Protocol of the intercomparison at C.E.M.B.R.E.U., Briançon, France on September 15 to 18, 2003 with the travelling standard spectroradiometer 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 spectroradiometer operated by the University of Grenoble (FRB) and the travel standard B5503. The measurement site is located at Briançon; Latitude 44.88 N, Longitude 6.64 E and altitude 1330 m.a.s.l..
The horizon of the measurement site is limited by mountains; To the east the instruments are in the shadow of a mountain until 7:56 UT (or 63° solar zenith angle) at the period of the intercomparison. In the west the sun sets at 16:45 UT (80° SZA).

B5503 arrived at Briançon in the afternoon of September 15, 2003. The spectroradiometer was installed on the roof of the building at les than 1 m distance from the FRB instrument. The spectroradiometer in use at Briançon is a Bentham DM-150 double monochromator. The intercomparison between B5503 and the FRB spectroradiometer lasted three days, from the morning of September 16 to the evening of September 18.

B5503 was calibrated several times during the intercomparison period using a 100 W portable calibration system. Three 100 W lamps (T53061, T53062, and T53063) were used to obtain an absolute spectral calibration traceable to the primary reference held at ECUV, which is traceable to PTB. The daily mean responsivity of the instrument based on these calibrations varied by less than 1% during the intercomparison period. No diurnal variations of the responsivity could be observed during the measurement period. The internal temperature of B5503 was 24.6±0.4 °C. The diffuser head was heated to a temperature of 30±8°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 402 nm, every 0.5 nm, and 3 seconds between each wavelength increment. To accommodate the dark current measurement of the FRB instrument, B5503 started 3 seconds later to be synchronous. Due to the absence of a local operator, the operator of B5503 was requested to start the FRB instrument manually every day in the morning and to set the clock of the instrument. The clock of B5503 was set manually by the B5503 operator using a portable GPS receiver in the morning of every day of the intercomparison. The FRB

instrument was set to start only at 6:00 UT every day, which corresponds to a SZA of 85°.

September 15 (258):

B5503 was installed on the measurement site at 14:24 UT and left to stabilize over night.

B5503 was calibrated in the evening from 17:00 to 18:10 UT.

September 16 (259):

Synchronised measurements are available from 6:00 UT to 17:00 UT. Weather conditions were very good with some cirrus clouds in the afternoon but otherwise clear sky conditions.

B5503 calibrated at 8:43, 11:13, and 16:42 UT.

September 17 (260):

Synchronised scans are available from 6:00 to 17:00 UT. Weather conditions very good, with clear skies and only occasionally some cirrus clouds.

Lamp measurements from B5503 at 8:43 and 15:44 UT.

September 18 (261):

Synchronised scans are available from 6:00 to 16:30 UT. B5503 missed three scans from 8:30 to 9:30 UT due to a calibration. Weather conditions were very good, no clouds for the whole day.

Lamp measurements from B5503 from 8:30 to 9:50 UT.

The slit function of FRB was measured in the late evening of this day.

Results:

65 synchronised simultaneous spectra from B5503 and FRB are available from the measurement period. The wavelength shifts of the submitted solar spectra of the FRB spectroradiometer retrieved through the SHICRivm analysis were between –100 and -50 pm and stable. Before submission, FRB corrected the wavelength scale of each spectrum using a method similar to SHICRivm. Uncorrected spectra were off by about –1.5 nm. Submitted spectra were in the range 293 to 397.5 nm, every 0.5 nm.

FRB submitted a revised data set after the end of the campaign. The difference between the original and revised data set is about +7% and is based on a recalibration of the instrument after the campaign (see comments of the local operator on the next page).

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

- Global solar irradiances measured by FRB were usually between 18% lower to 10% lower than those measured by B5503.
- The spectral ratios between FRB and B5503 are slightly decreasing with wavelength, from 0.9 at 300 nm to 0.85 at 397 nm and show some fine structure of the order of 5%.
- The diurnal variability of the ratios show two features centred at 8 and 16 UT, which are more pronounced at longer wavelengths; in the morning, the ratios FRB to B5503 decreased by about 3% to 5%

dependent on wavelength; Since this period coincidences with the sun being behind the mountain (only diffuse light) this effect might be due to a remaining cosine error of FRB. In the afternoon the ratios decrease by about 4 to 5% and reach their minimum at 16 UT (73° SZA). After that, they increase again and reach noon values by 17 UT (84° SZA).

- There is an asymmetry between morning and afternoon which might be due to the special morning situation of only diffuse light before 7:56 UT (SZA of 63°).

Conclusion:

FRB measures global solar irradiance on average 13% lower than B5503. The diurnal variation is of the order of 5% and depends slightly on wavelength; longer wavelengths show a more pronounced diurnal variability at SZA above 60°.

Comments from the local operator:

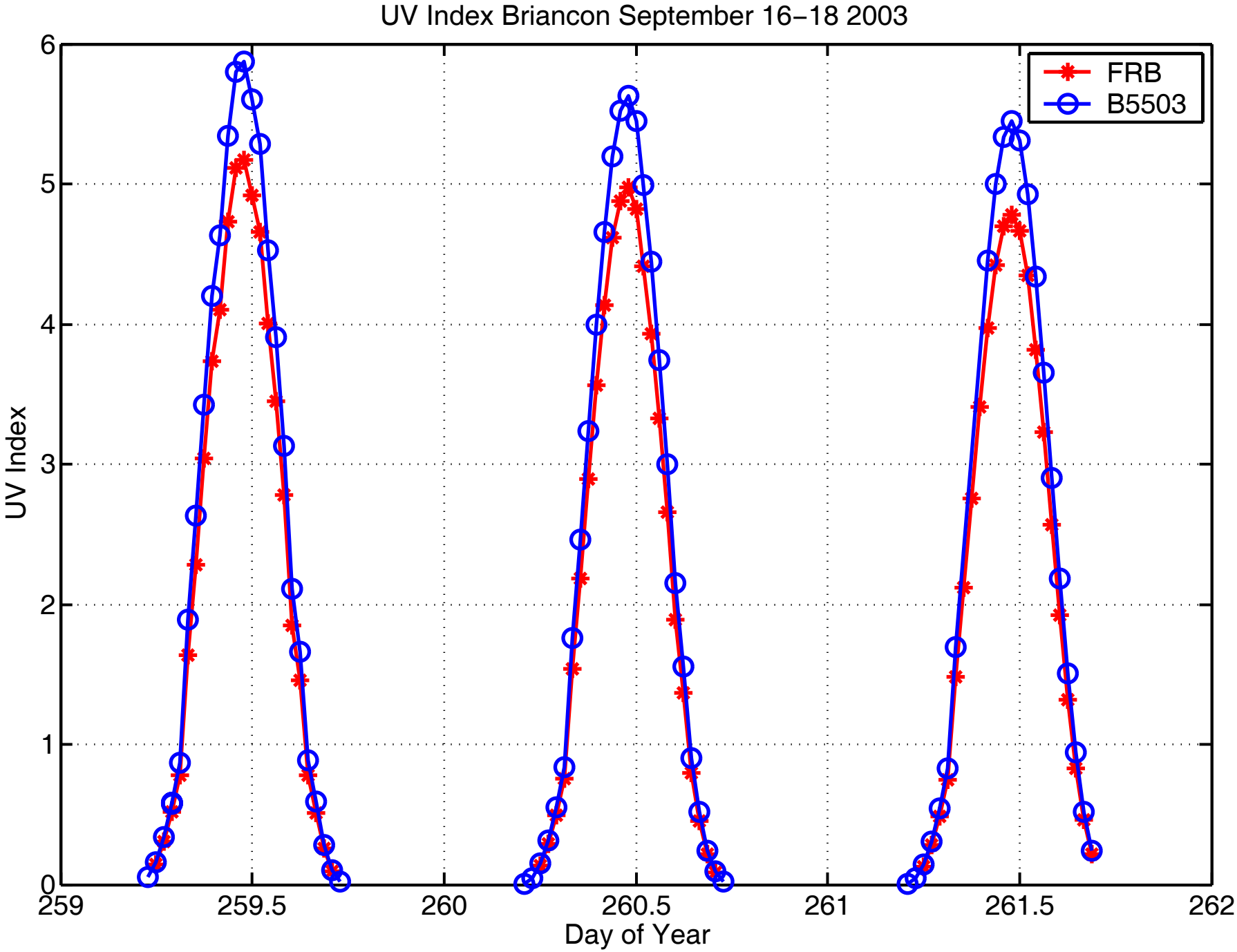
Instrument description:

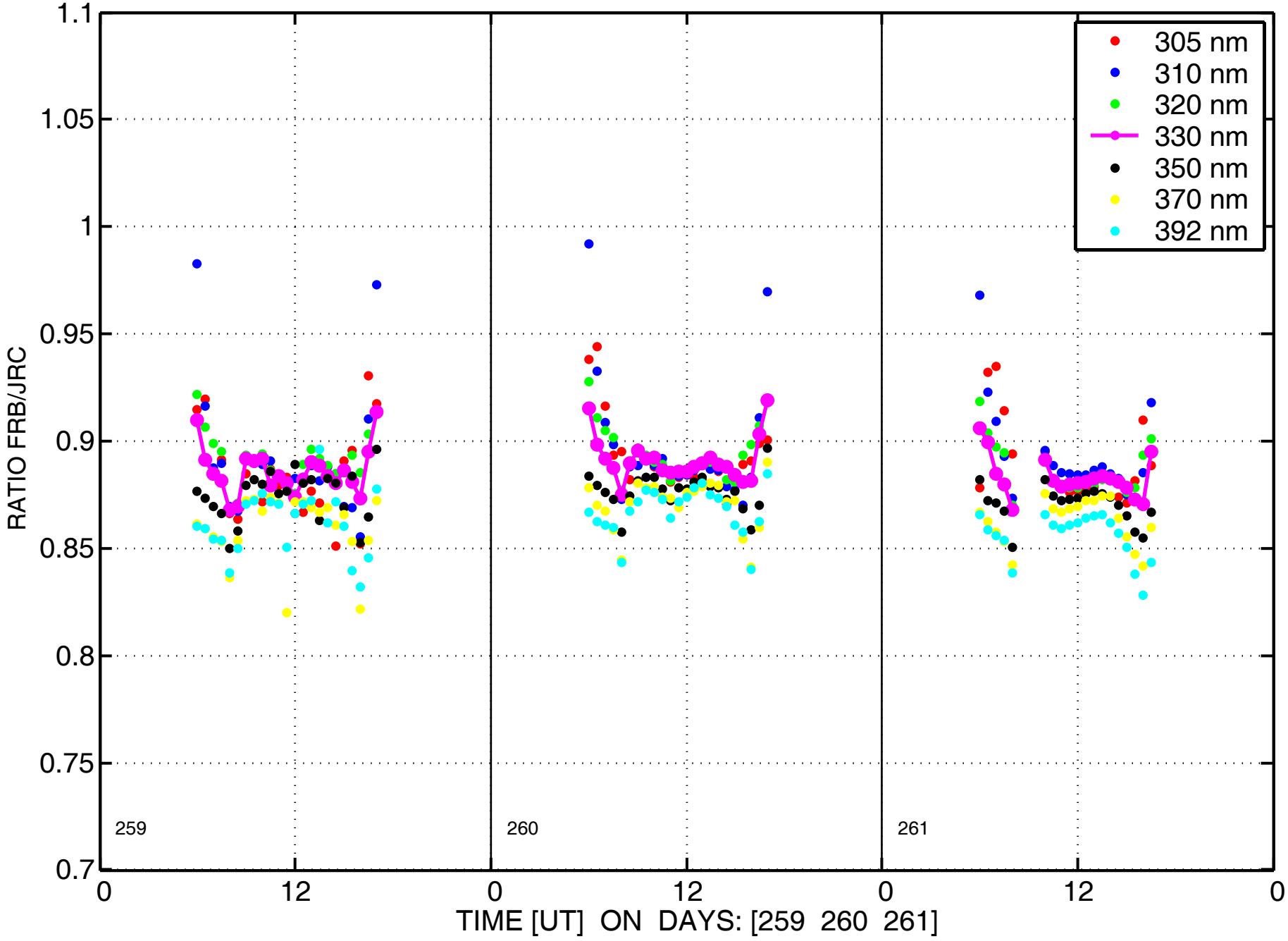
Bentham double monochromator DM150E; holographic gratings: 1200 L/mm.
Slit width : 0.37 mm; bandpass ~ 0.8 nm; routine step : 0.5 nm.
Temperature stabilisation: 25.5 +/- 1°C.
The incident light is collected with a Teflon diffuser and transmitted to the monochromator by a fiber optic bundle. The diffuser is not protected by a dome.

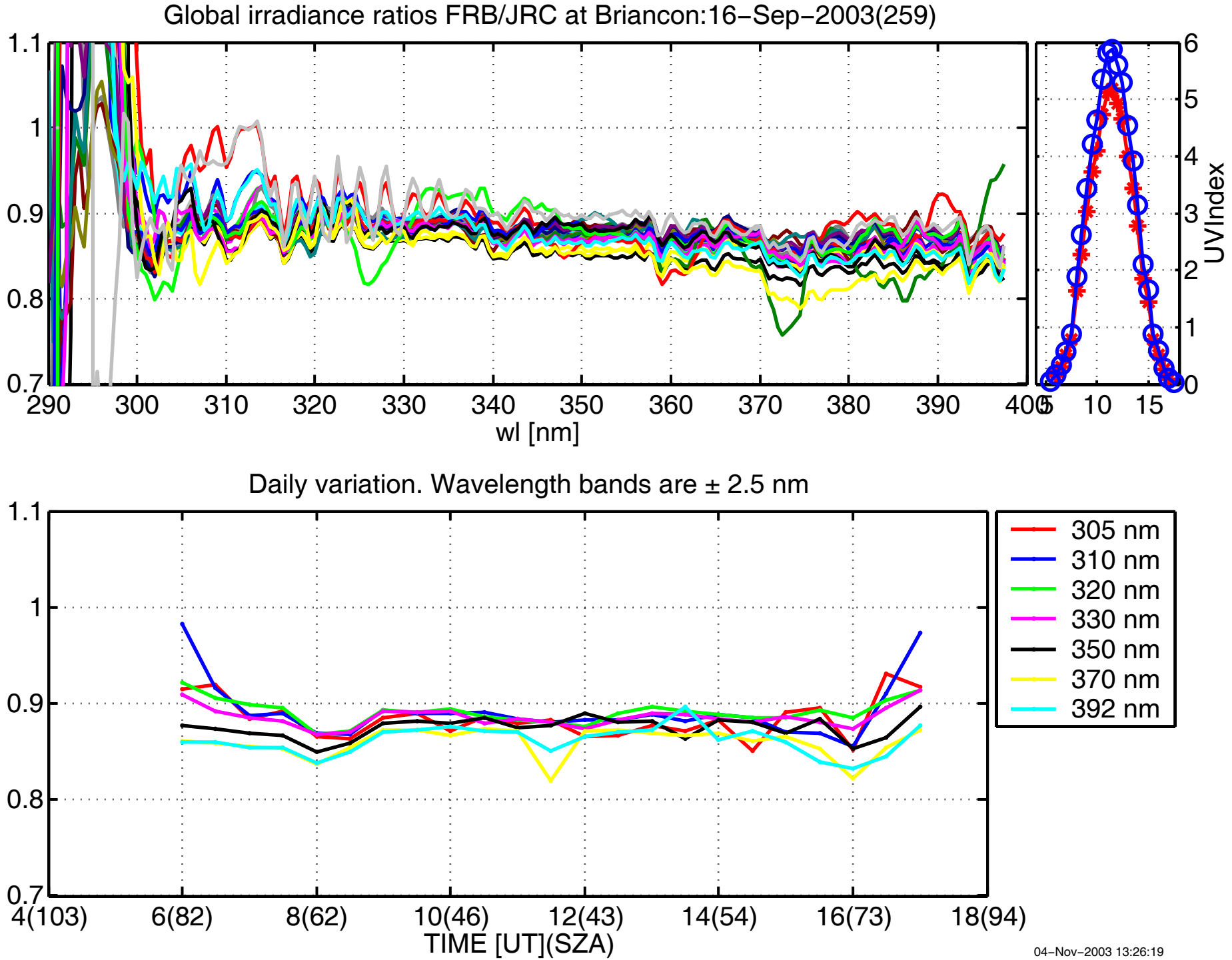
Extra data corrections:

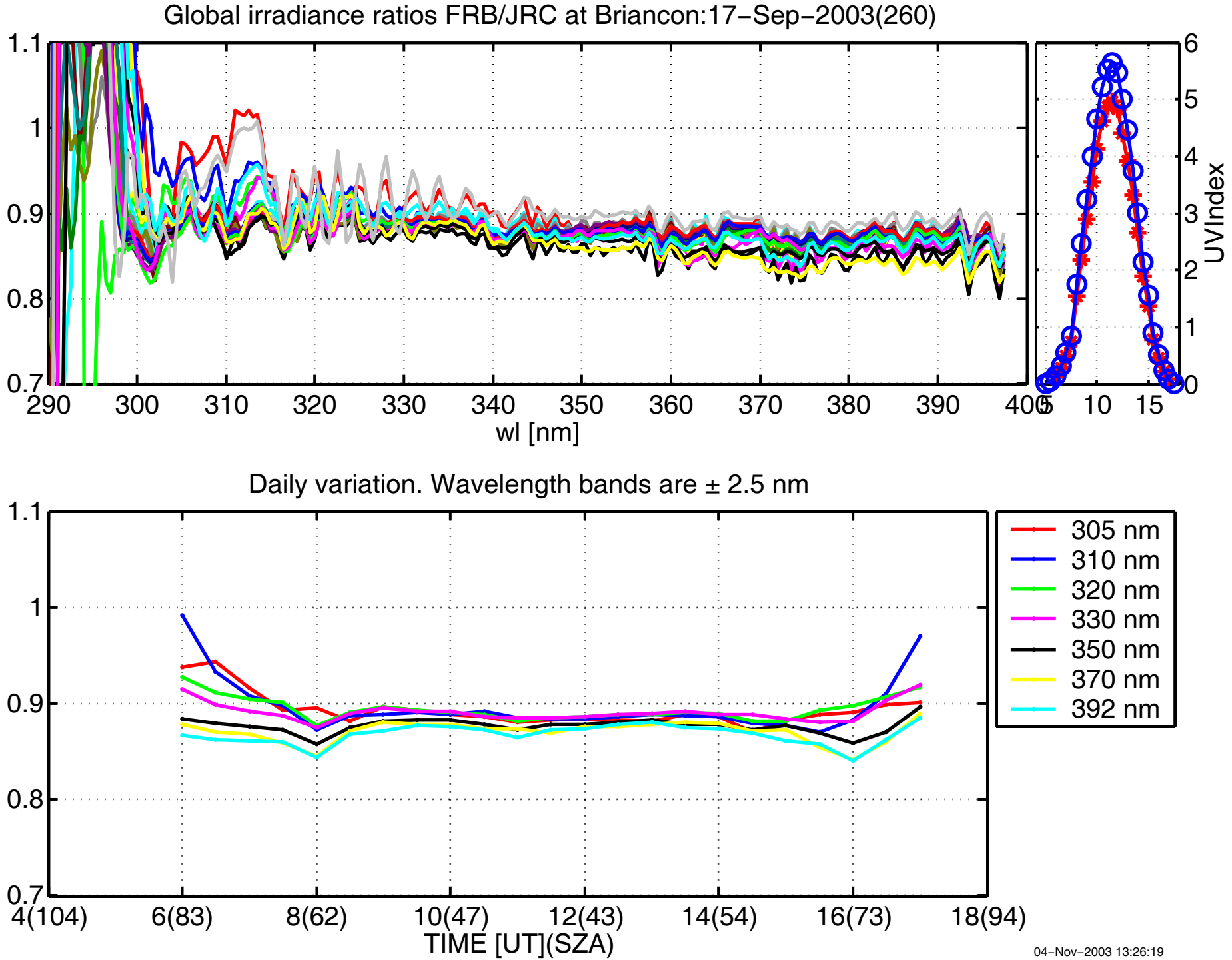
- Because a mechanical shift in the drive of the instrument occurred on 16 of September (~ 6h UT) and has not been detected at once, we had to correct the wavelength (-1.5 nm) for each measured irradiance in all the data files.

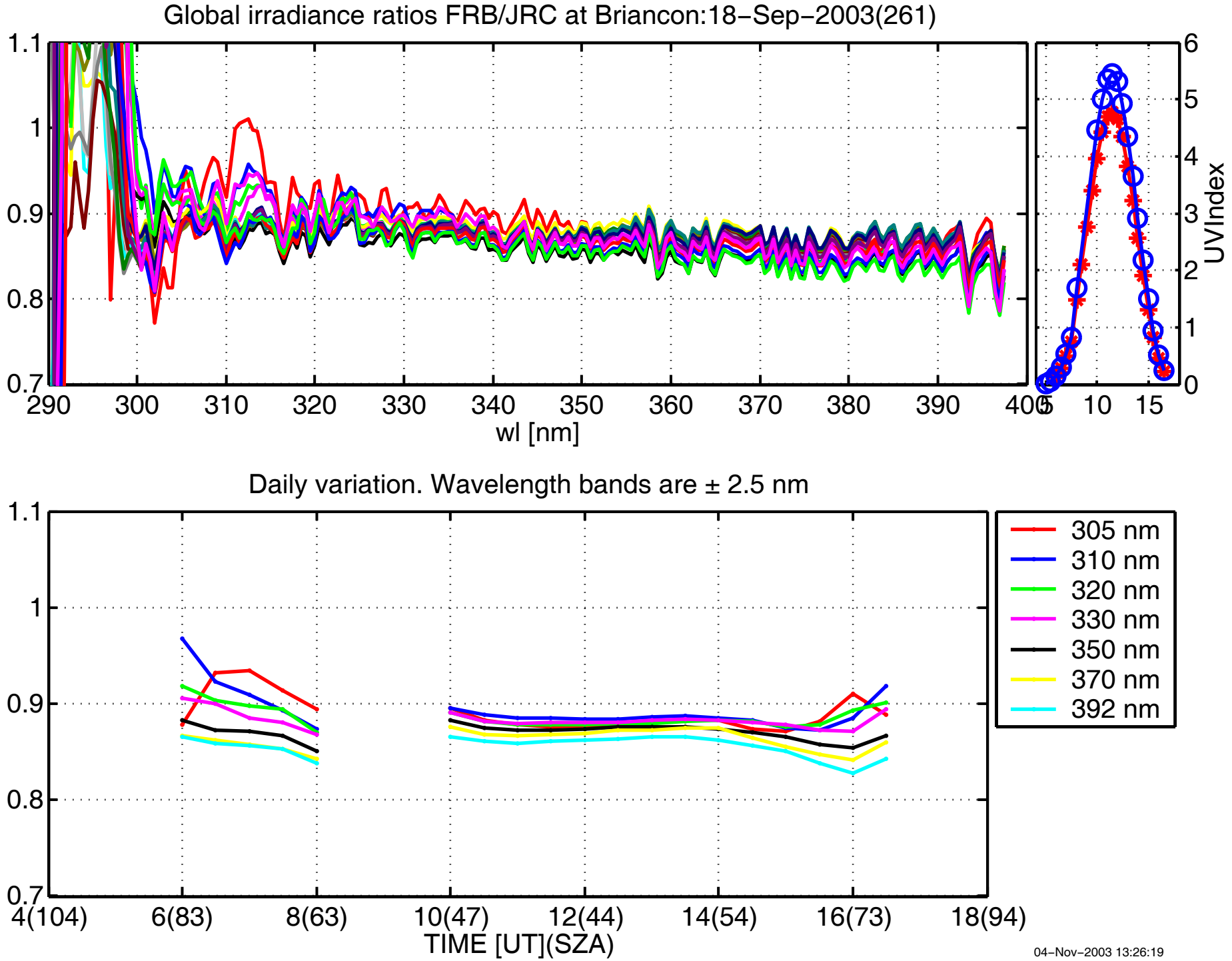
- A second set of data has been submitted following a new calibration of our instrument, carried out in 16 of October in order to reduce the first observed difference between the B5503 data and ours.

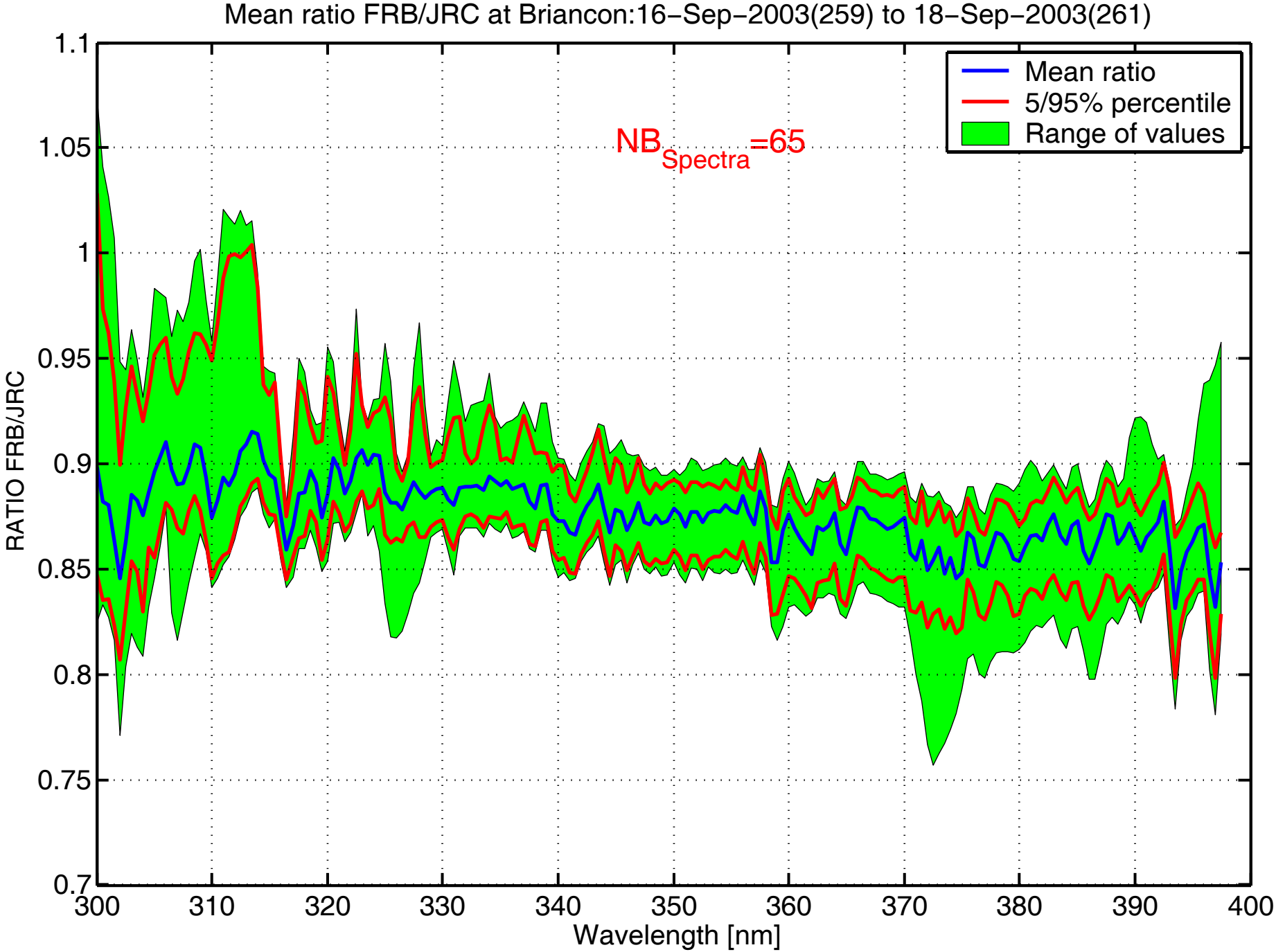

UV Index Briancon September 16−18 2003
FRB
B5503
UV Index
Day of Year
0
1
2
3
4
5
6
259
259.5
260
260.5
261
261.5
262

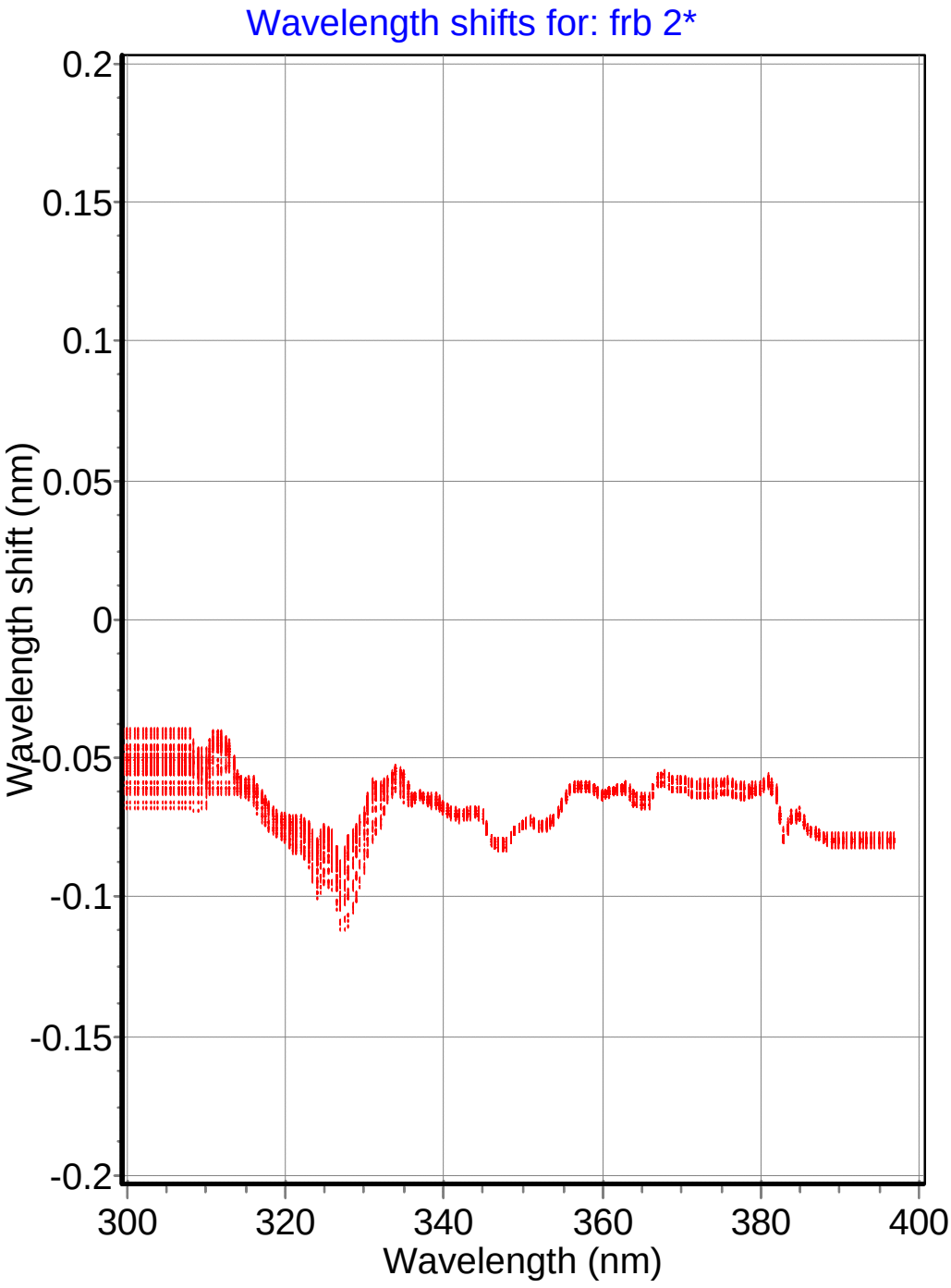

Global irradiance ratios FRB/JRC at Briancon:16−Sep−2003(259) to 18−Sep−2003(261)
RATIO FRB/JRC
TIME [UT] ON DAYS: [259 260 261]
305 nm
310 nm
320 nm
330 nm
350 nm
370 nm
392 nm
259
260
261
1.1
1.05
1
0.95
0.9
0.85
0.8
0.75
0.7
0
12
0
12
0
12
0
04−Nov−2003 13:26:19

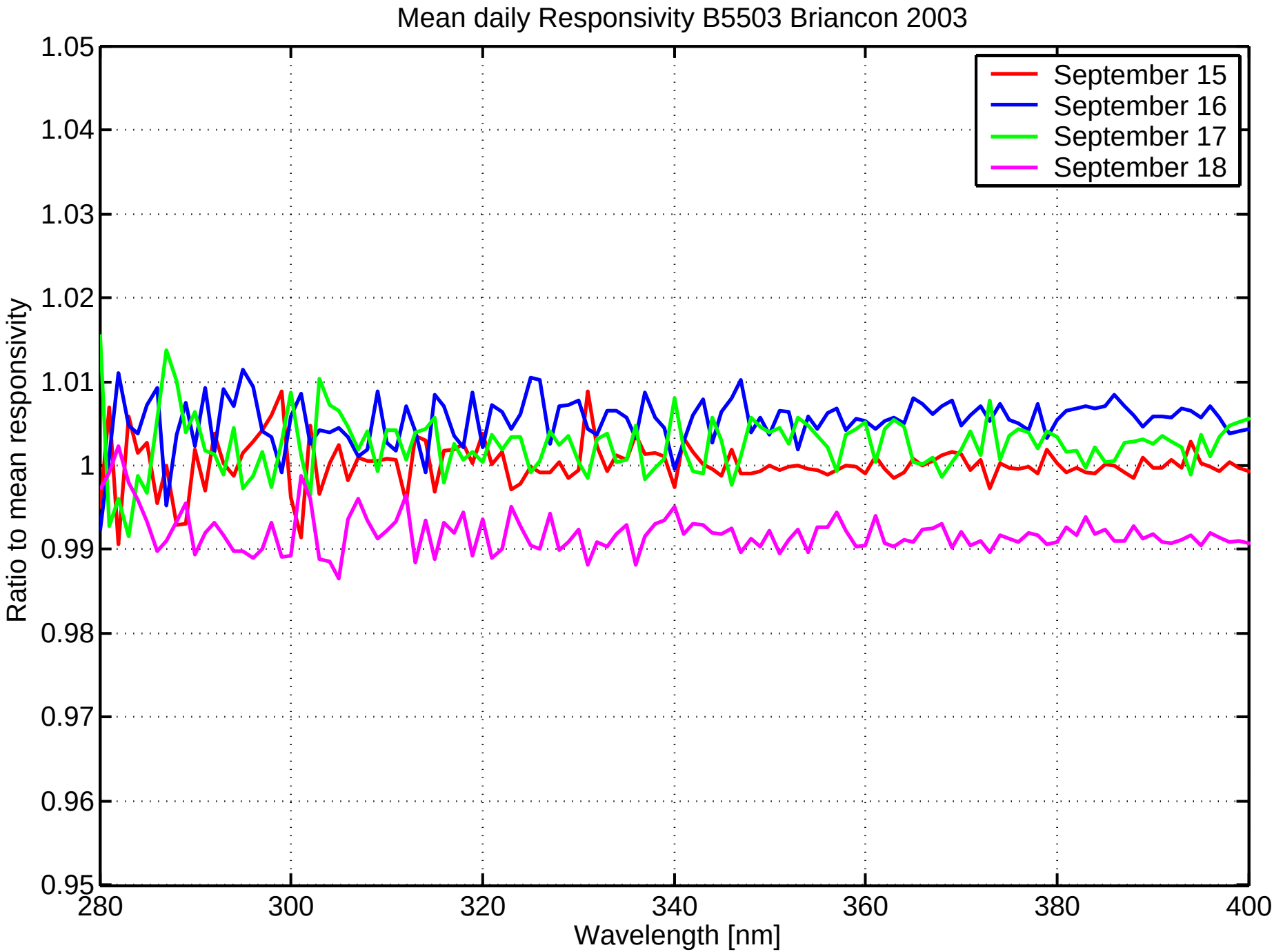

Global irradiance ratios FRB/JRC at Briancon:16−Sep−2003(259)
1.1
1
0.9
0.8
0.7
290
300
310
320
330
340
350
360
370
380
390
400
wl [nm]
6
5
4
3
2
1
0
UVIndex
5
10
15
Daily variation. Wavelength bands are ± 2.5 nm
305 nm
310 nm
320 nm
330 nm
350 nm
370 nm
392 nm
4(103)
6(82)
8(62)
10(46)
12(43)
14(54)
16(73)
18(94)
TIME [UT](SZA)
04−Nov−2003 13:26:19


Global irradiance ratios FRB/JRC at Briancon:17−Sep−2003(260)
1.1
1
0.9
0.8
0.7
290
300
310
320
330
340
350
360
370
380
390
400
wl [nm]
6
5
4
3
2
1
0
UVIndex
5
10
15
Daily variation. Wavelength bands are ± 2.5 nm
1.1
1
0.9
0.8
0.7
4(104)
6(83)
8(62)
10(47)
12(43)
14(54)
16(73)
18(94)
TIME [UT](SZA)
305 nm
310 nm
320 nm
330 nm
350 nm
370 nm
392 nm
04−Nov−2003 13:26:19


Global irradiance ratios FRB/JRC at Briancon:18−Sep−2003(261)
1.1
1
0.9
0.8
0.7
290
300
310
320
330
340
350
360
370
380
390
400
wl [nm]
6
5
4
3
2
1
0
UVIndex
5
10
15
Daily variation. Wavelength bands are ± 2.5 nm
1.1
1
0.9
0.8
0.7
4(104)
6(83)
8(63)
10(47)
12(44)
14(54)
16(73)
18(94)
TIME [UT](SZA)
305 nm
310 nm
320 nm
330 nm
350 nm
370 nm
392 nm
04−Nov−2003 13:26:19


Mean ratio FRB/JRC at Briancon:16−Sep−2003(259) to 18−Sep−2003(261)
Mean ratio
5/95% percentile
Range of values
NB Spectra =65
RATIO FRB/JRC
Wavelength [nm]
1.1
1.05
1
0.95
0.9
0.85
0.8
0.75
0.7
300
310
320
330
340
350
360
370
380
390
400


Wavelength shifts for: frb 2*
0.2
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
Wavelength shift (nm)
300
320
340
360
380
400
Wavelength (nm)


Mean daily Responsivity B5503 Briancon 2003
Ratio to mean responsivity
Wavelength [nm]
September 15
September 16
September 17
September 18
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

View EAST