Protocol of the intercomparison at the Belgian Institute for Space Aeronomy (IASB) in Brussels, September 6-8 2004 with the travelling standard spectroradiometer B5503 from ECUV within the project QASUME

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Operator: Josef Schreder

The purpose of the visit was the comparison of global solar irradiance measurements between the spectroradiometer operated by IASB (BRU) and the travel standard B5503 within the project QASUME. The measurement site is located at Brussels; Latitude 50.796 N, Longitude 4.357 E and altitude 120 m.a.s.l.
The horizon of the IASB measurement site is nearly free in direction from W to N to S. In the direction S to SW trees obscure the horizon by up to about 15°. The local environment is urban.

B5503 arrived at Brussels in the afternoon of September 3, 2004. The spectroradiometer was installed in a temperature stabilized room below the measurement platform of IASB. The intercomparison between B5503 and BRU lasted 2 1/2 days, from noon of September 6 to the evening of September 8.

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 varied by less than 0.5% 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.

<u>September 3 (247):</u>
Arrival and setup of B5503 in the afternoon. It is left (turned on) until September 6.

<u>September 6 (250):</u>

Hardware failure of the temperature stabilisation of B5503 resulted in an internal temperature of 41°C during the previous two days. The problem was fixed in the morning, and temperature stabilisation is resumed at 10:00 UT.

Synchronised measurements are available from 12:00 to 18:00 UT. Weather conditions were cloudless sky during the whole day.

September 7(251):

Synchronised measurements are available from 4:00 to 18:00 UT. Weather conditions were fog in the morning until 8:30 UT, then a mix of sun and clouds until about 13:30 UT, then cirrus.

B5503 calibrated at 12:46 UT and 13:14 UT (no scans lost).

September 8 (252):

Synchronised measurements are available from 4:00 to 15:00 UT.

Weather conditions from beginning are cloudless sky in the morning with increasing cirrus clouds during the day.

B5503 calibrated at 13:12 UT and 13:45 UT (no scans lost).

Results:

51 synchronised scans are available from BRU.

The wavelength shifts of the submitted solar spectra of the BRU spectroradiometer retrieved through the SHICRivm analysis were stable to within 30 pm over the whole wavelength range. The wavelength shifts vary spectrally between +0.19 nm at 310 nm to 0.03 nm at 375 nm. There seems to be a periodicity of about 40 nm with an amplitude of about 0.1 nm (see graph).

The intercomparison of the global irradiance measured by BRU relative to B5503 can be summarized as follows:

- Global irradiances measured by BRU were between 0 to 6% higher than those measured by B5503.
- No significant spectral features are observed in the spectral ratios of the two instruments (BRU has a FWHM resolution of about 0.25 nm).
- Diurnal variations are below 3% on the 2 1/2 measurement days.

Conclusion:

The global solar irradiance spectra measured by the BRU spectroradiometer are on average 3% higher than those measured by B5503. The variability of the ratios during the measurement period (5^{th} to 95^{th} percentile) is of the order of 3% between 310 nm and 360 nm and 5% above 360 nm. Diurnal variations of the ratios are below 3%.

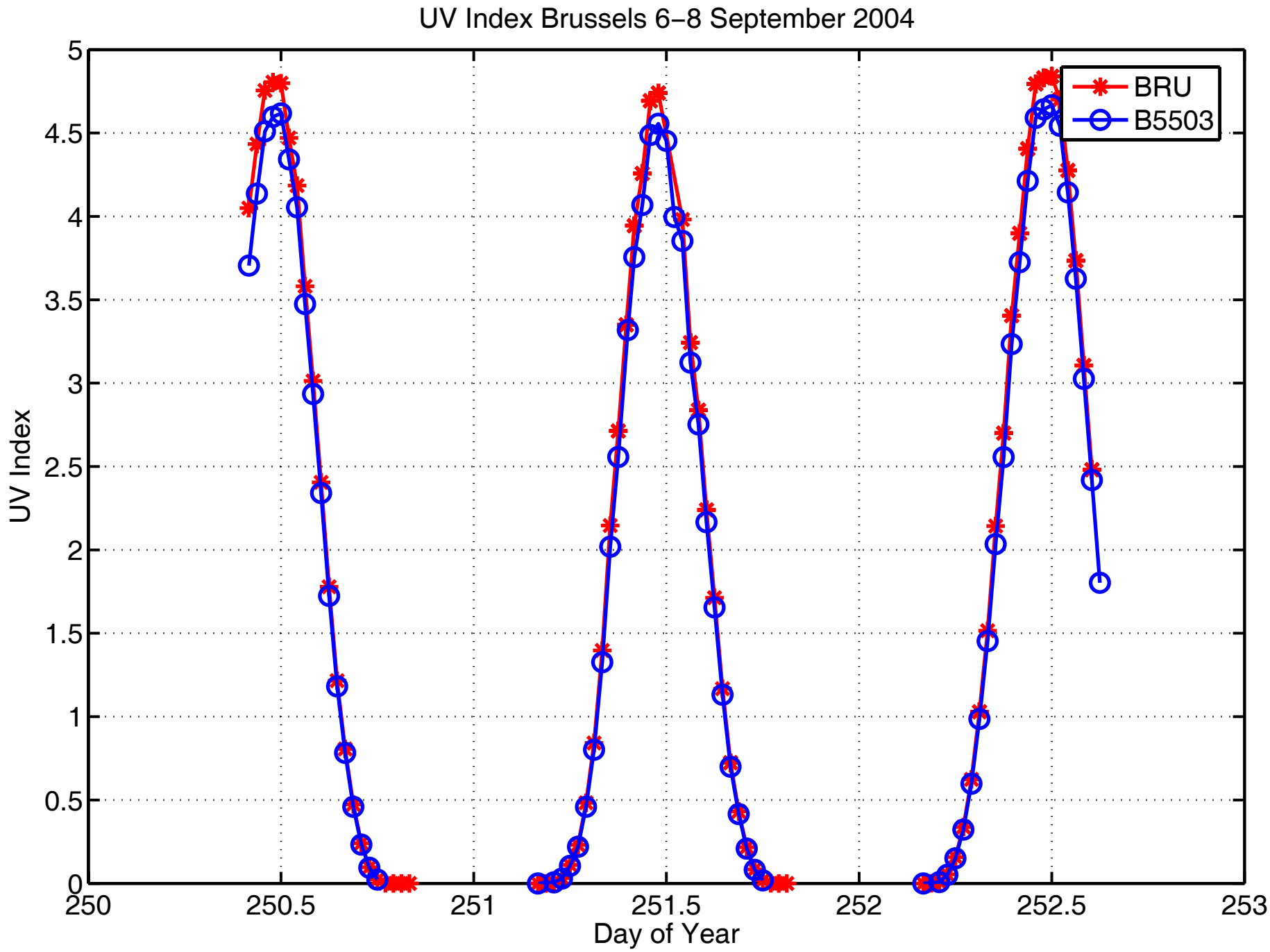
Comments from the local operator:

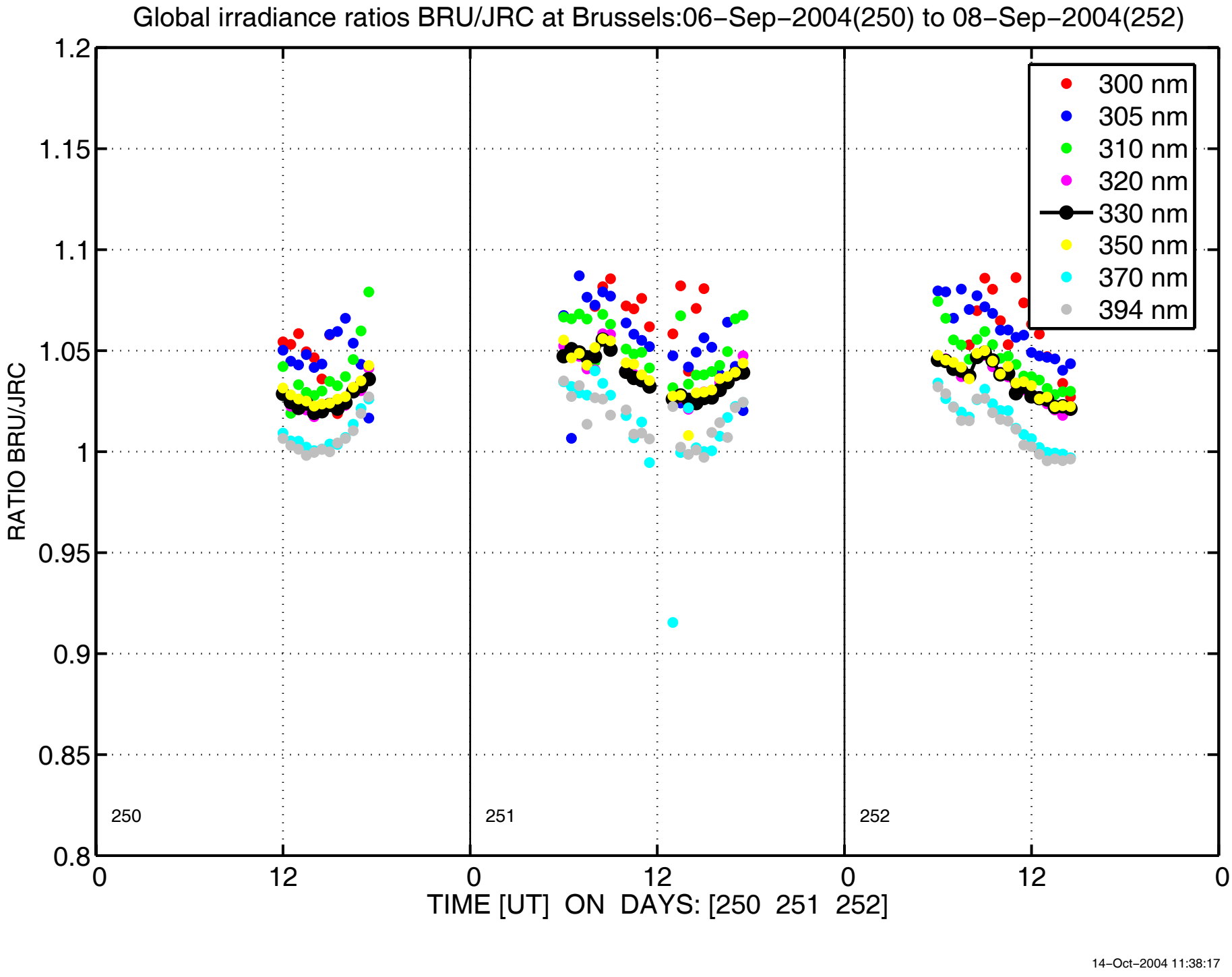
The intercomparaison was performed with the Bentham double monochromator DTM300 newly installed at the UV-VIS solar monitoring station of IASB. The characteristics are the following : focal length of 30 cm, FWHM of 0.26 nm. The detector is a Peltier cooled housing with side window bi-alkali PMT (200-600 nm, DH-10-Te from Bentham). The front optics is a 4 meters UV fiber and an UV-diffusor optimized for low cosine error (model J1002 from Schreder-CMS, Austria). No cosine corrections are applied on the data. The whole spectroradiometer and the electronics is in a dark room just below the roof while the optical head is on the roof for global sun irradiance monitoring. The temperature of the dark room, also used for absolute radiometric calibration is stabilized at 20 °C. The spectroradiometer is controlled by the BenWin+ software provided by Bentham. The first absolute radiometric calibration was performed before this campaign using two very new NIST1000 W standards of spectral irradiance: F-545 and F-546 FEL lamps.

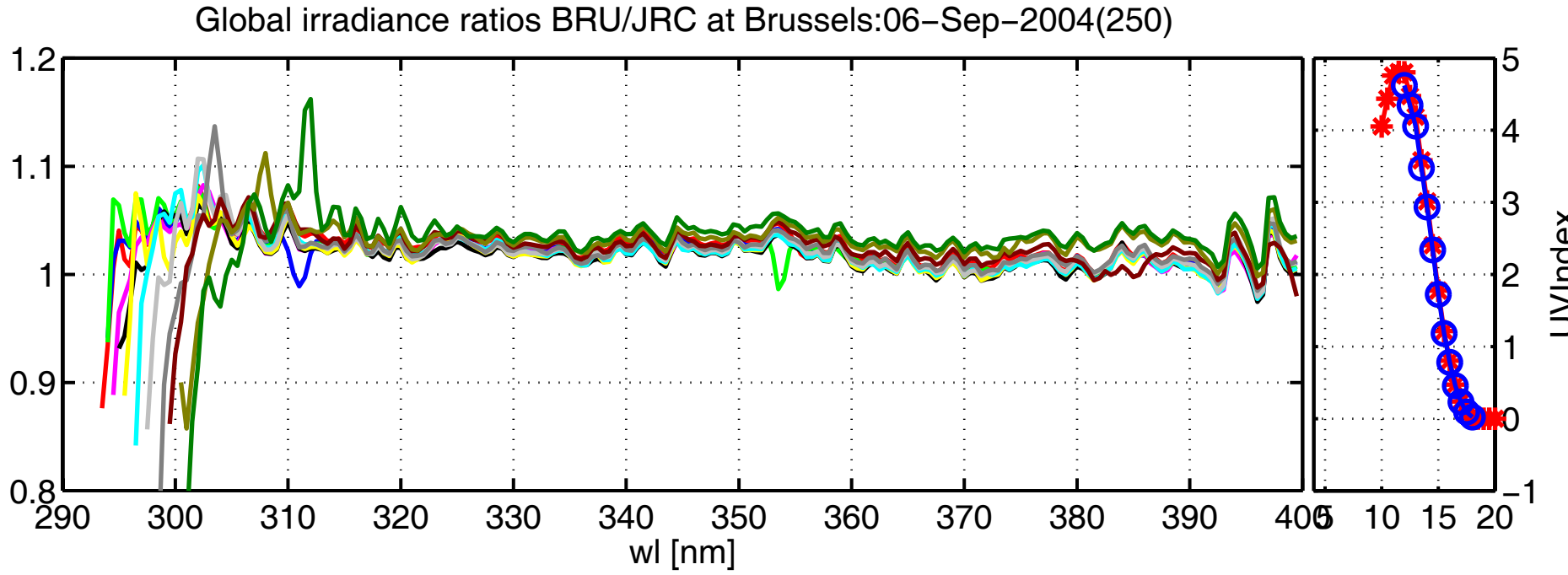
The satisfying results of the intercomparaison campaign can by explained by the robustness and the good thermal regulation of both Bentham instruments, the availability of high quality standards of spectral irradiance, the use of identical UV-diffusor and the very good weather conditions.

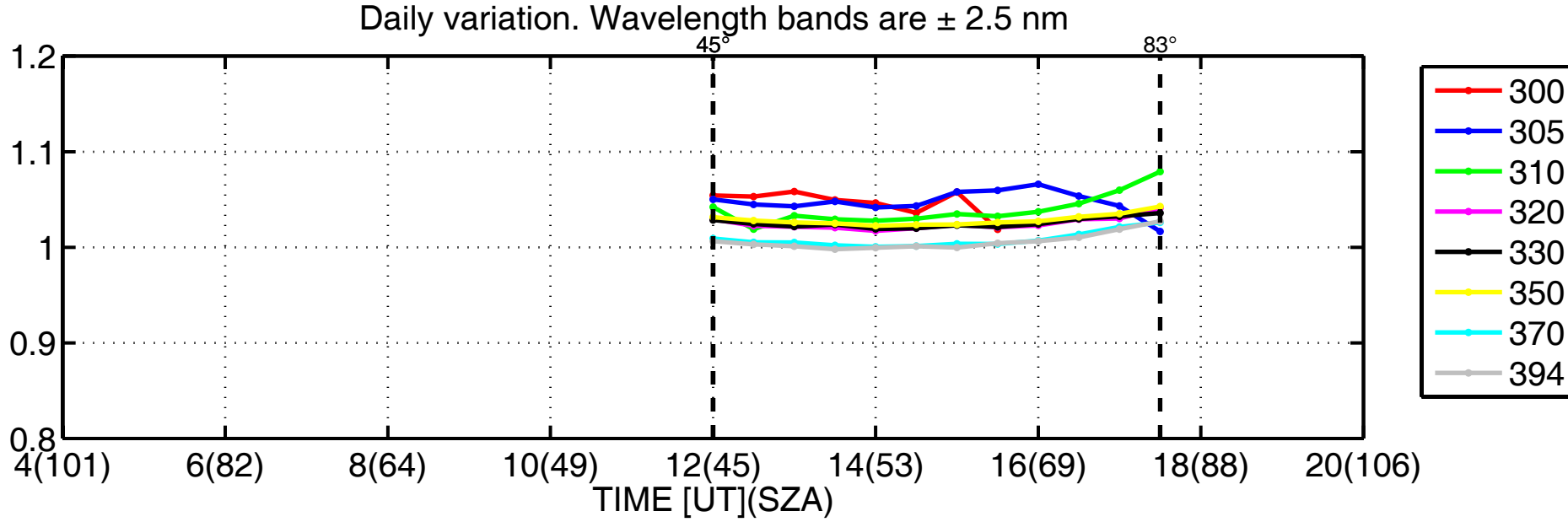
Two items will be improvement for the belgian instrument :

1. The thermal regulation of the IASB diffusor. The J1002 head was not temperature stabilized. The origin of the diurnal variations of the BRU/JRC ratio seems to be due to the temperature dependance of this teflon diffusor. An external device for the thermal regulation for our J1002 head has already been ordered to remove this effect in the close future.
2. The wavelength scale calculated in the BenWin+, is not accurate enough for solar UV measurement as it can be seen from SHICRivm wavelength shift results. The distorsion an the periodicity of the wavelength scale will charcterized and removed using a polynomial interpollation on a large sample of spectral lines provided by low pressure and hollow cathode lamps.


UV Index Brussels 6–8 September 2004
BRU
B5503
UV Index
Day of Year
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
250
250.5
251
251.5
252
252.5
253


Global irradiance ratios BRU/JRC at Brussels:06−Sep−2004(250) to 08−Sep−2004(252)
RATIO BRU/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
330 nm
350 nm
370 nm
394 nm
250
251
252
0
12
0
12
0
12
0
TIME [UT] ON DAYS: [250 251 252]
14−Oct−2004 11:38:17





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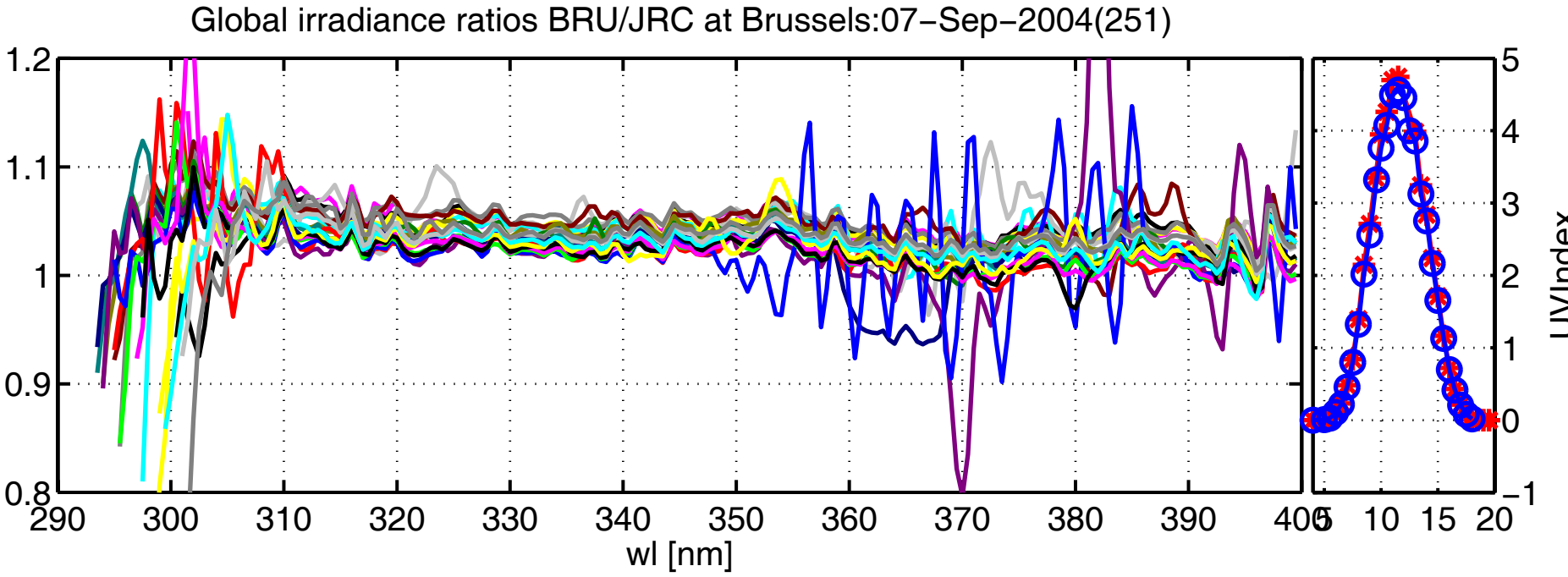

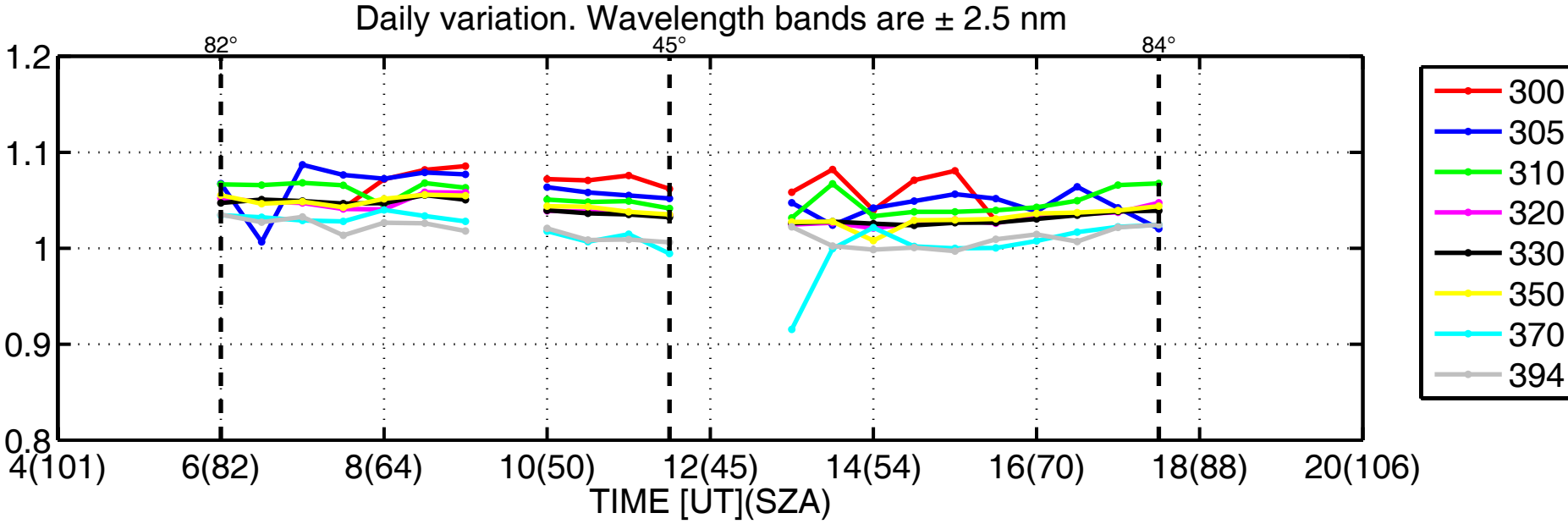

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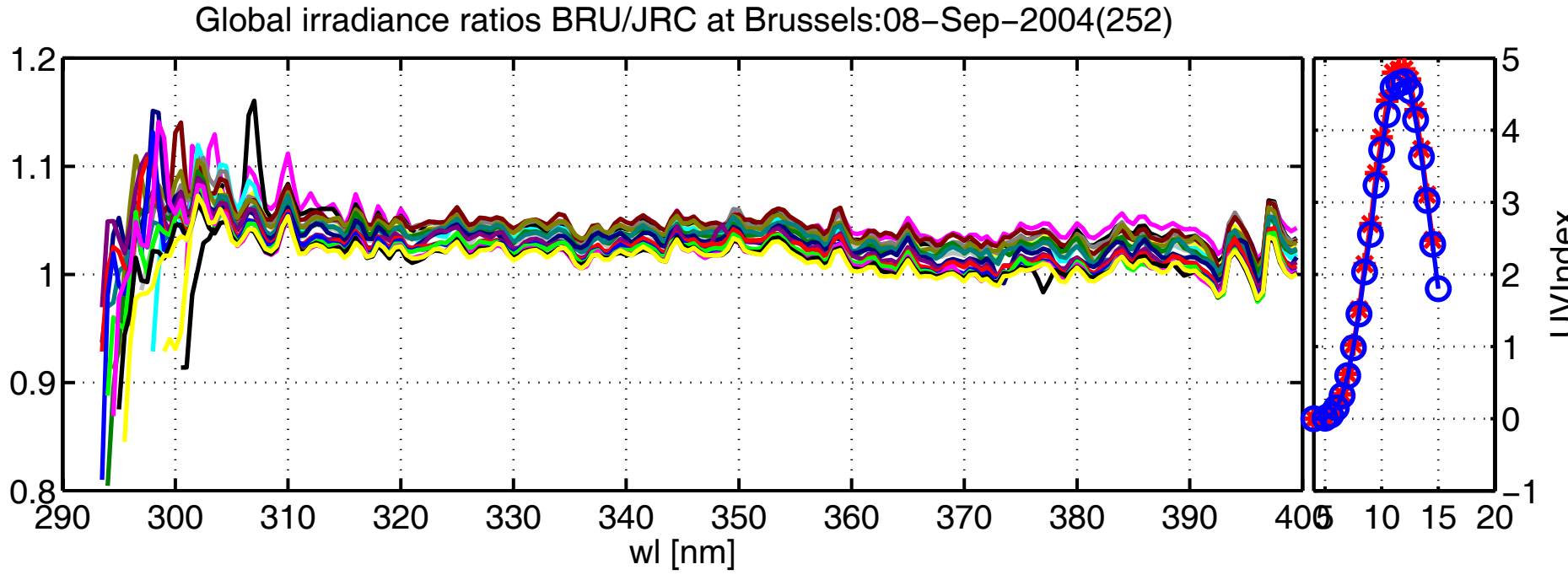

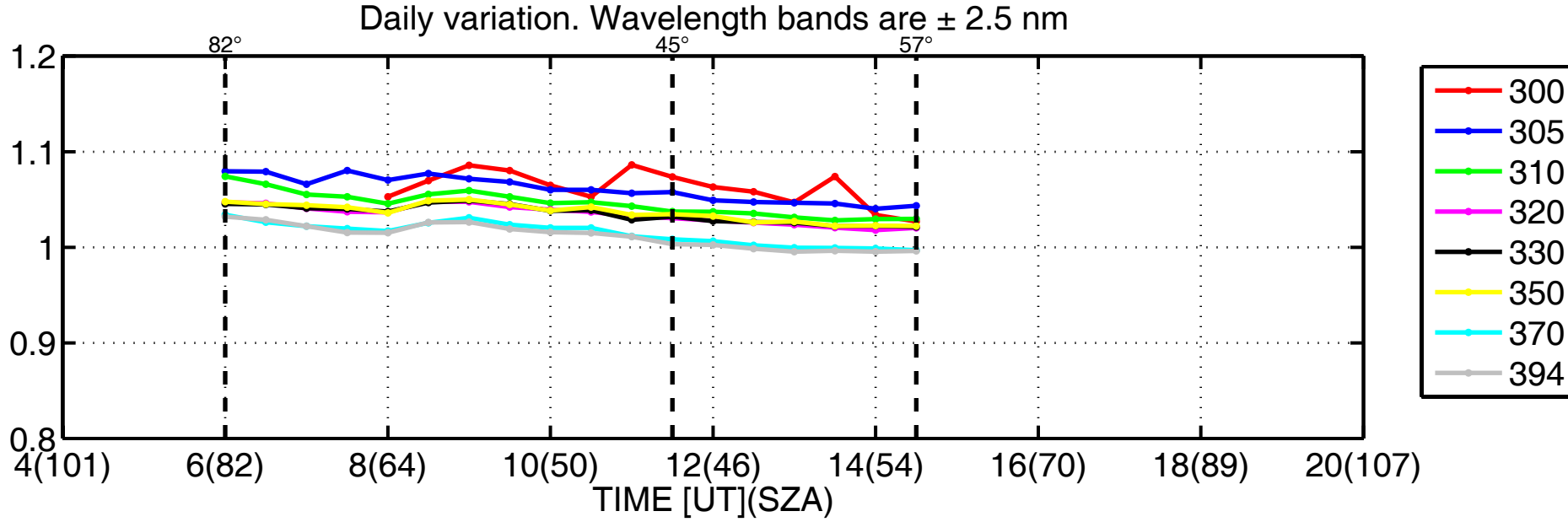

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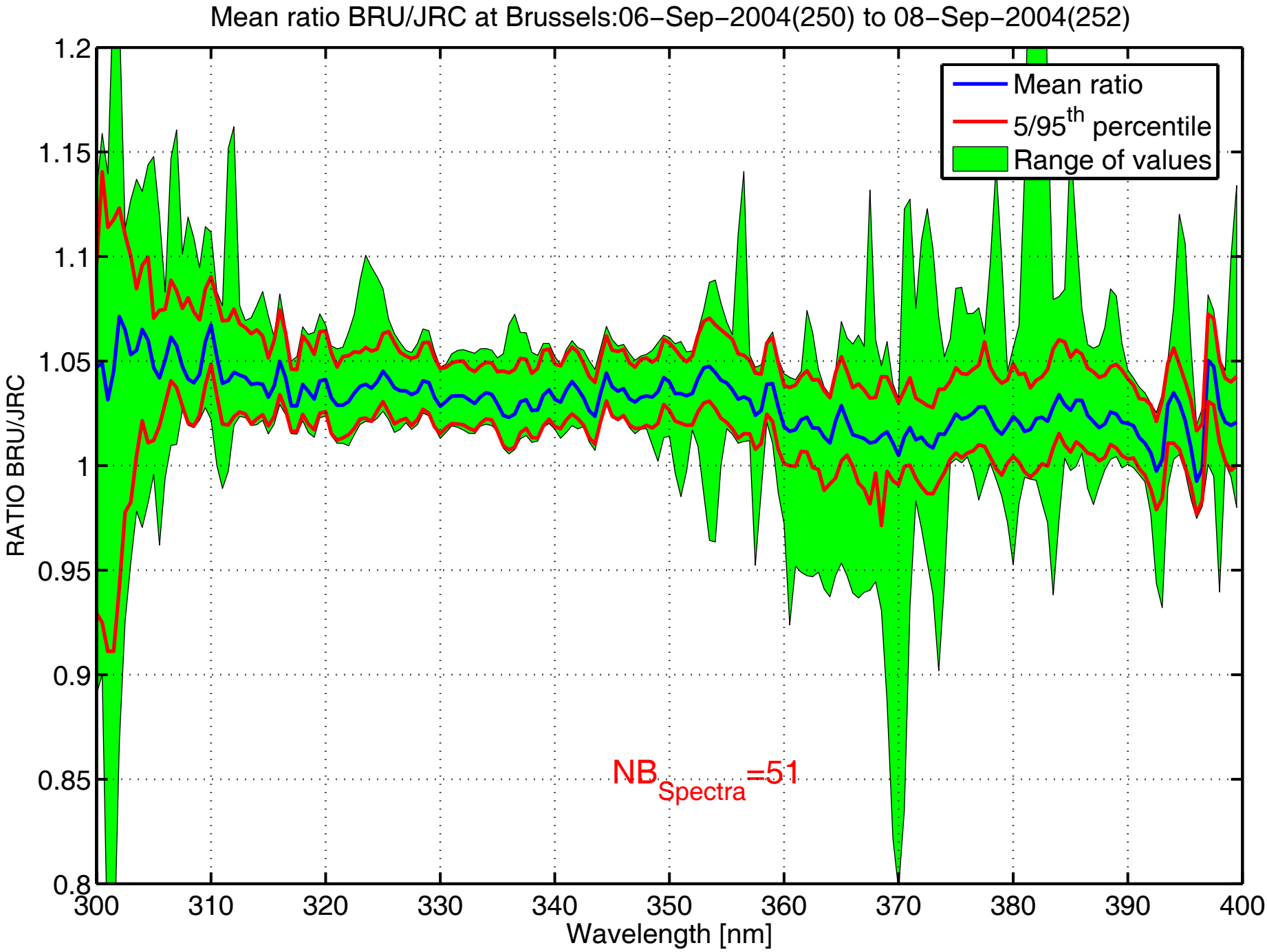
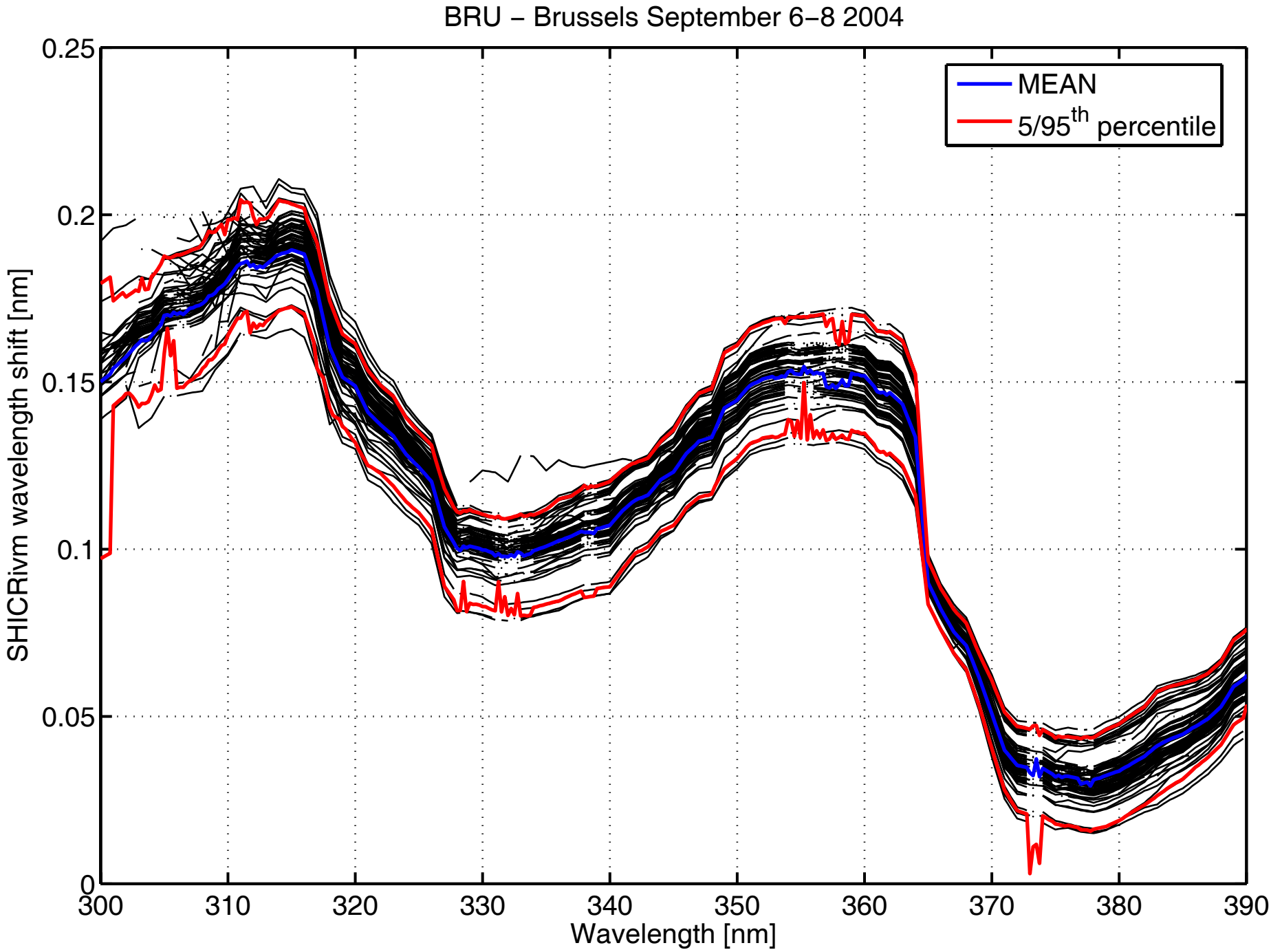
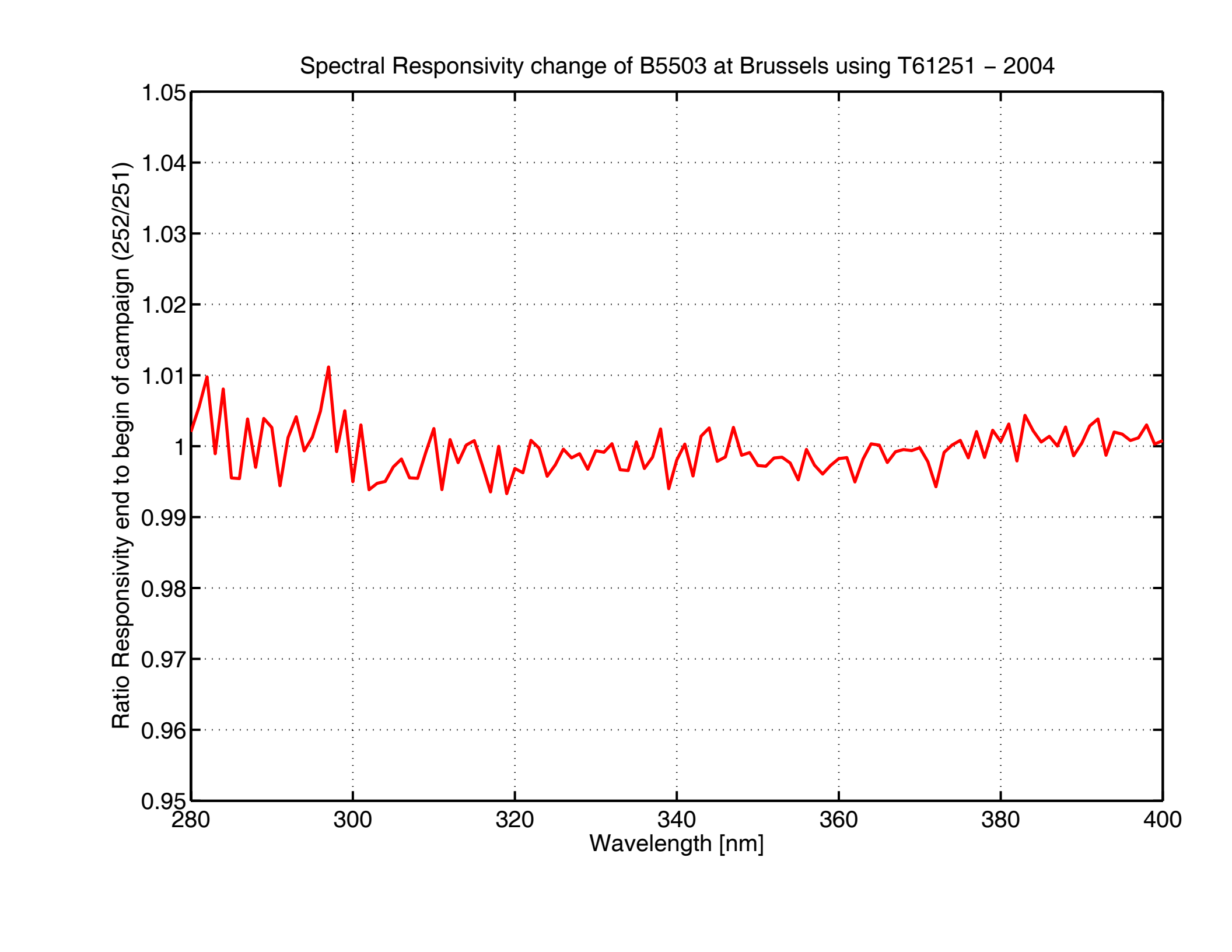

Mean ratio BRU/JRC at Brussels:06−Sep−2004(250) to 08−Sep−2004(252)
Mean ratio
5/95th percentile
Range of values
RATIO BRU/JRC
Wavelength [nm]
NBSpectra=51
1.2
1.15
1.1
1.05
1
0.95
0.9
0.85
0.8
300
310
320
330
340
350
360
370
380
390
400


BRU – Brussels September 6–8 2004
MEAN
5/95th percentile
SHICRivm wavelength shift [nm]
Wavelength [nm]
0.25
0.2
0.15
0.1
0.05
0
300
310
320
330
340
350
360
370
380
390


Spectral Responsivity change of B5503 at Brussels using T61251 – 2004
Ratio Responsivity end to begin of campaign (252/251)
Wavelength [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


BRU
QASUME