

Calibration Report: Pyranometer CM22-000025

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Calibration date: 2020-03-09. Data limited to one day due to COVID-19 pandemic.
Next calibration: 2022-07-01.
Reference standard: AHF-31041

The calibration coefficients and their associated uncertainties (U95%) have been determined for one pyrheliometer. The unit of the calibration coefficient (S) is $\mu\text{V}/(\text{W}/\text{m}^2)$. The reference standard was Eppley Laboratories Inc., absolute cavity radiometer AHF31041, with its associated data acquisition system. Cavity AHF31041 participated in the 2015 International Pyrheliometer Comparison (IPC XII) at the Physikalisch-Meteorologisches Observatorium, in Davos Switzerland. It is therefore traceable to the World Radiation Reference. Cavity AHF31041's calibration is verified annually at the National Pyrheliometer Comparison held at the National Renewable Energy Laboratory in Golden Colorado, most recently in September of 2019.

The sensitivity factors and their associated uncertainties (95%) are as follows:

| Sensor | S ($\mu\text{V}/(\text{W}/\text{m}^2) \pm \text{U95\%}$) | Method |
|-------------|--|---------------|
| CM22-000025 | 9.251 \pm 0.52% | shade/unshade |

Application

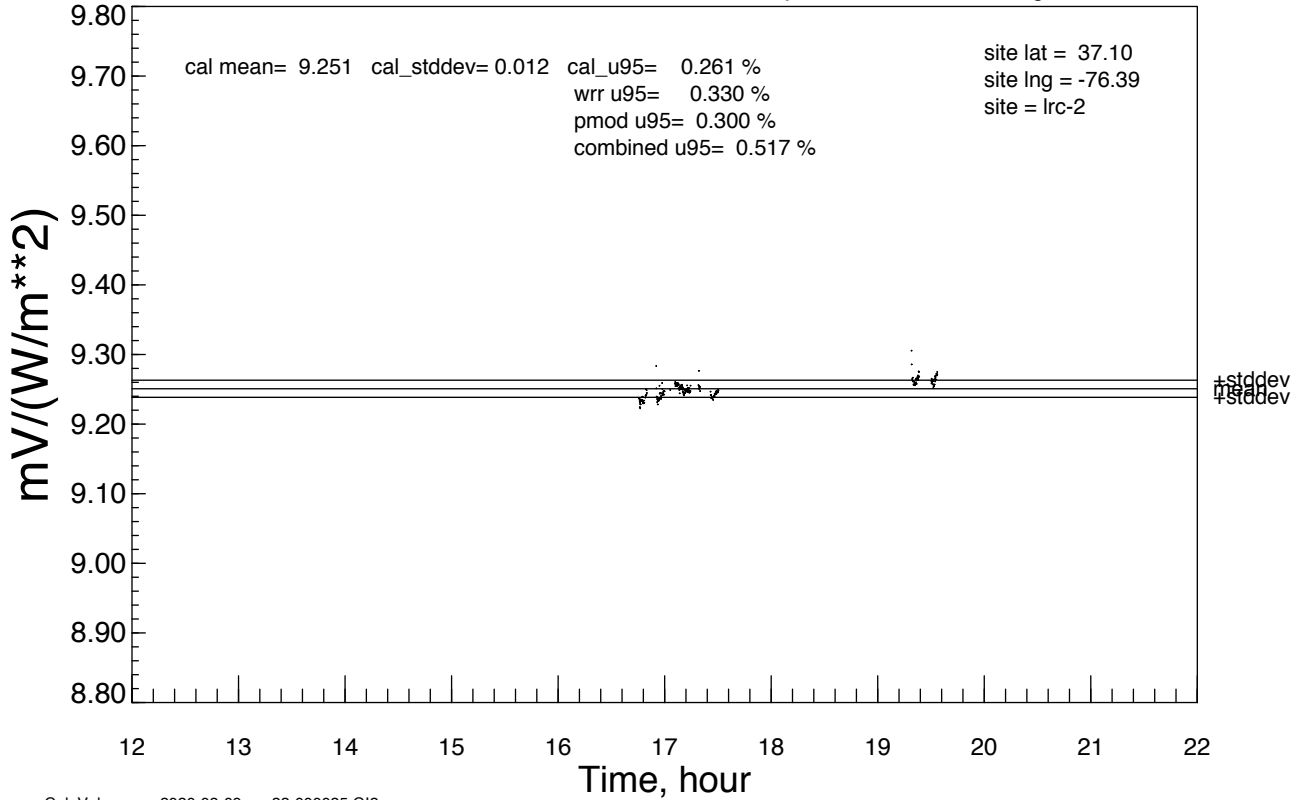
$$I = (\mu\text{V output})/S \pm \text{sqrt}(2)*\text{U95\%}$$

Where: I = the irradiance measured by the pyranometer
($\mu\text{V output}$) = microvolt output of the pyranometer
S = calibration coefficient of the pyranometer
U95% = the 95 % confidence level

Some supporting plots, a list of past calibration values, and a brief description of the calibration process is presented below.

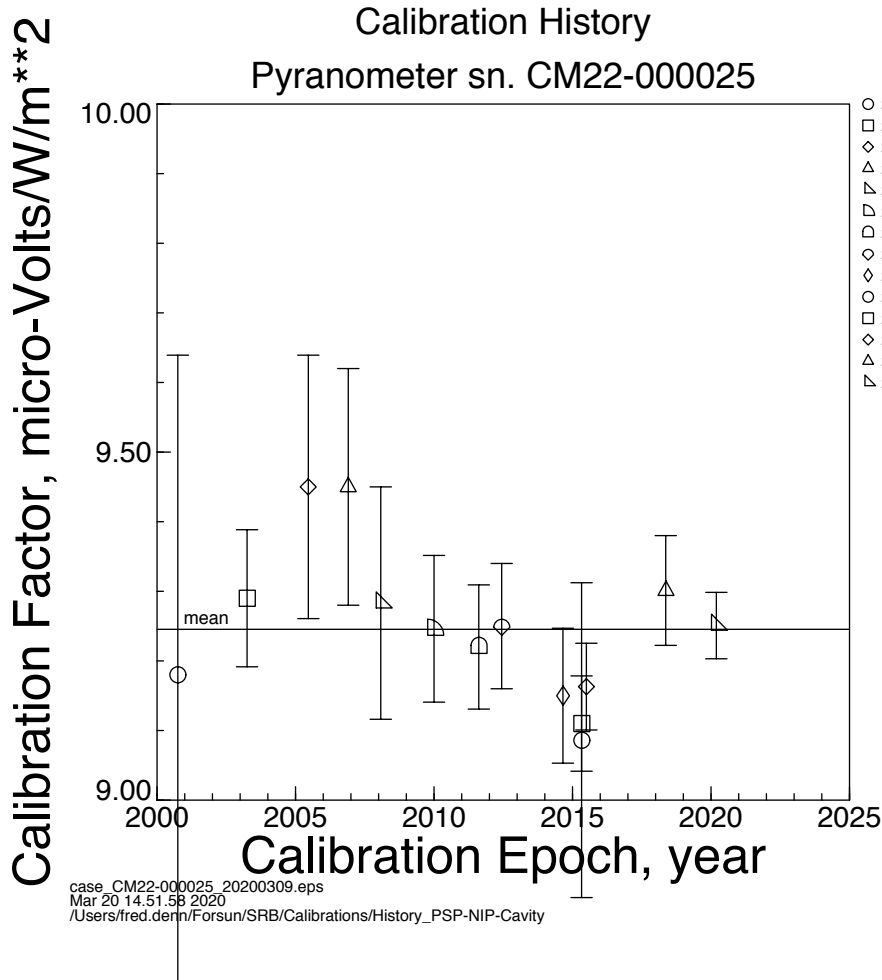
Calibration factors

/Users/denn/data0/COVE_BSRN_cals/COVE_cal_2020-03-09/GI2/GI2_2020-03-09.DAT_cm22-000025_diffuse_filled
/Users/denn/data0/COVE_BSRN_cals/COVE_cal_2020-03-09/GI2/GI2_2020-03-09.DAT_cm22-000025_global
/Users/denn/data0/COVE_BSRN_cals/COVE_cal_2020-03-09/cavity/ahf31041_20200309.original.dat.stable



Cal_Vals_case_2020-03-09_cm22-000025.GI2.eps
Mar 19 15:04:51 2020
/Users/fred.denn/Forsun/SRB/Calibrations/Cavity_second_based/Cal_pyr

Calibration coefficients for several days. Each symbol represents a cavity run which is approximately 25 minutes. These data are combined to get a final calibration coefficient for the entire, multi-day, calibration session.



Calibration history for pyranometer CM31-000507. The solid horizontal line represents the mean value. The symbols and their error bars represent the mean and U95 of each calibration event. The column on the right presents numerical values for each calibration event and a brief description of the calibration method used.

CALIBRATION HISTORY

(doy = day of year)

Pyranometer: Kipp and Zonen CM22-000025

| date | doy | S ($\mu\text{V}/\text{W}/\text{m}^2$) | U95 (%) | calibration type |
|--------------|------|---|---------|------------------------------|
| 2020 Mar 09 | 069 | 9.251 | 0.52 | shade/unshade |
| 2018 May 15 | 136 | 9.301 | 0.85 | relative to CM22-000024 |
| 2015 July 01 | 182 | 9.163 | 0.68 | shade/unshade |
| 2015 May 01 | 121 | 9.110 | 0.75 | UNLEVEL shade/unshade |
| 2014 Aug 28 | 271 | 9.15 | 1.06 | shade/unshade |
| 2012 Jun 11 | 163 | 9.25 | 0.97 | shade/unshade |
| 2011 Aug 15 | 227 | 9.22 | 0.97 | shade/unshade |
| 2010 Jan 01 | 001 | 9.25 | 1.14 | shade/unshade |
| 2008 Feb 02 | 033 | 9.28 | 1.8 | lost document, shade/unshade |
| 2006 Nov 25 | 329 | 9.45 | 1.88 | shade/unshade |
| 2006 May 17 | ---- | ---- | ---- | bad cavity data, removed |
| 2003 Apr 03 | 093 | 9.29 | 1.06 | Forgan's alternate |
| 2000 Oct 01 | 275 | 9.18 | 5.00 | manufacturers original |

A Very Brief Description of the Calibration Process.

- 1) Deploy the Cavity Radiometer, select the 4 second data collection parameter file. Start the cavity calibration process.
- 2) Modify the field radiometer program, set the parameter that causes one second data collection.
- 3) Prepare the tracker hardware to operate in manual shade/unshade mode. Either in manual mode or with the automatic pneumatic cylinder.
- 4) Start the cavity in sun-run mode, do this on a minute that is a multiple of 5 into the hour. Note a cavity calibration and sun-run takes almost 30 minutes.
- 5) Raise or lower the tracker shading balls every 5 minutes, on multiples of 5 minutes into the hour.
- 6) Continue this process as long as sky conditions permit while cavity irradiance is greater than 700 Watts/meter**2.
- 7) On both the cavity computer and the field radiometer computer, open a web browser and email the data files to the data processing computer, Files could also be copied to an external memory stick.
- 8) Remove data that is flagged as “unstable” in the cavity data file.
- 9) Run a splitter program on the field radiometer file to generate a separate file for the shaded and unshaded periods for each instrument.
- 10) Run a plotting program on each data file so the data can be reviewed for: cloud events; bad shading; errors in the splitting routine; ect. Remove bad data.
- 11) Run a calibration program to determine the calibration coefficient for each instrument.
- 12) Combine several days of calibration data to get a final calibration coefficient.
- 13) Produce a calibration document, such as this one, for each instrument. To be considered valid a calibration must be both traceable to recognized standards, in this case the World Radiation Reference (WRR) in Davos Switzerland, and documented.