Physikalisch-Meteorologisches Observatorium Davos
World Radiation Center

pmod wrc

Calibration Certificate

No. 2018-1656-03

Calibration Item

Pyrgeometer

Manufacturer	Kipp & Zonen
Type	CGR4 with PT-100 body thermistor
Serial number	110399

Customer

Alfred Wegener Institut
Helmholtz-Zentrum für Polar und Meeresforschung
Flughafen Bremen
Henrich-Focke-Str.9
D-28199 Bremen
Germany

Calibration Mark

2018-1656-03

Period of Calibration

25-Jul-2018 to 05-Aug-2018

Davos Dorf, 06 August, 2018

C. Thomann
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 document "QM-SOP-IRS-0015_Pyrgeometer_Calibration_SOP". 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 2014 recommended CODATA value.

$$\sigma = 5.670367 \cdot 10^{-8} W m^{-2} K^{-4}$$

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 = 10.91 μV W^{-1} m^2**

U = 0.36 μV W^{-1} m^2

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

$k_1 = 0.02$ $k_2 = 0.9978$

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

Logger used for WISG reference : CR23X1-1028 (2018)
Logger used for DUT : CR23X-2049 (2018)

Radiation and temperature conditions during the calibration:

Longwave downward radiation (LDR)	291	W/m^2	to	335	W/m^2
Net radiation	-100	W/m^2	to	-72	W/m^2
Pyrgeometer body temperature	12.6	°C	to	20.1	°C
Integrated water vapour (IWV)	17.7	mm	to	24.4	mm
Residuals (2.5% to 97.5% percentile)	0.5	W/m^2			

Measurement period	25-Jul-2018 to 05-Aug-2018
Measurement days	9

Comments

The coefficients k_1 and k_2 were determined in the reference blackbody source of PMOD/WRC on 24 July 2018 using blackbody temperatures between -19 °C and +15 °C and pyrgeometer body temperatures between -10 °C and +20 °C.

The dome of the instrument was cleaned regularly and the sillicagel was changed on arrival.

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