Calibration Report: Eppley PIR Pyrgeometer

SUMMARY

Calibration Date : 6 April 1998 Calibration Due Date : 6 April 2000

Serial No.	*C*	*k1*	*k2*	*k3*	*Cs*	K'
	$mV / W / m^2$				$mV / W / m^2$	
27174F3	4.519	0.106	1.003	3.027	4.03	2.95
31606F3	3.865	0.069	1.000	3.366	3.54	3.36
26168F3	4.290	0.061	1.010	3.234	4.22	2.82
24323F3	4.055	0.082	1.006	3.662	3.79	3.53
26036F3	4.359	0.122	1.004	3.577	3.84	3.48

$$E = \frac{U_{emf}}{C}\left(1 + k_1 s T_B^3\right) + k_2 s T_B^4 - k_3 s \left(T_D^4 - T_B^4\right) - f\Delta T_{S-N} \qquad \text{EQN 1}$$

Where:

E = Irradiance, W/m^2

U_{emf} = Thermopile output voltage, mV

C = Sensitivity Coefficient, $mV / W / m^2$

k1, *k2*, *k3* = Correction factors

s = Stephan-Boltzmann Constant, 5.67 x 10^{-8} $W/m^2 K^4$

T_B = Output of body thermister YSI 44031, K

T_D = Output of dome thermister YSI 44031, K

f = Correction factor for long wave component of direct sun if the instrument is used without a shading disk.

$\Delta T_{S\text{-}N} = (T_{SE} - T_N) + (T_{SW} - T_N)$

T_{SE}, T_N, T_{SW} = Output of dome thermisters, southeast, north and southwest respectively, K

$$E = \frac{U_{emf}}{Cs} + s T_B^4 - \text{K'}\, s \left(T_D^4 - T_B^4\right) \qquad \text{EQN 2}$$

Where:

E = Irradiance, W/m^2

Cs = Sensitivity Coefficient, $mV / W / m^2$

U_{emf} = Thermopile output voltage, mV

s = Stephan-Boltzmann Constant, 5.67 x 10^{-8} $W/m^2 K^4$

T_B = Output of body thermister YSI 44031, K

K' = Dome heating constant

T_D = Output of dome thermister YSI 44031, K

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ABSTRACT

Five Eppley Laboratory, Inc. Precision Infrared Pyrgeometers (PIR) sensors were modified and calibrated. This modification and calibration was performed in order that the instruments comply with specifications set in the Baseline Surface Radiation Network (BSRN) Operator's Manual, V 1.0, 1997. The modification and calibration were performed by Physikalisch-Meteorolisches Observatorium Davos (PMOD) in Davos-Dorf, Switzerland on 6 April 1998. The serial numbers of the units modified and calibrated were 27174F3, 31606F3, 26168F3, 24323F3 and 26036F3.

1. Introduction

Five Eppley Laboratory Inc. Precision Infrared Radiometers (PIR) Pyrgeometer instruments were modified and calibrated to meet the 1997 Baseline Surface Radiation Network (BSRN) specifications. The five instruments were modified by installing three new dome thermisters, model YSI 44031. These engineering and calibration tasks were completed by the Physikalisch-Meteorolisches Observatorium Davos (PMOD) in Davos Dorf, Switzerland.

2. Results

Calibration results for each instrument are shown in the above summary page along with the governing equations. The use of Eqn. 1 with the above tabular values is described in each of the Calibration Certificates provided by PMOD. Equation 2 and the associated tabular value are provided as a historical connection to the Albrecht et al. single sensitivity factor method.

3. Discussion

These sensors have been modified and calibrated to permit the measurement of diffuse radiation. Global measurements involve determination of the factor *f*. The manufacturer, Eppley Laboratories, Inc., defines an uncertainty of 5%. Field data need to be examined in order to assess the standard uncertainty in the measurements made by the modified instruments.

The single sensitivity factor calibration histories of the five sensors are as follows:

27174F3

Apr-1999	PMOD	4.03	$mV/W/m^2$
Jul - 1992	CMDL	4.331	$mV/W/m^2$
Sep-1988	Eppley	4.38	$mV/W/m^2$

31606F3

Apr-1998	PMOD	3.54	$mV/W/m^2$
1997	Eppley	3.82	$mV/W/m^2$

26168F3

Apr-1998	PMOD	4.22	$mV/W/m^2$
Jul-1992	CMDL	4.366	$mV/W/m^2$
Oct-1987	NARCK	4.43	$mV/W/m^2$
Sep-1987	Eppley	4.38	$mV/W/m^2$
Apr-1986	Eppley	4.52	$mV/W/m^2$
Apr-1984?	Eppley	4.38	$mV/W/m^2$

24323F3

Apr-1998	PMOD	3.79 $mV/W/m^2$
Jul-1992	CMDL	4.022 $mV/W/m^2$
Oct-1987	NARCK	4.19 $mV/W/m^2$
Sept-1987	Eppley	4.01 $mV/W/m^2$
Apr-1986	Eppley	4.06 $mV/W/m^2$
Aug-1984	Eppley	4.01 $mV/W/m^2$

26036F3

Apr-1998	PMOD	3.84 $mV/W/m^2$
Jul-1992	CMDL	4.055 $mV/W/m^2$
Oct-1987	NARCK	4.28 $mV/W/m^2$
Sep-1987	Eppley	4.14 $mV/W/m^2$
Apr-1986	Eppley	4.26 $mV/W/m^2$
Nov-1985	Eppley	4.14 $mV/W/m^2$

Each instrument single sensitivity factor, *Cs*, has remained within a variability of 5% or less through each of the calibrations which did not involve physical changes to the instrument. This variability is within manufacturer stated design specifications.

4. Summary

A modification and calibration of five Eppley Laboratory Inc. Precision Infrared Radiometer, (PIR) instruments has been completed. Data analyses have been performed. The calibration factors are presented in the summary table above and in the Calibration Certificates.

No apparent performance anomalies are indicated from the single sensitivity factor calibration history of the sensors.

These calibration factors can be used with these three instruments from 6 April 1998.

REFERENCES

World Climate research Program Baseline Surface Radiation Network Operations Manual, Version 1.0, :.J.B. McArthur, June, 1997.

Philipona, R., C. Frolich, Ch,. Betz, 1995: Characterization of pyrgeometers and the accuracy of atmospheric long-wave measurements, Applied Optics, 34(9),1598-1605.

Albrecht, B. and Cox, S.K.: Procedures for Improving Pyrgeometer Performance. Journal of Applied Meteorology, 16 1977, P 188-179.