

Protocol of the intercomparison at LKO, Arosa, Switzerland on July 19 to 27, 2010 with the travelling reference spectroradiometer QASUME from PMOD/WRC

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The purpose of the visit was the comparison of spectral global solar irradiance measurements between the 7 spectrophotometers participating in the 5th Regional Brewer Calibration Center – Europe (RBCC-E) Campaign (see Table 1) and the travel reference spectroradiometer QASUME. Lichtklimatische Observatorium (LKO) in Arosa; Latitude 46.78 N, Longitude 9.68 E and altitude 1846 m.a.s.l.. The horizon of the measurement site is free down to $\sim 80^\circ$ solar zenith angle (SZA), see Figure on Page 35.

Measurements between 4:00 UT and 19:00 UT have been analysed.

QASUME arrived at LKO in the morning of July 19, 2010. The spectroradiometer was installed in line to the Brewer spectrophotometers with the entrance optic of QASUME between 2 and 10 m away from the other instruments. The measurement campaign lasted seven days, from July 20 to the evening of July 27; the core comparison days were July 24 till 26.

QASUME was calibrated several times during the intercomparison period using a portable calibration system. Three lamps (T68522, T68523, and T61253) were used to obtain an absolute spectral irradiance calibration traceable to the primary reference held at PMOD/WRC, 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. The internal temperature of QASUME was 23.9 ± 0.1 °C. The diffuser head was heated to a temperature of 28.2 ± 1.5 °C.

The wavelength shifts relative to an extraterrestrial spectrum as retrieved from the SHICRivm analysis were between ± 50 pm in the spectral range 290 to 400 nm.

Table 1: Participating Brewer spectrophotometers; 4 single and 3 double monochromators.

Instrument ID	Institution	Operator	Country
#017-MKII	IOS	Ken Lamb	Canada
#040-MKII	MeteoSwiss	Herbert Schill	Switzerland
#072-MKII	MeteoSwiss	Herbert Schill	Switzerland
#156-MKIII	MeteoSwiss	Herbert Schill	Switzerland
#064-MKII	Inst. of Geophysics	Janusz Jaroslowski	Poland
#163-MKIII (ISQ)	PMOD/WRC	Julian Gröbner	Switzerland
#185-MKIII (IZ3)	INM IZANA	Alberto Redondas	Spain

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.

DOY	Date	DAY	Weather	Comment
200	19-Jul	Monday	Mostly clear sky with few cirrus clouds	Installed at 10:30 UT Calibrated: 15:54 using T68523
201	20-Jul	Tuesday	Mostly clear sky with few cirrus clouds	Calibrated: 8:51 using T68523
202	21-Jul	Wednesday	Mix of sun & clouds Clear sky in the morning	
203	22-Jul	Thursday	Mix of sun & clouds	
204	23-Jul	Friday	Mix of sun & clouds Rain showers	Calibrated: 7:17 using T68523
205	24-Jul	Saturday	Mix of sun & clouds Rain showers	UV Days
206	25-Jul	Sunday	Mix of sun & clouds Rain showers	UV Days
207	26-Jul	Monday	Mix of sun & clouds Rain showers	UV Days
208	27-Jul	Tuesday	Mix of sun & clouds Rain showers	End of Campaign: 18:15 UT Calibrated: 12:42 using T68523 Calibrated: 13:00 using T61253 Calibrated: 13:15 using T68522 End of Campaign: 19:34 UT

Results:

In total 17 to 53 synchronised simultaneous spectra from QASUME and the Brewer spectrophotometers are available from the measurement period. Measurements between 4:00 and 19:00 UT have been analysed (SZA smaller than 90°).

Remarks:

1. The first day of the intercomparison was dedicated to the setup and training phase. The official “UV-days” were 24 and 26 July (205-207). However, synchronized UV scans are also available from the start of the campaign.
2. Unfortunately the weather conditions were only perfect at the very start of the campaign, when all instruments were still in the setup phase. From 23 July till the end of the campaign (204-207) numerous rain showers disturb the measurements.
3. Although different calibrations and measurements were performed during the campaign, traffic on the roof could be limited. Therefore only few scans are disturbed.
4. The time synchronisation between QASUME and various Brewers could not always be achieved which led to several missing scans.
5. Because of the weather condition no calibration certificates could be produced. For the production of the performance records all solar scans were excluded which are affected by rain.

Additional Measurements:

1. Angular Response Measurement of Brewer #163
2. Measurement of the Slit function the Brewer spectrophotometers using the HeCd-Laser of PMOD/WRC.

Table 2: Mean values of the ratio Brewer/QASUME (305 – 320 nm), the diurnal variability and the wavelength shifts.

Instrument ID	Brewer to QASUME [%]	Diurnal variability [%]	Wavelength shift [pm]
#017	-5	±2	-20 .. +20
#040	-4	±3	-20 .. +50
#072	-3	±3	-10 .. +50
#156	3	±2	+20 .. +100
#064	-6	±2	-10 .. +60
#163	0	±1	-40 .. +20
#185	-2	±2	-30 .. +50





































































