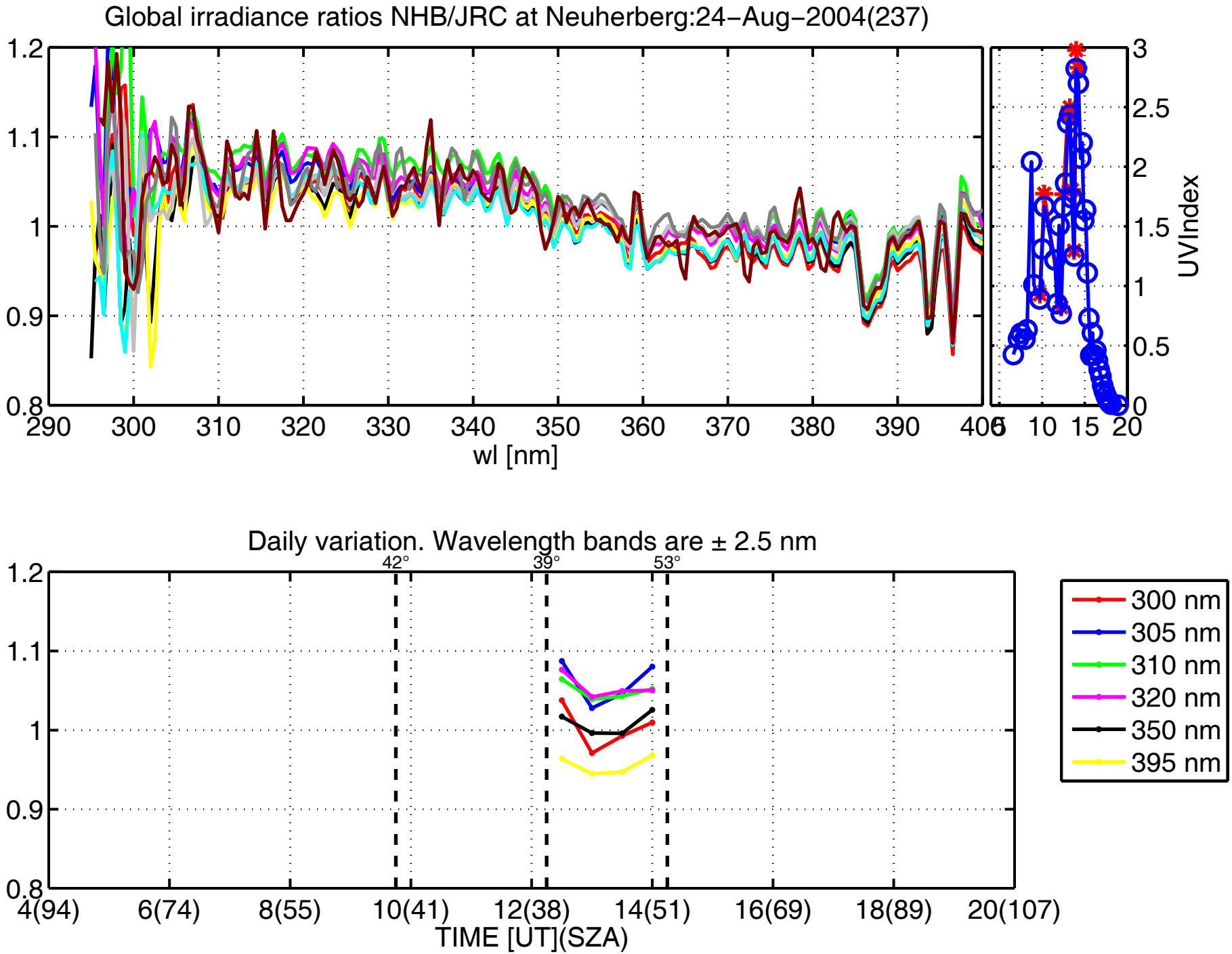

UV Index Neuherberg August 23–27 2004
B5503
NHB
UV Index
Day of Year
0
1
2
3
4
5
6
7
236
236.5
237
237.5
238
238.5
239
239.5
240
240.5
241

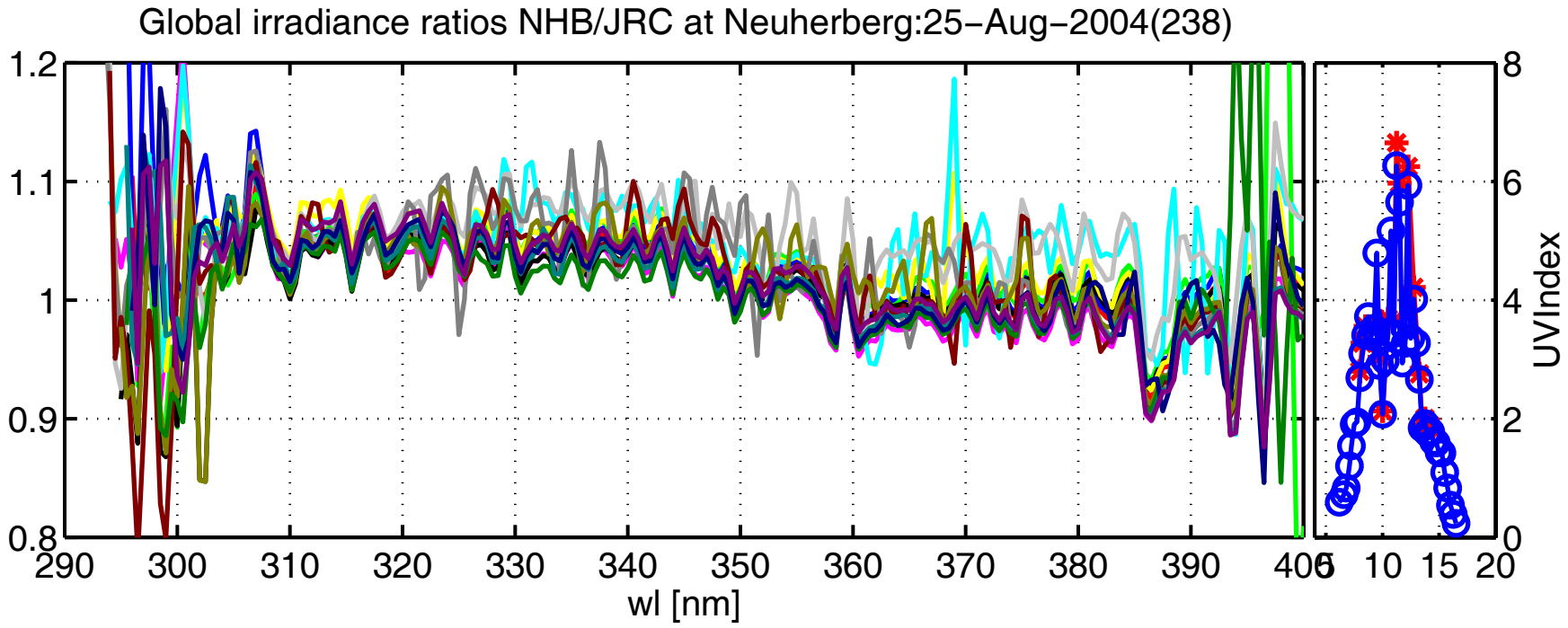

Global irradiance ratios NHB/JRC at Neuherberg:23−Aug−2004(236) to 27−Aug−2004(240)
RATIO NHB/JRC
1.2
1.15
1.1
1.05
1
0.95
0.9
0.85
0.8
300 nm
305 nm
310 nm
320 nm
350 nm
395 nm
236
237
238
239
240
0
12
0
12
0
12
0
12
0
12
0
TIME [UT] ON DAYS: [236 237 238 239 240]
18−Nov−2004 10:28:48

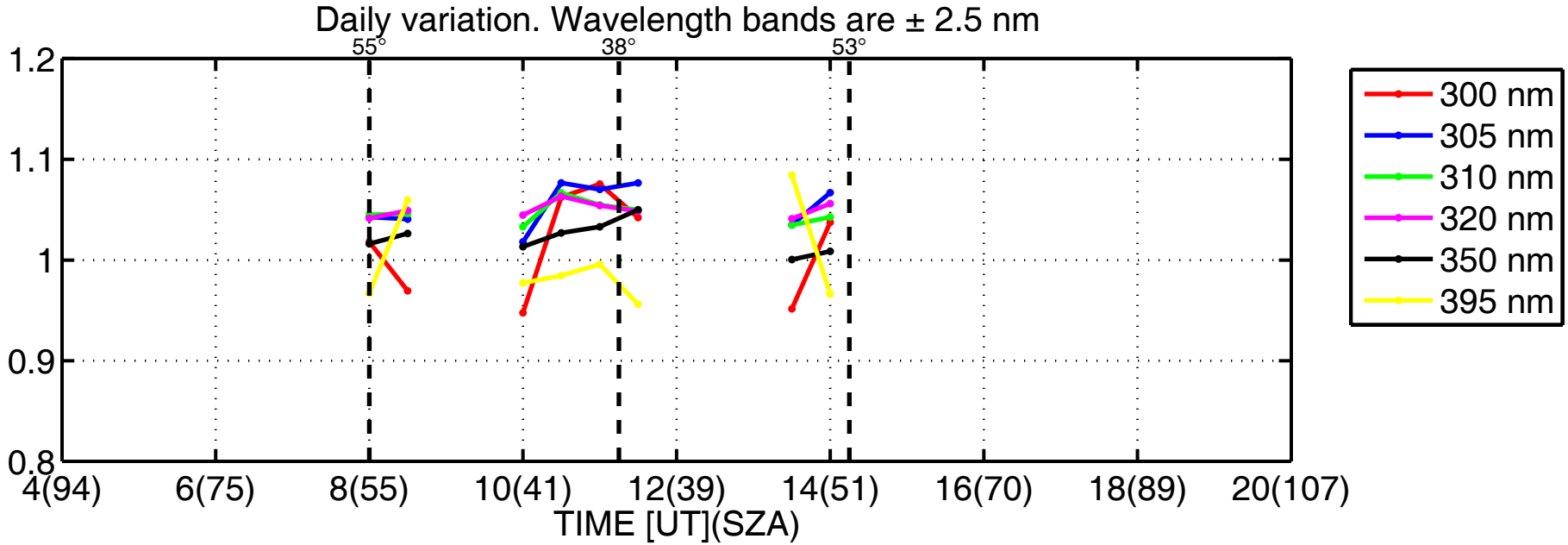




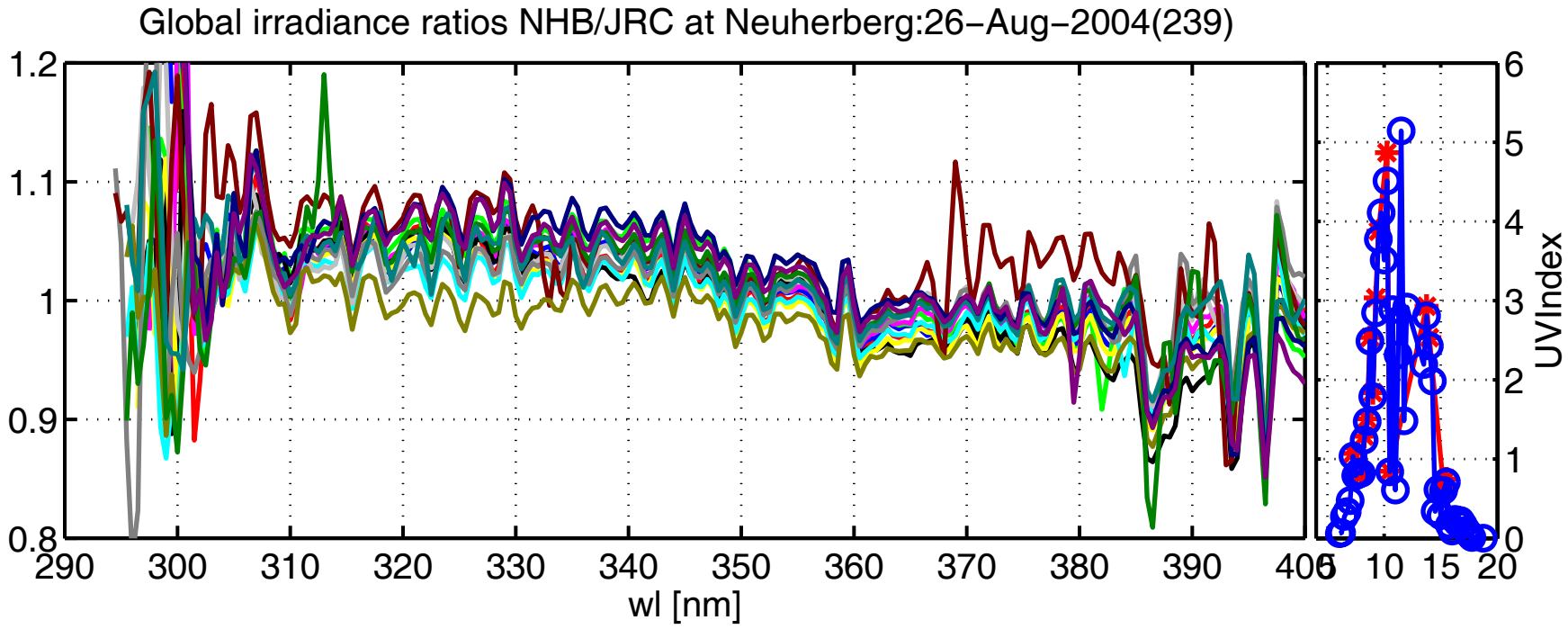
18−Nov−2004 10:28:48

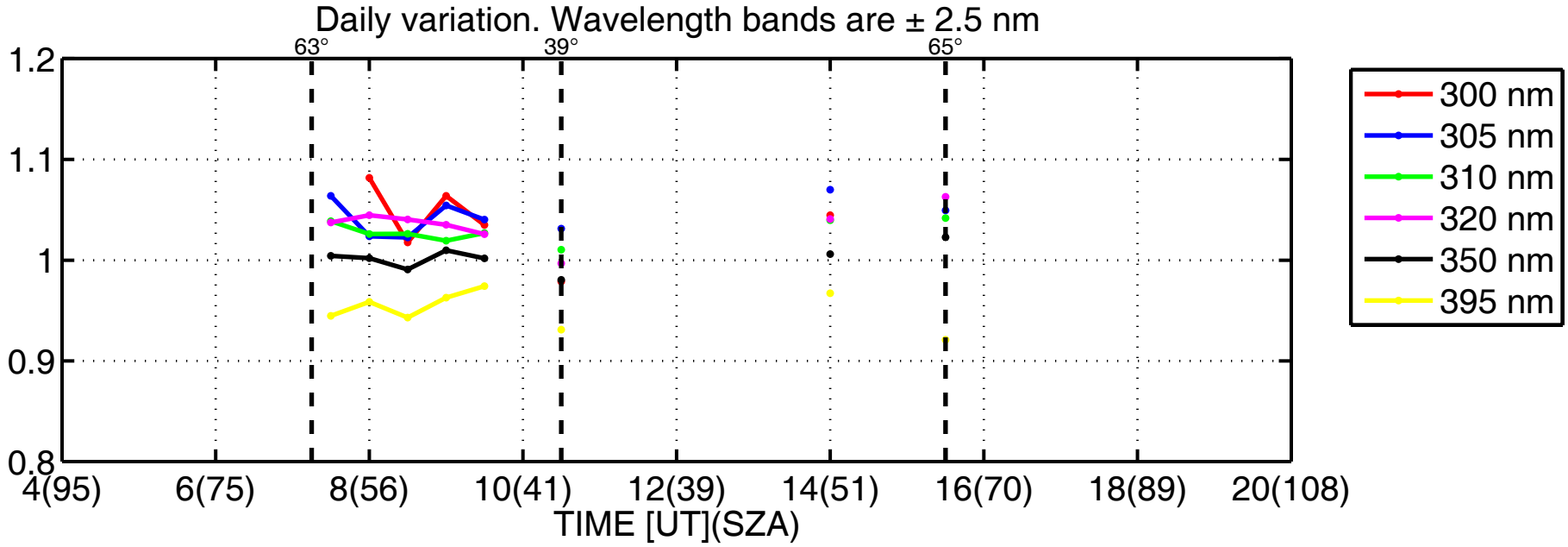

Global irradiance ratios NHB/JRC at Neuherberg:24−Aug−2004(237)
1.2
1.1
1
0.9
0.8
290
300
310
320
330
340
350
360
370
380
390
400
wl [nm]
3
2.5
2
1.5
1
0.5
0
5
10
15
20
UVIndex
Daily variation. Wavelength bands are ± 2.5 nm
42°
39°
53°
4(94)
6(74)
8(55)
10(41)
12(38)
14(51)
16(69)
18(89)
20(107)
TIME [UT](SZA)
300 nm
305 nm
310 nm
320 nm
350 nm
395 nm
18−Nov−2004 10:28:48



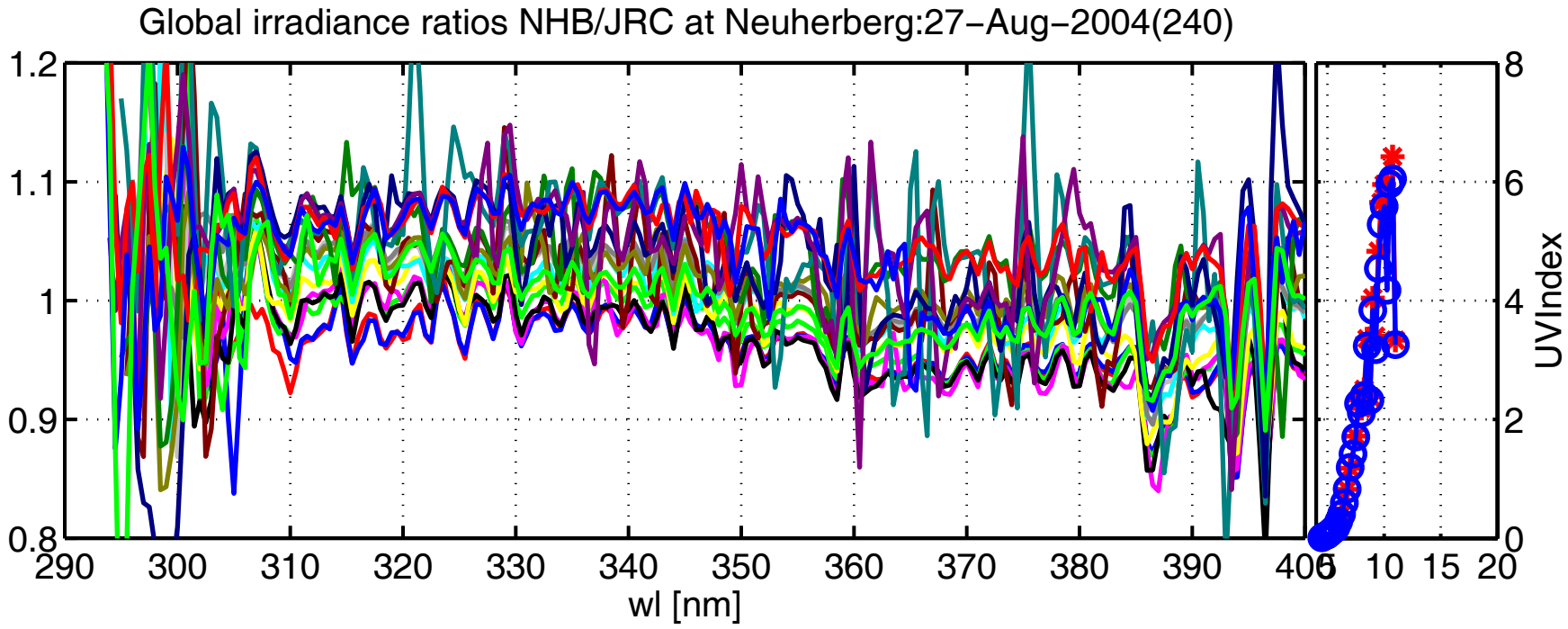


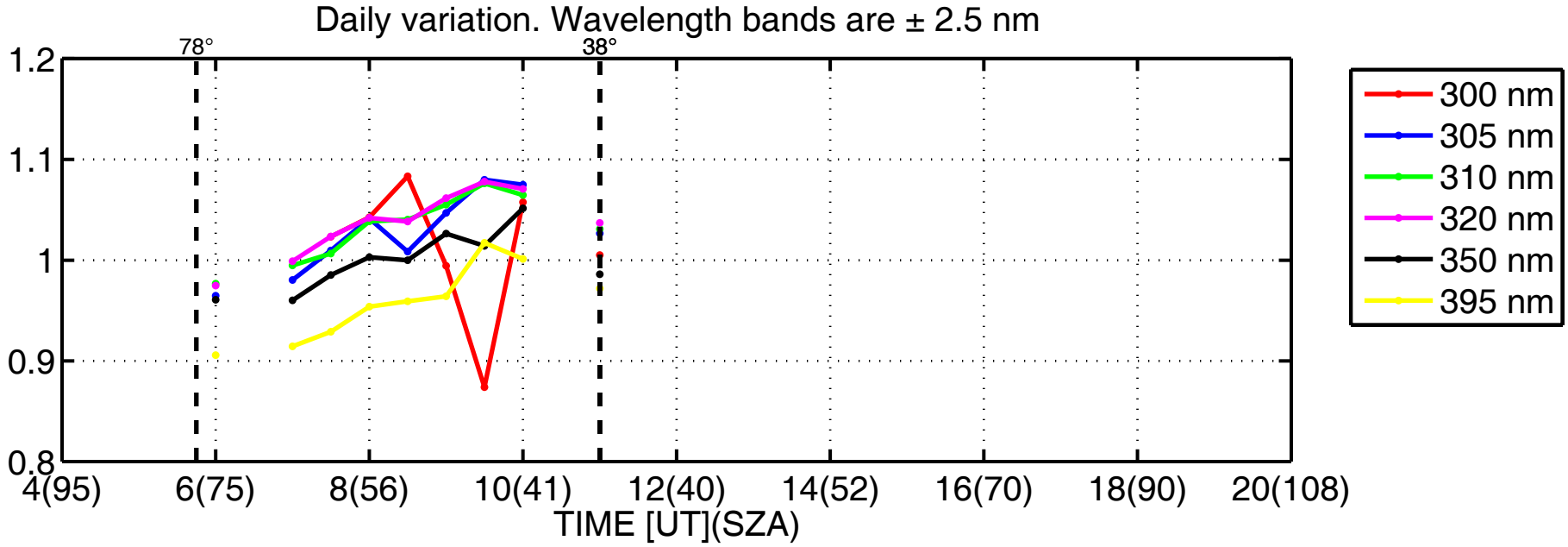
18−Nov−2004 10:28:48



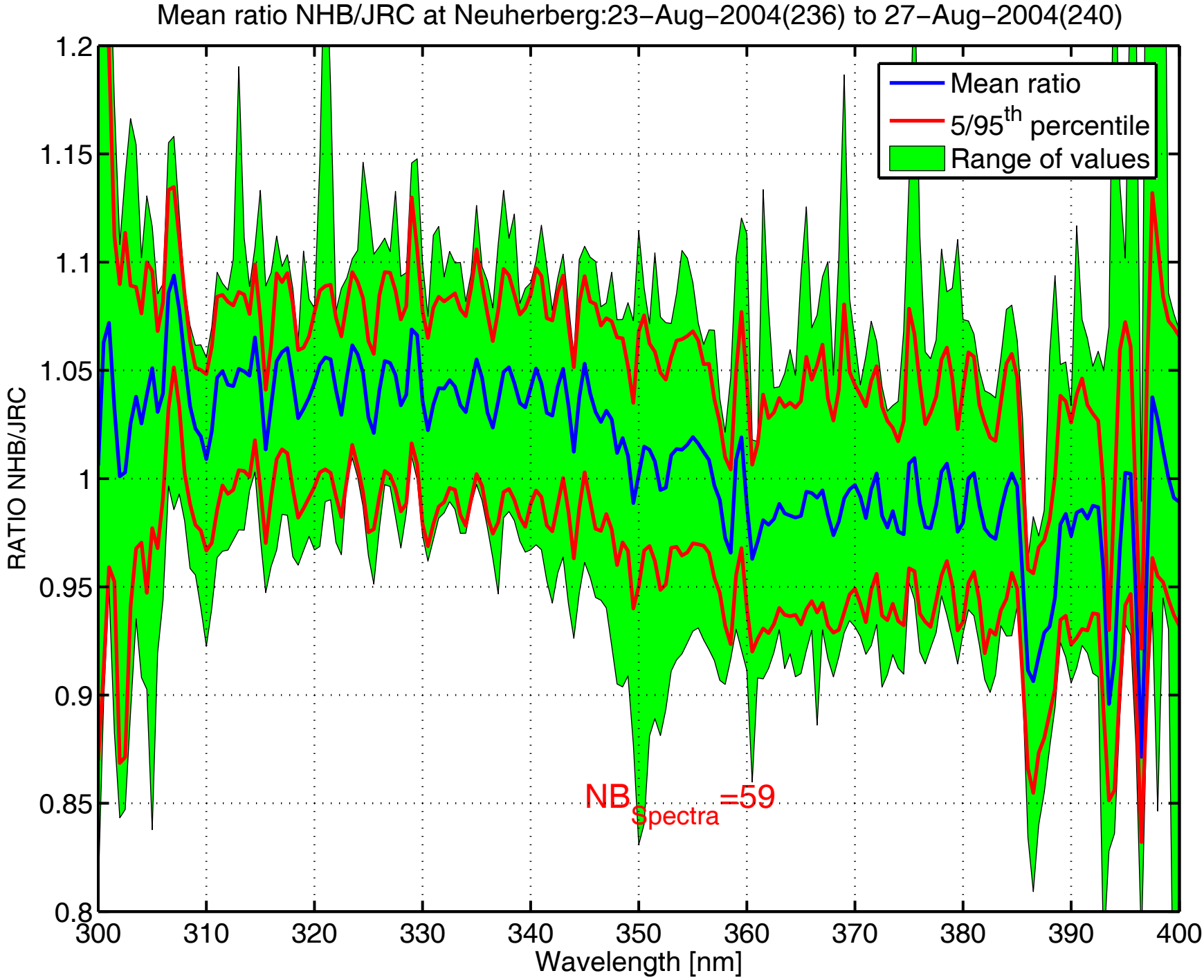


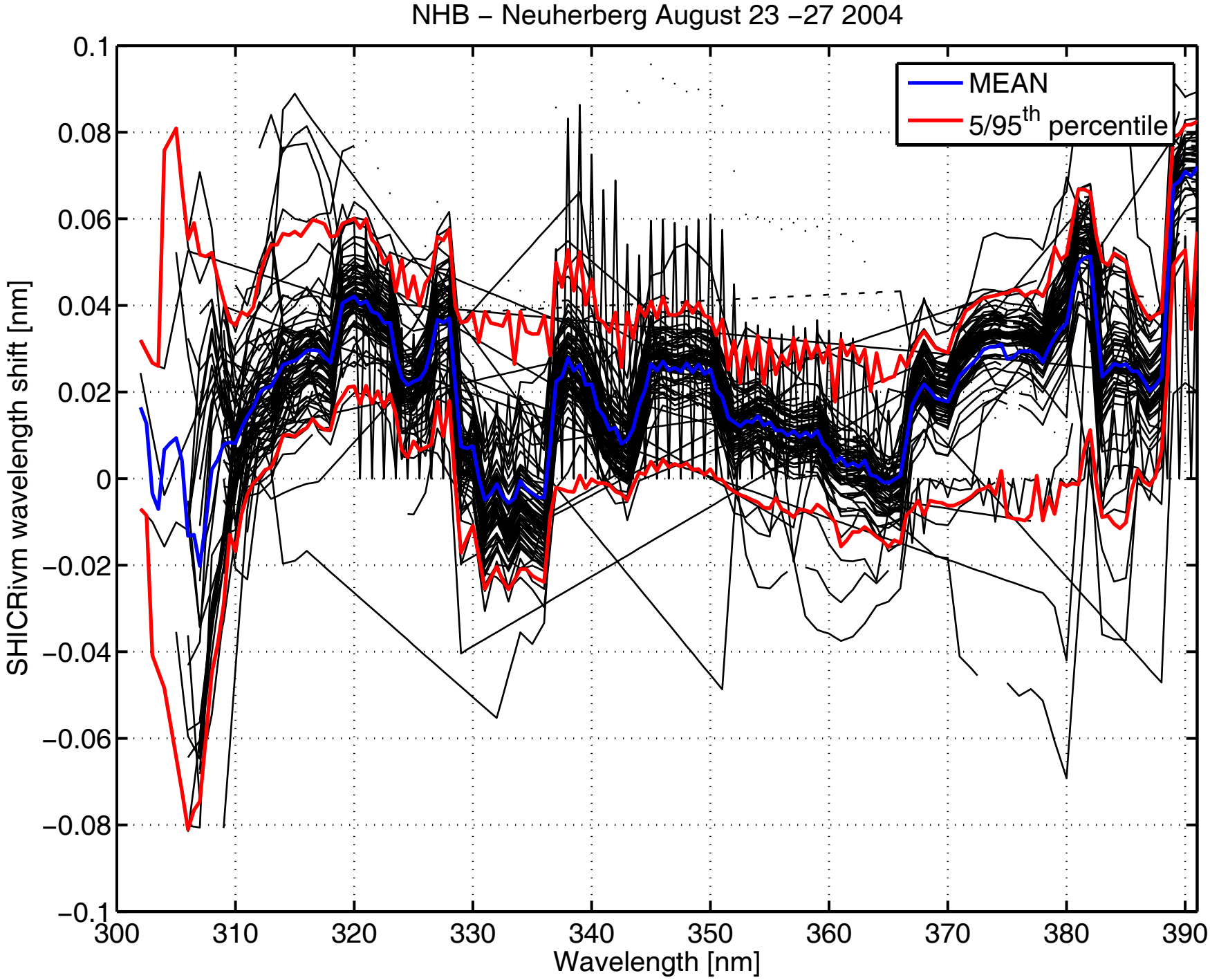
18−Nov−2004 10:28:48

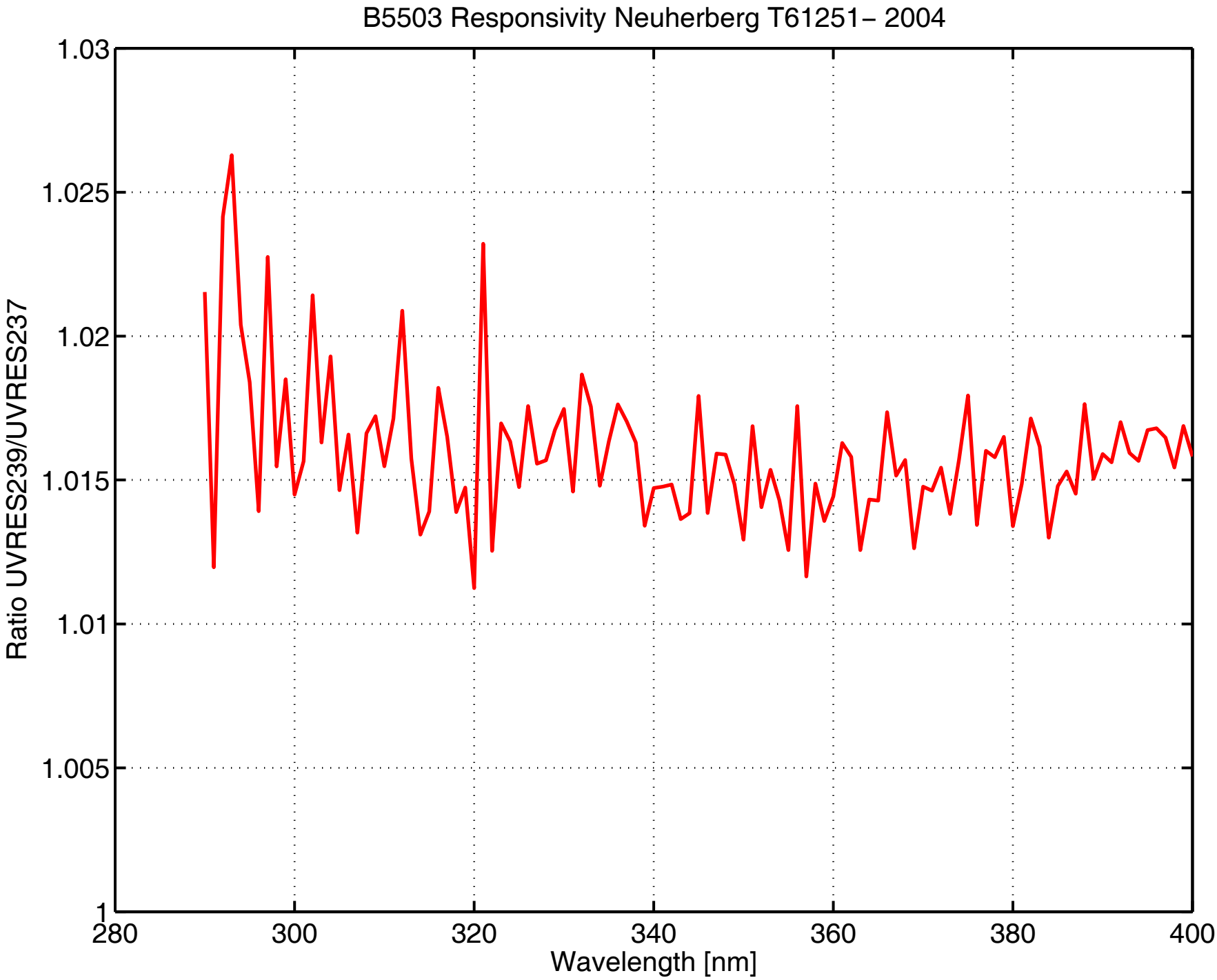




18−Nov−2004 10:28:48


Mean ratio NHB/JRC at Neuherberg:23−Aug−2004(236) to 27−Aug−2004(240)
Mean ratio
5/95th percentile
Range of values
RATIO NHB/JRC
Wavelength [nm]
NBSpectra=59
1.2
1.15
1.1
1.05
1
0.95
0.9
0.85
0.8
300
310
320
330
340
350
360
370
380
390
400


NHB – Neuherberg August 23 –27 2004
MEAN
5/95th percentile
SHICRivm wavelength shift [nm]
Wavelength [nm]
0.1
0.08
0.06
0.04
0.02
0
−0.02
−0.04
−0.06
−0.08
−0.1
300
310
320
330
340
350
360
370
380
390


B5503 Responsivity Neuherberg T61251– 2004
Ratio UVRES239/UVRES237
1.03
1.025
1.02
1.015
1.01
1.005
1
280
300
320
340
360
380
400
Wavelength [nm]


CCR ISPRA