Physikalisch-Meteorologisches Observatorium Davos
World Radiation Center

pmod wrc

Calibration Certificate

No. 2013-113-02

Calibration Item **Pyrgeometer**

Manufacturer	Kipp & Zonen
Type	CGR4 with PT100 body thermistor
Serial number	110385

Customer

Alfred Wegener Institut
Helmholtz-Zentrum für Polar und Meeresforschung
Am Luneort 15
27572 Bremerhaven
Germany

Calibration Mark 2013-113-02

Period of Calibration 02-Sep-2013 to 14-Sep-2013

Davos Dorf, 16 September, 2013

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In charge of calibration

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Calibration procedure

This instrument was calibrated by an outdoor comparison to the pyrgeometer reference group (PIR 31463F3, PIR 31464F3, CG4 FT004, and CG4 010535) of the infrared radiometry section of the World radiation Center (WRC-IRS) at PMOD/WRC according to the SOP "IRS_Pyrgeometer_calibration". The comparison is made during nighttime with cloudy and cloud-free situations. The pyrgeometer was installed in a PMOD-VHS ventilation unit with a heated air flow around the dome.

From the measurements the sensitivity factor C is determined by using the standard relation (see Eq. 1 below), which involves the pyrgeometer signal U_{emf} and the body temperature T_B of the pyrgeometer. Body temperature is determined using equation (2) below. The longwave downward irradiance E is calculated using the following equation:

$$E = \frac{U_{emf}}{C}(1 + k_1 \cdot \sigma T_B^3) + k_2 \cdot \sigma T_B^4 \tag{1}$$

The Stefan-Boltzmann constant σ was set to the 2006 recommended CODATA value.

$$\sigma = 5.6704 \cdot 10^{-8} W m^{-2} K^{-4}$$

The conversion of the resistance to temperature used the equation shown below:

$$T = \frac{-a + \sqrt{a^2 - 4b\left(1 - \frac{R}{100}\right)}}{2b} + 273.15 \tag{2}$$

where the temperature T is given in Kelvin and the thermistor resistance R is given in Ohm. The constants a and b are listed below:

$$a = 3.90802 \cdot 10^{-3} \quad b = -5.80195 \cdot 10^{-7}$$

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Calibration results

Sensitivity: **$C = 8.55\ \mu V\ W^{-1}\ m^2$**

$u = 0.28\ \mu V\ W^{-1}\ m^2$

The sensitivity C was derived using the following pyrgeometer coefficients k_1 and k_2:

$k_1 = 0.03$ $k_2 = 0.9997$

The reported relative expanded uncertainty of measurement u is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.

Calibration remarks

Radiation and temperature conditions during the calibration:

Longwave downward radiation (LDR)	245	W/m^2	to	313	W/m^2
Net radiation	-99	W/m^2	to	-74	W/m^2
Pyrgeometer body temperature	2.4	°C	to	16.1	°C
Integrated water vapour (IWV)	10.7	mm	to	22.0	mm
Residuals (2.5% to 97.5% percentile)	0.7	W/m^2			

Measurement period	02-Sep-2013 to 14-Sep-2013
Measurement days	8

Comments

The coefficients k_1 and k_2 were determined in the reference blackbody source of PMOD/WRC on 30 August 2013 using blackbody temperatures between -19 °C and +15 °C and pyrgeometer body temperatures between -10 °C and +20 °C.

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