06/20/02

Report of the intercomparison at Innsbruck, Austria 3 – 6 June 2002 with the travelling reference spectrometer B5503 from ECUV within the project QASUME

Report prepared by J. Gröbner

Operators: J. Gröbner, S. Kazadzis, J. Schreder.

The purpose of the visit was the comparison of global solar irradiance measurements between the spectrometer operated by the University of Innsbruck, Institute for Medical Physics (UIIMP) and the reference travelling spectroradiometer (B5503) operated by the European reference centre for ultraviolet radiation measurements (ECUV) located at the Joint Research Centre (JRC) of the European Commission. B5503 is a commercial double monochromator spectroradiometer (DM-150) from Bentham, UK optimized for measurements of global solar ultraviolet irradiance. The radiation is sampled with an input optic connected to the entrance slit of the spectroradiometer through a 4 m long optical quartz fiber. The integrated directional response of the input optic deviates less than 2% from the desired cosine response. It uses gratings with 2400 lines/mm with entrance and exit slits to obtain a spectral resolution of about 0.8 nm. The instrument can be operated in the wavelength range 250 to 500 nm. The whole system is temperature stabilized.

The visit at UIIMP follows the previous intercomparison at the home site of B5503. The measurement site is located on the roof of a building roughly 10 meters above ground. Latitude is 47.260 and longitude 11.384E, altitude 577 m.a.s.l. The horizon of the measurement site is free down to 80 deg to the south (See horizon-graph in Annex). Higher obstructions are located in the North-East.

B5503 left ECUV in the morning and arrived at UIIMP in the afternoon of June, 3, 2002. The instrument was installed on the platform beside the spectrometer operated by UIIMP and left to stabilize over night. The intercomparison between B5503 and the spectrometer from UIIMP lasted two nearly full days from June 4 to 5 from sunrise to sunset.

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 June, 4 was held from 8 to 10 UT, and the second on June, 6 from 8-10 UT. The stability of the instrument during the intercomparison is 1%, based on the 100W calibration data (see appended graph). The internal temperature of B5503 was 27.3+-0.1deg 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 450 nm (see appended graphs).

The time base was set at regular intervals relative to Atomic Clocks either via GPS or through Internet. The time accuracy was ±0.5 sec.

Protocol:
Measurements initiated on the morning of June, 4. Quality controlled measurements started at 7:00 UT and lasted until 18:30 UT. Synchronous global irradiance measurements were performed every 30 min in the range 290 to 450 nm with an increment of 0.5 nm every 3 sec.
Measurements on June, 5 are quality controlled from 4 UT to 16 UT and lasted until 18:30. Sunrise was at 3:30 UT and sunset at 18:55. The minimum solar zenith angle was 23 deg.

From 9 to 11:30 UT on June, 4 UIIMP measured the laserline from a HeCd laser at 325 nm. The laser beam was attenuated by a small Teflon sheet which was put between the laser and the diffuser.

On June, 4 the day was characterized by a mix of sun and clouds. June 5 was overcast and nearly no direct sun for the whole day. There were rapidly moving clouds for most of the day due to Foehn conditions with a reasonably strong wind from the south (see appended graphs).

Results:
The wavelength shifts in the spectral range 310 to 450 nm of the spectrometer from UIIMP relative to an extraterrestrial spectrum as retrieved from the SHICRivm analysis were between –90 and +70 pm on June 4, and -60 to +30 pm on June 5.

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

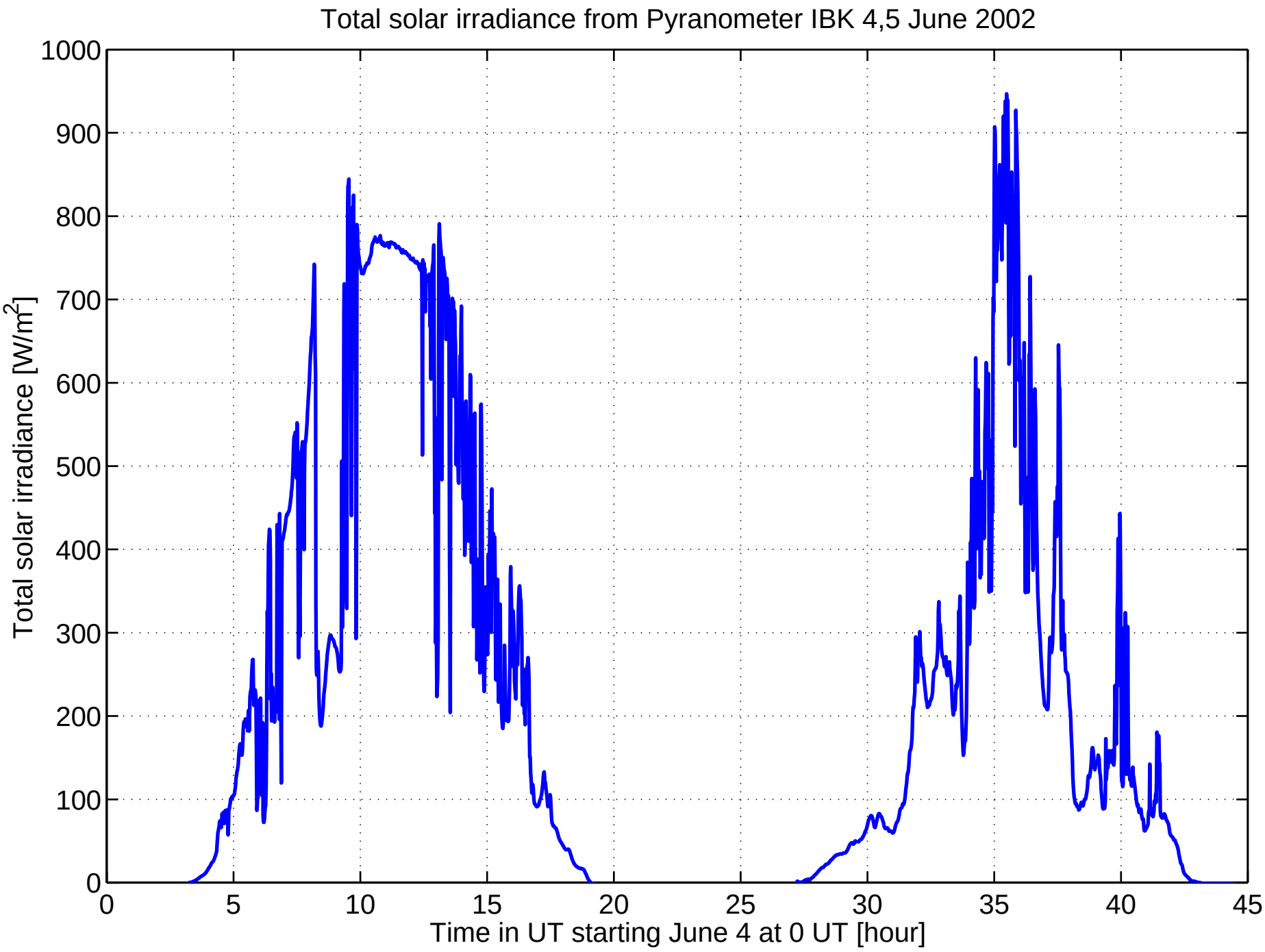
- The global irradiance measured by the spectrometer from UIIMP is about 3-5% higher relative to the measurements of B5503 for wavelengths longer or equal than 310 nm. Between 300 and 310 nm the radiation measured by UIIMP progressively diminishes by about 5% relative to B5503. This relative change with wavelength is as yet unexplained. One possible explanation could be the difference in resolution between the two spectroradiometers which the analysis software is not able to fully compensate for.
- The variability between the two spectrometers has an amplitude of 5% which might be systematic and could be due to variations in temperature of either spectrometer system.

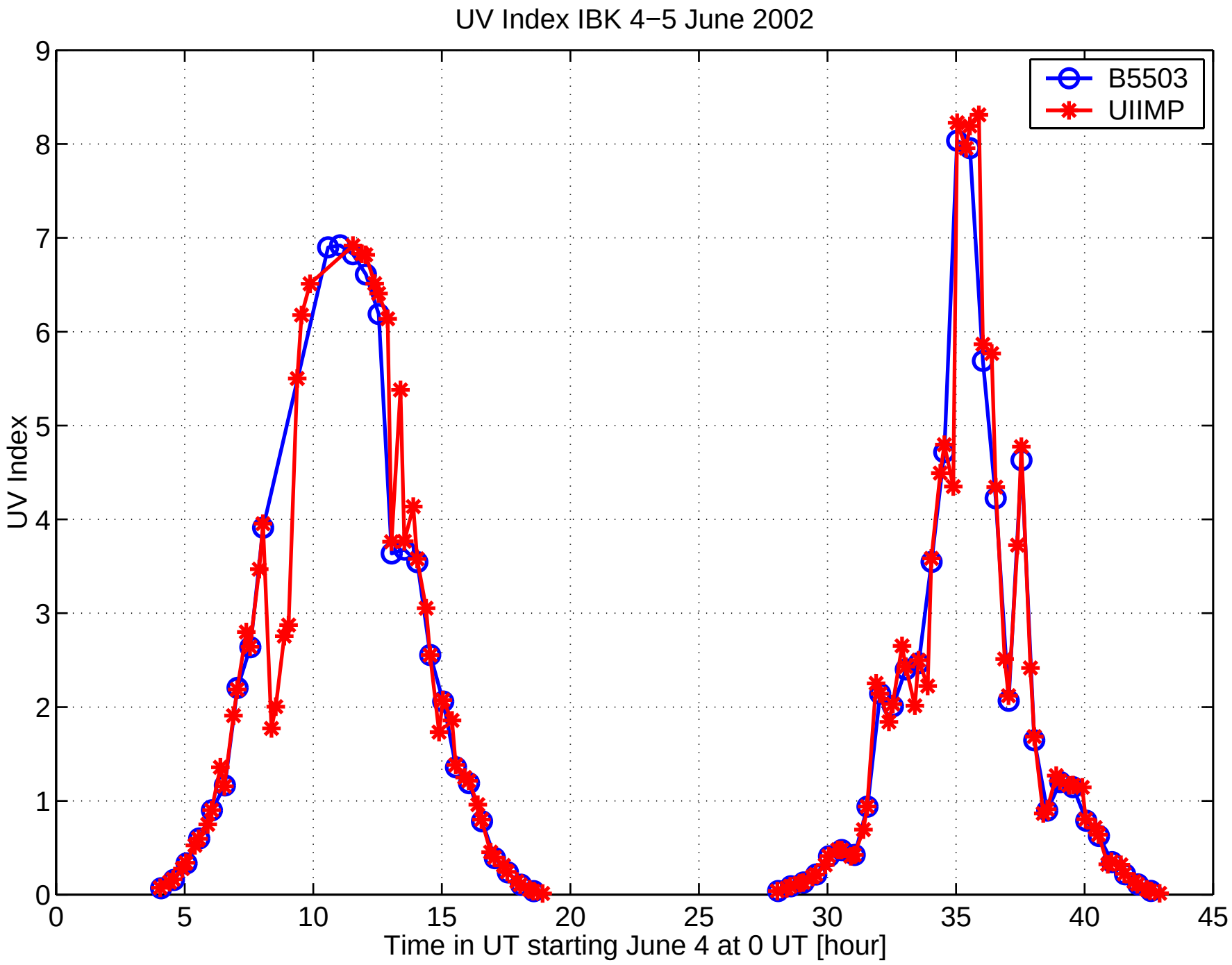
Comments from the site operator:

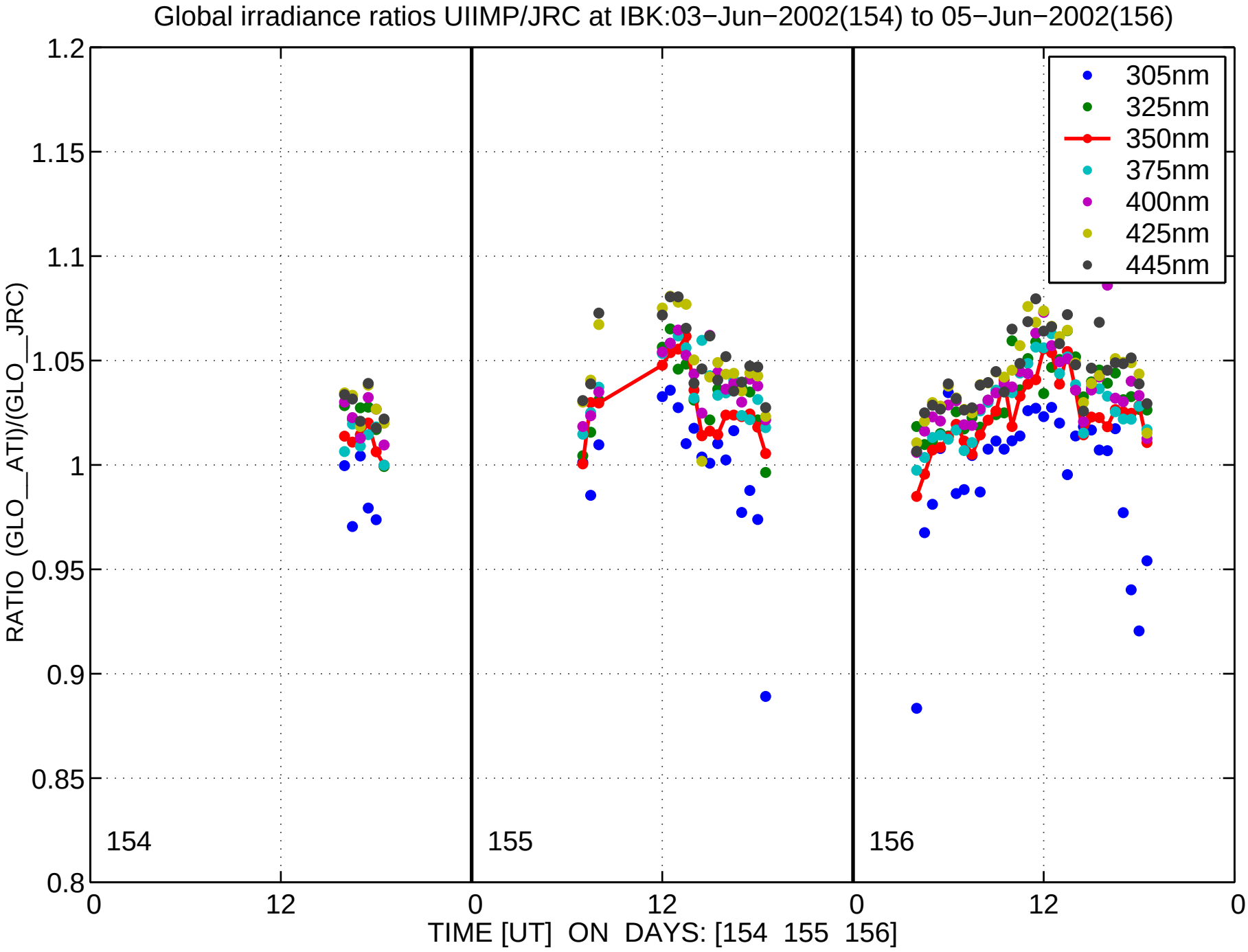
The spectroradiometer from UIIMP is a DTM300 double monochromator from Bentham, UK. The slits were set to give about 0.47 nm FWHM, gratings with 2400 lines/mm were used. The output signal of the monochromator is measured with a side-window photomultiplier. The entrance optic consists of a specially shaped cosine diffuser (Schreder Co., Austria), which has a nearly perfect cosine response. It is connected with a 2 m long quartz fiber connected to the entrance slit. The whole system is stabilized within a thermostated box at 28.5°C. During regular operation the temperature of the monochromator housing varies by about ±0.2°C.

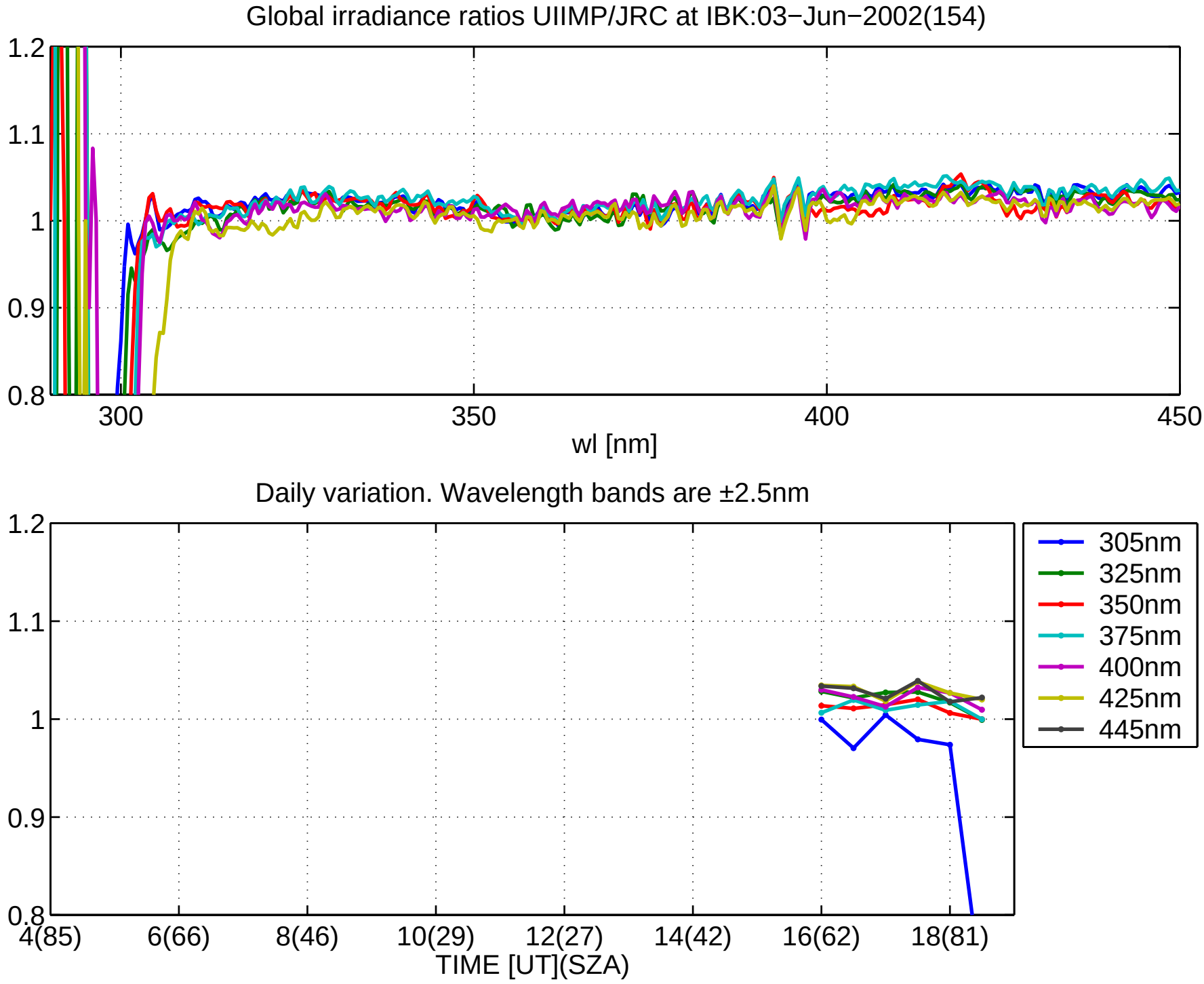
Calibration of the DTM300 of UIIMP:
Due to an accident, the usual 1000W secondary standard lamp was broken on 22. May 2002. As a replacement, another 1000W lamp was calibrated against the primary standard lamp of UIIMP on 24. May, and with this new secondary lamp, the DTM 300 was calibrated on 24. May.
After the intercomparison on 11. June, the secondary lamp was compared against the primary lamp again, and agreement of ±0.5% was found for the wavelength range 250 to 500 nm. Then the spectrometer was calibrated again, showing no significant difference greater 1% relative to the calibration on 24. May. Therefore, it was assumed that the DTM300 was stable over the time of the intercomparison, and no revision to the data is necessary.
The comparison of the ratio of the spectrometer, weighted with the sensitivity of a Scintec-broadband detector, to the signal of the broadband detector was about 3-4% higher in Innsbruck compared to the ratio in Ispra. However, this magnitude of variation is usually within the uncertainty of this ratio.

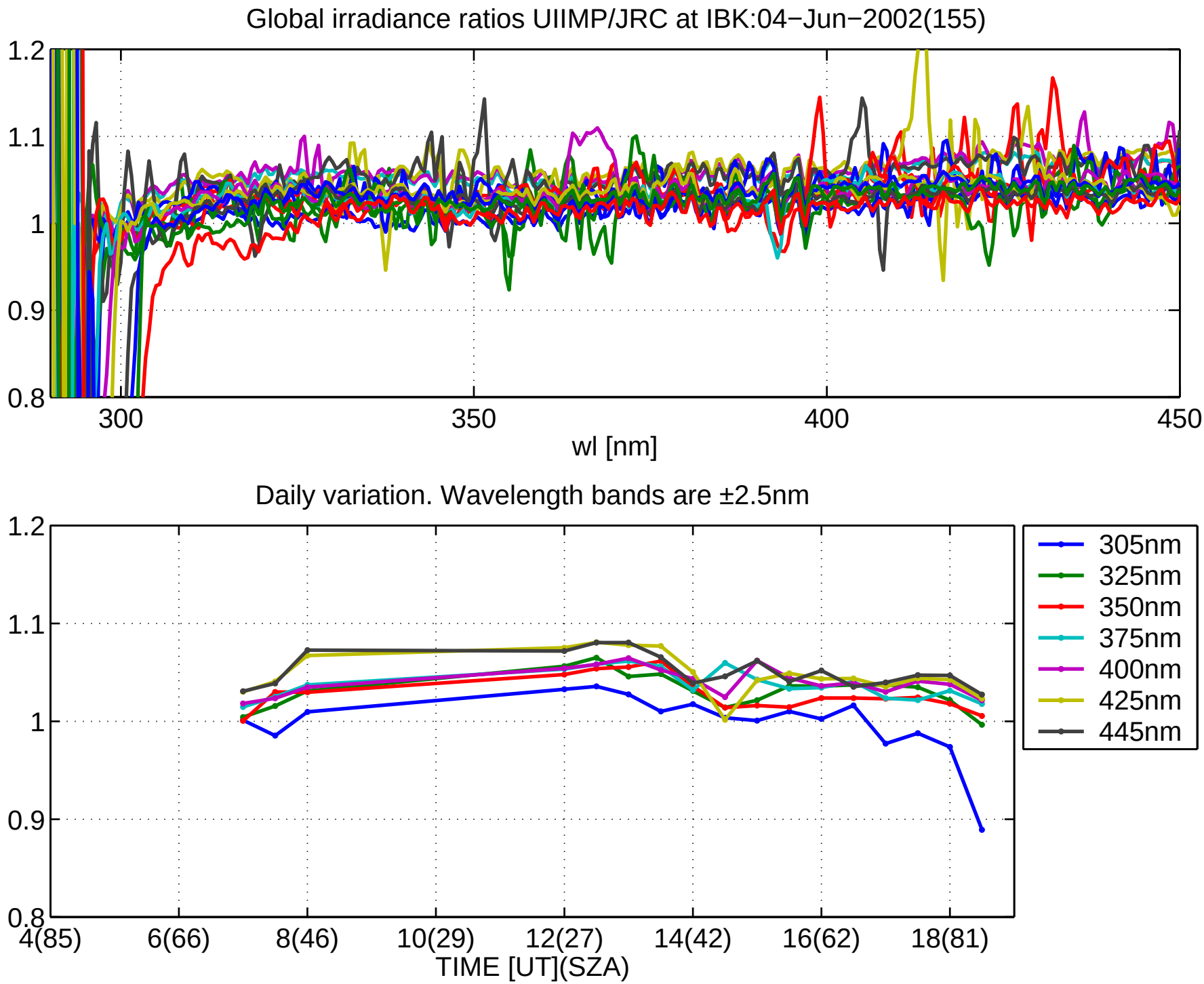
Temperature stabilisation of the DTM300 of UIIMP during the intercomparison:
On 4. June 2002 (day 155) the temperature stabilisation of the DTM300 of UIIMP was not working between 13:05 and 17:15 UT. As a consequence, the temperature of the DTM300 was 8° higher than usual. The resulting error in wavelength setting was to the most part automatically corrected, so that only deviations in the order of ±50 pm resulted (see figure in the appendix: the wavelength shift has higher fluctuations on day 155 than on day 156).

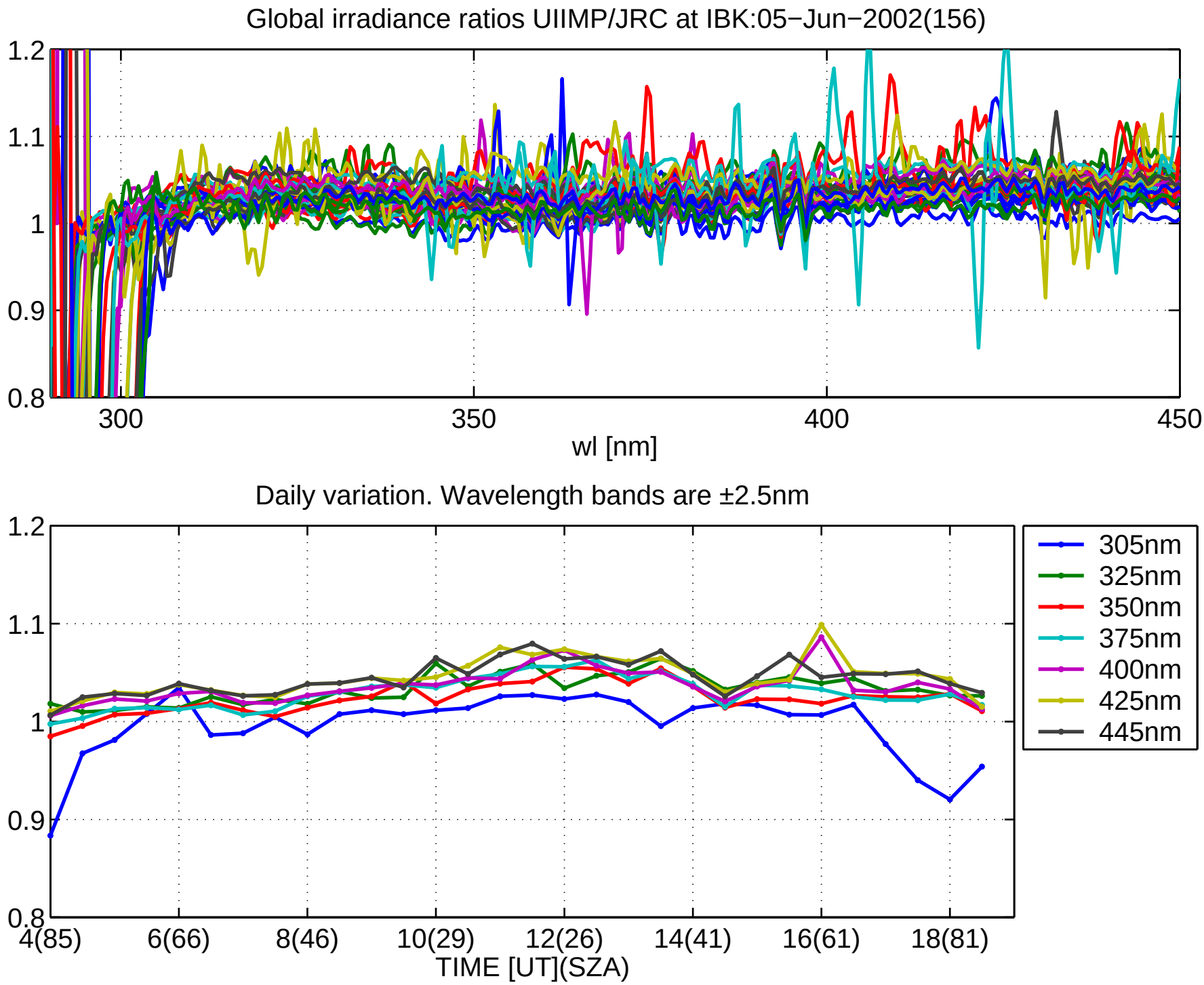

Total solar irradiance from Pyranometer IBK 4,5 June 2002
Total solar irradiance [W/m2]
Time in UT starting June 4 at 0 UT [hour]
0
100
200
300
400
500
600
700
800
900
1000
0
5
10
15
20
25
30
35
40
45

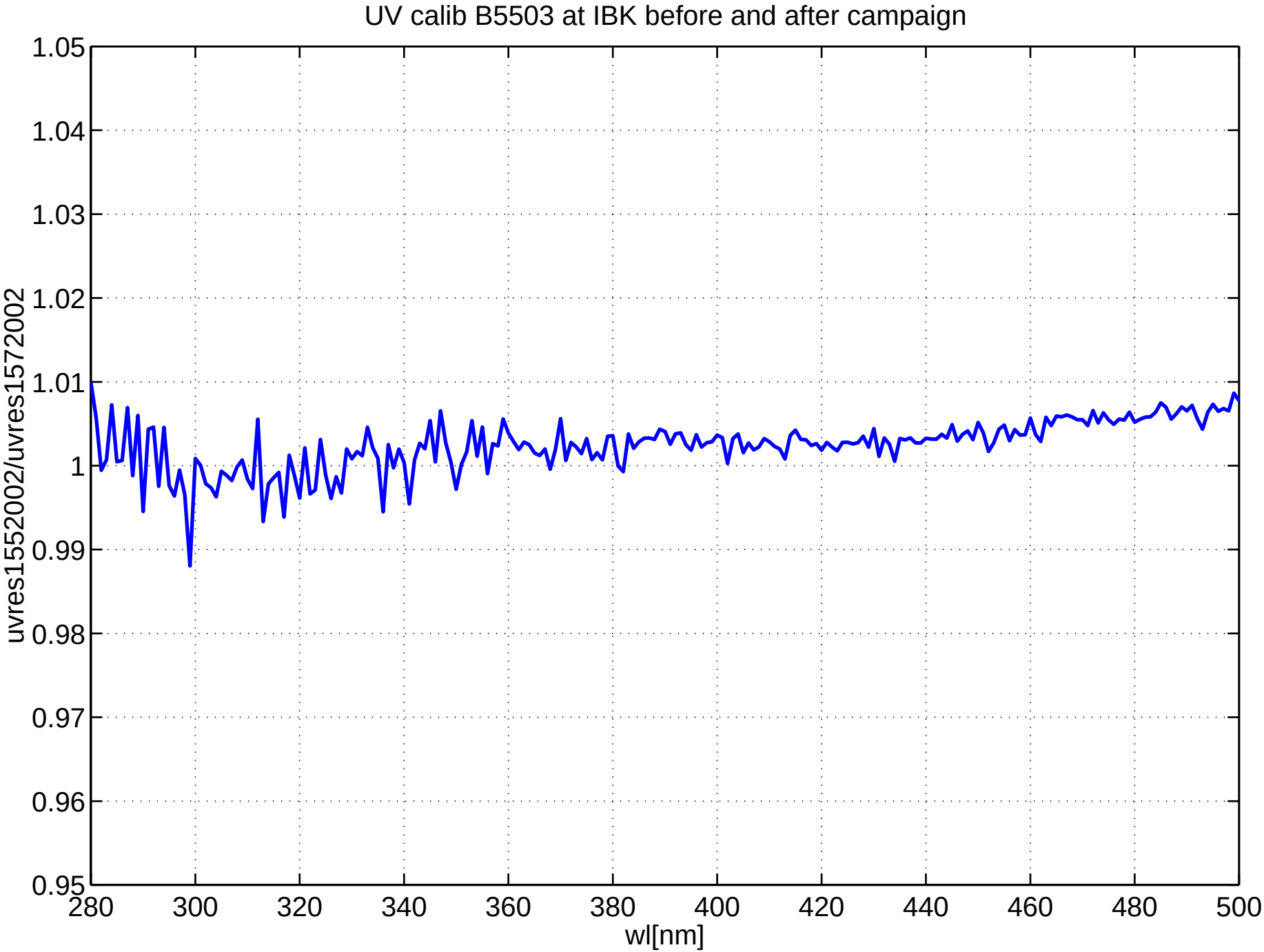

UV Index IBK 4−5 June 2002
B5503
UIIMP
UV Index
Time in UT starting June 4 at 0 UT [hour]
0
1
2
3
4
5
6
7
8
9
0
5
10
15
20
25
30
35
40
45

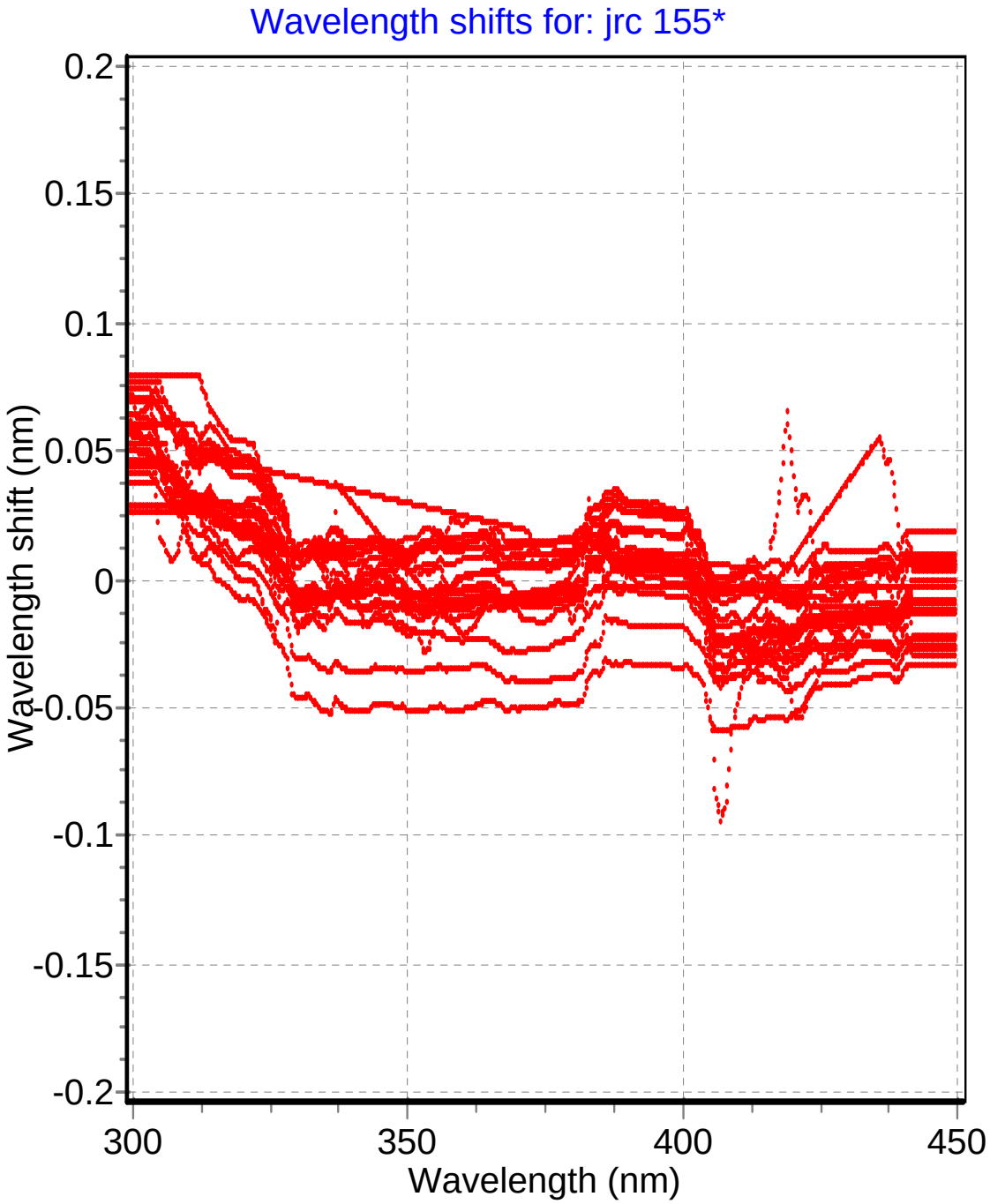

Global irradiance ratios UIIMP/JRC at IBK:03−Jun−2002(154) to 05−Jun−2002(156)
RATIO (GLO__ATI)/(GLO__JRC)
TIME [UT] ON DAYS: [154 155 156]
305nm
325nm
350nm
375nm
400nm
425nm
445nm
154
155
156
1.2
1.15
1.1
1.05
1
0.95
0.9
0.85
0.8
0
12
0
12
0
12
0

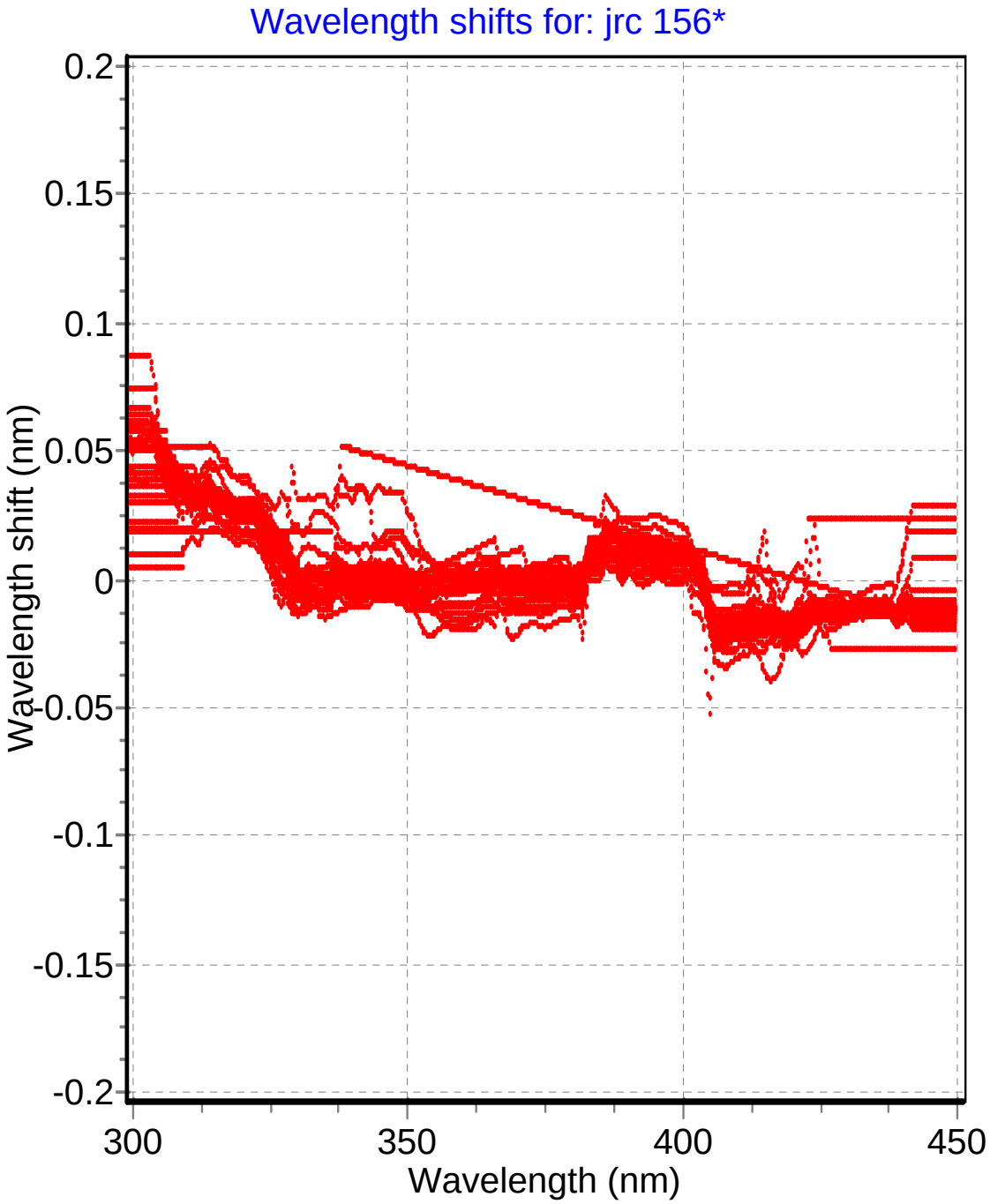

Global irradiance ratios UIIMP/JRC at IBK:03−Jun−2002(154)
1.2
1.1
1
0.9
0.8
300
350
400
450
wl [nm]
Daily variation. Wavelength bands are ±2.5nm
1.2
1.1
1
0.9
0.8
4(85)
6(66)
8(46)
10(29)
12(27)
14(42)
16(62)
18(81)
TIME [UT](SZA)
305nm
325nm
350nm
375nm
400nm
425nm
445nm

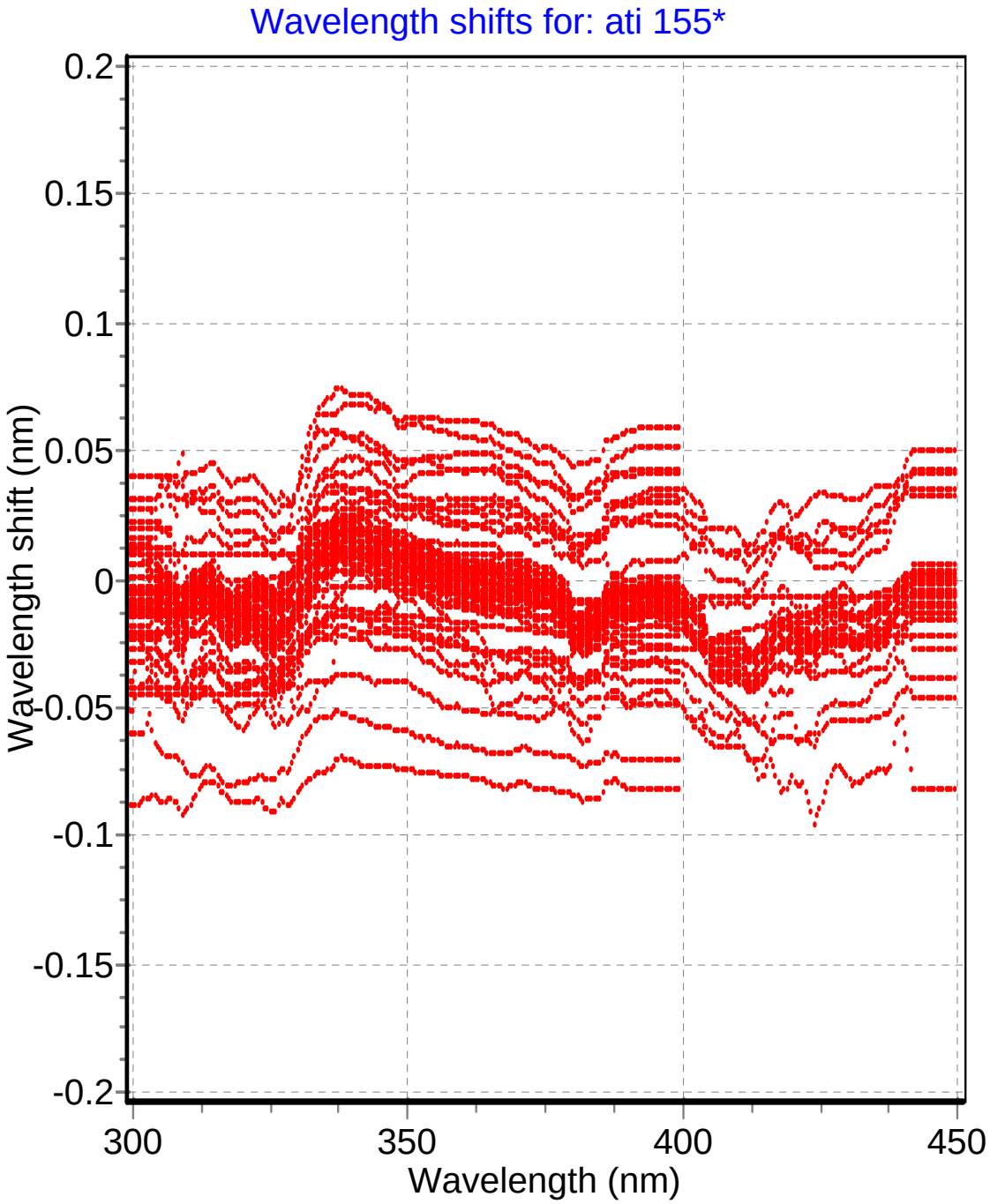

Global irradiance ratios UIIMP/JRC at IBK:04−Jun−2002(155)
1.2
1.1
1
0.9
0.8
300
350
400
450
wl [nm]
Daily variation. Wavelength bands are ±2.5nm
1.2
1.1
1
0.9
0.8
4(85)
6(66)
8(46)
10(29)
12(27)
14(42)
16(62)
18(81)
TIME [UT](SZA)
305nm
325nm
350nm
375nm
400nm
425nm
445nm

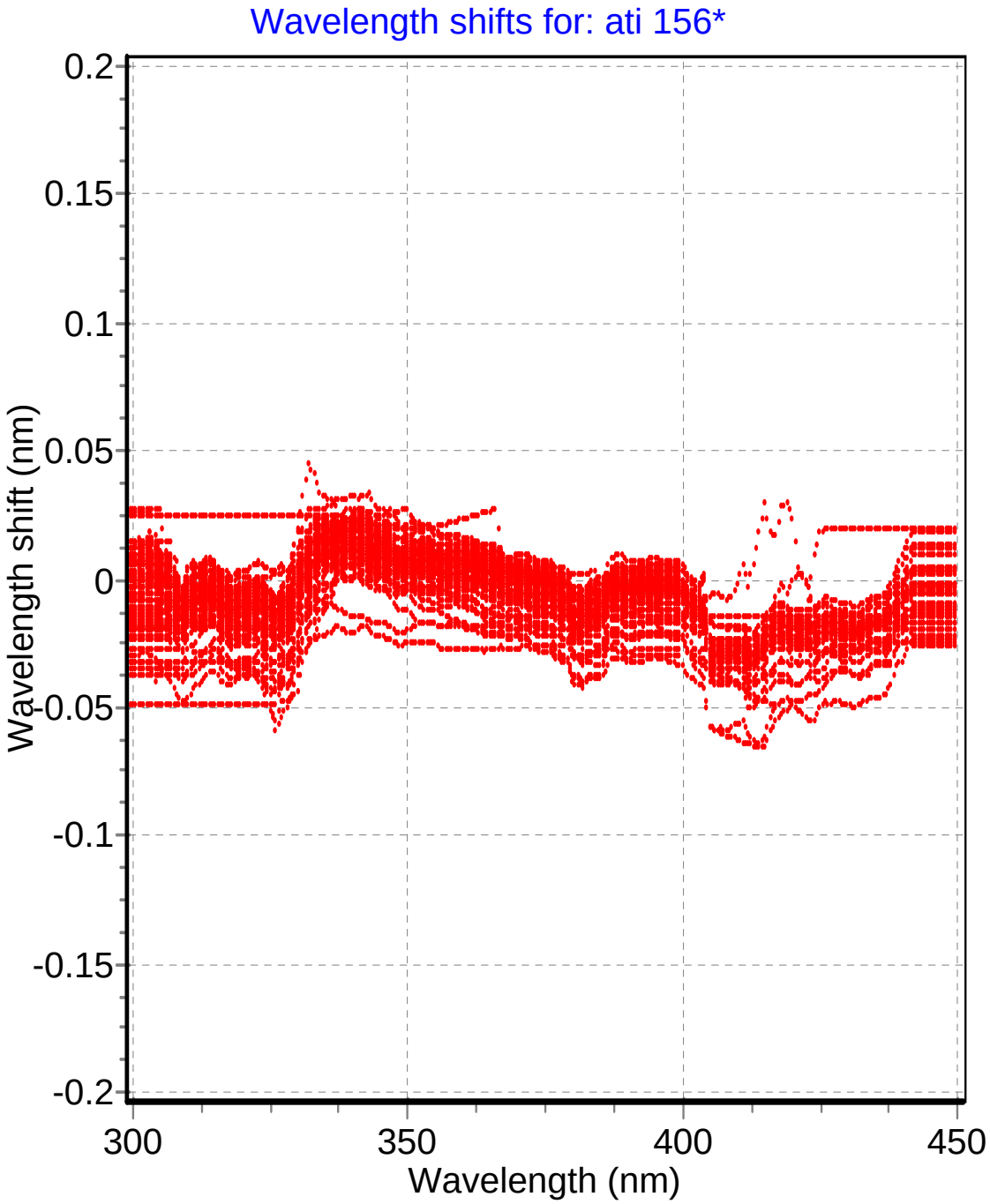

Global irradiance ratios UIIMP/JRC at IBK:05−Jun−2002(156)
1.2
1.1
1
0.9
0.8
300
350
400
450
wl [nm]
Daily variation. Wavelength bands are ±2.5nm
1.2
1.1
1
0.9
0.8
4(85)
6(66)
8(46)
10(29)
12(26)
14(41)
16(61)
18(81)
TIME [UT](SZA)
305nm
325nm
350nm
375nm
400nm
425nm
445nm

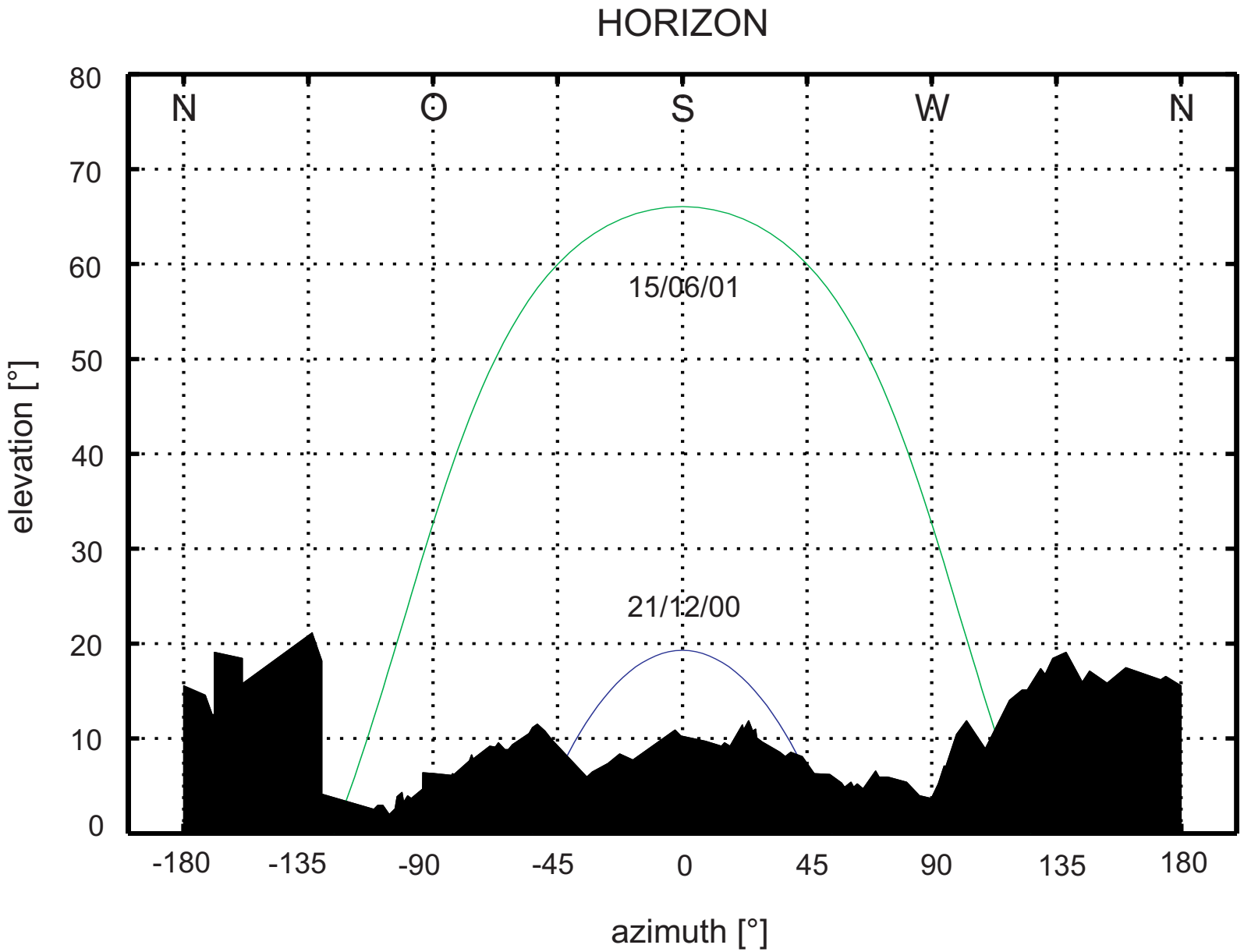

UV calib B5503 at IBK before and after campaign
uvres1552002/uvres1572002
wl[nm]
1.05
1.04
1.03
1.02
1.01
1
0.99
0.98
0.97
0.96
0.95
280
300
320
340
360
380
400
420
440
460
480
500


Wavelength shifts for: jrc 155*
0.2
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
Wavelength shift (nm)
300
350
400
450
Wavelength (nm)


Wavelength shifts for: jrc 156*
0.2
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
Wavelength shift (nm)
300
350
400
450
Wavelength (nm)


Wavelength shifts for: ati 155*
0.2
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
Wavelength shift (nm)
300
350
400
450
Wavelength (nm)


Wavelength shifts for: ati 156*
0.2
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
Wavelength shift (nm)
300
350
400
450
Wavelength (nm)


HORIZON
N
O
S
W
N
80
70
60
50
40
30
20
10
0
15/06/01
21/12/00
elevation [°]
-180
-135
-90
-45
0
45
90
135
180
azimuth [°]