Calibration Report: Pyrheliometer
Kipp and Zonen CH1-960133

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Calibration date: 2020 March 09. There is only day of data, due to the COVID-19 Pandemic.
Next calibration due: 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 μV/(W/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 2018.

The sensitivity factor and its associated uncertainty (95%) are as follows:

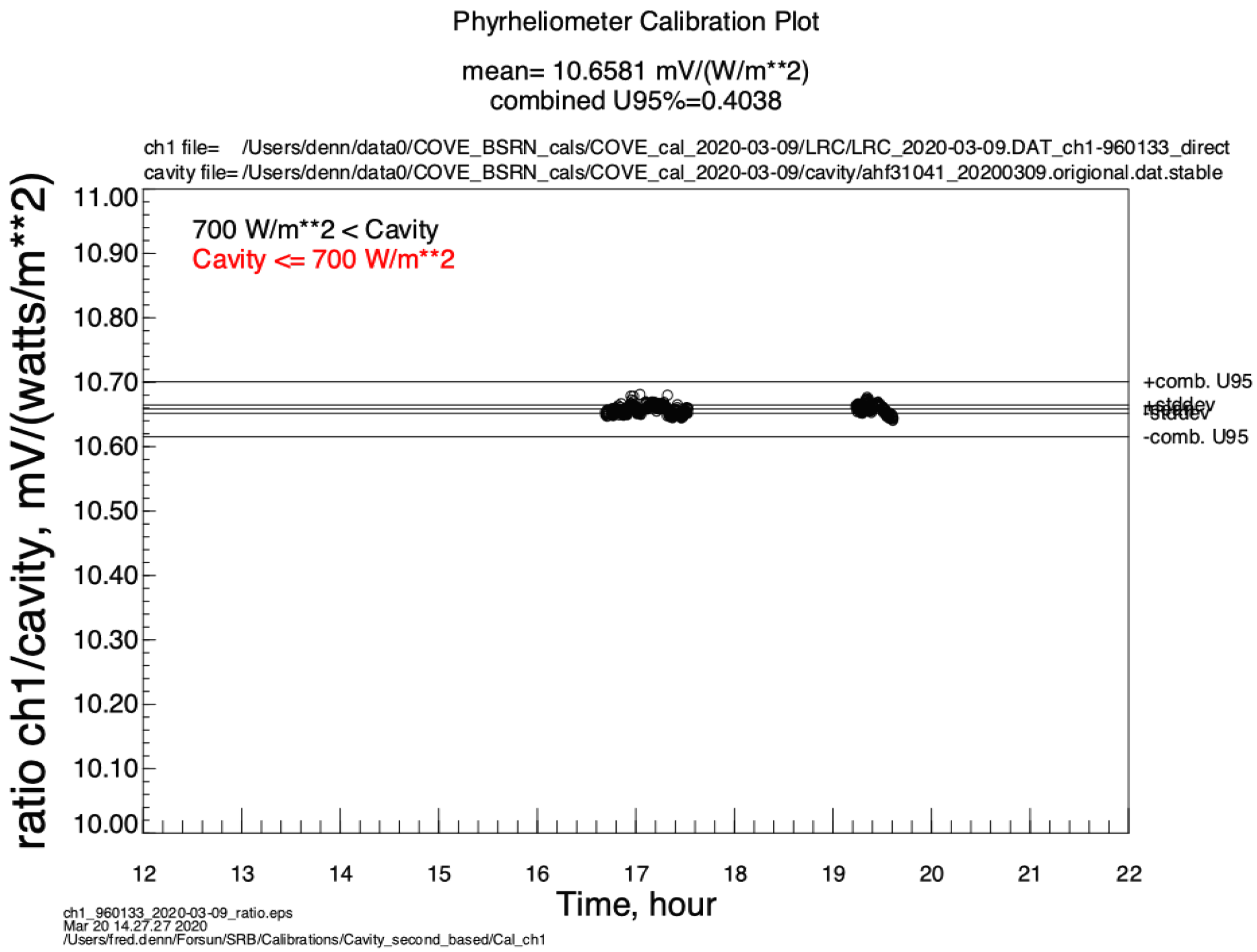
Manufacturer	Serial Number	logger μV/(W/m^2)	S U95
Kipp and Zonen	CH1-960133	10.658	± 0.40%

Application

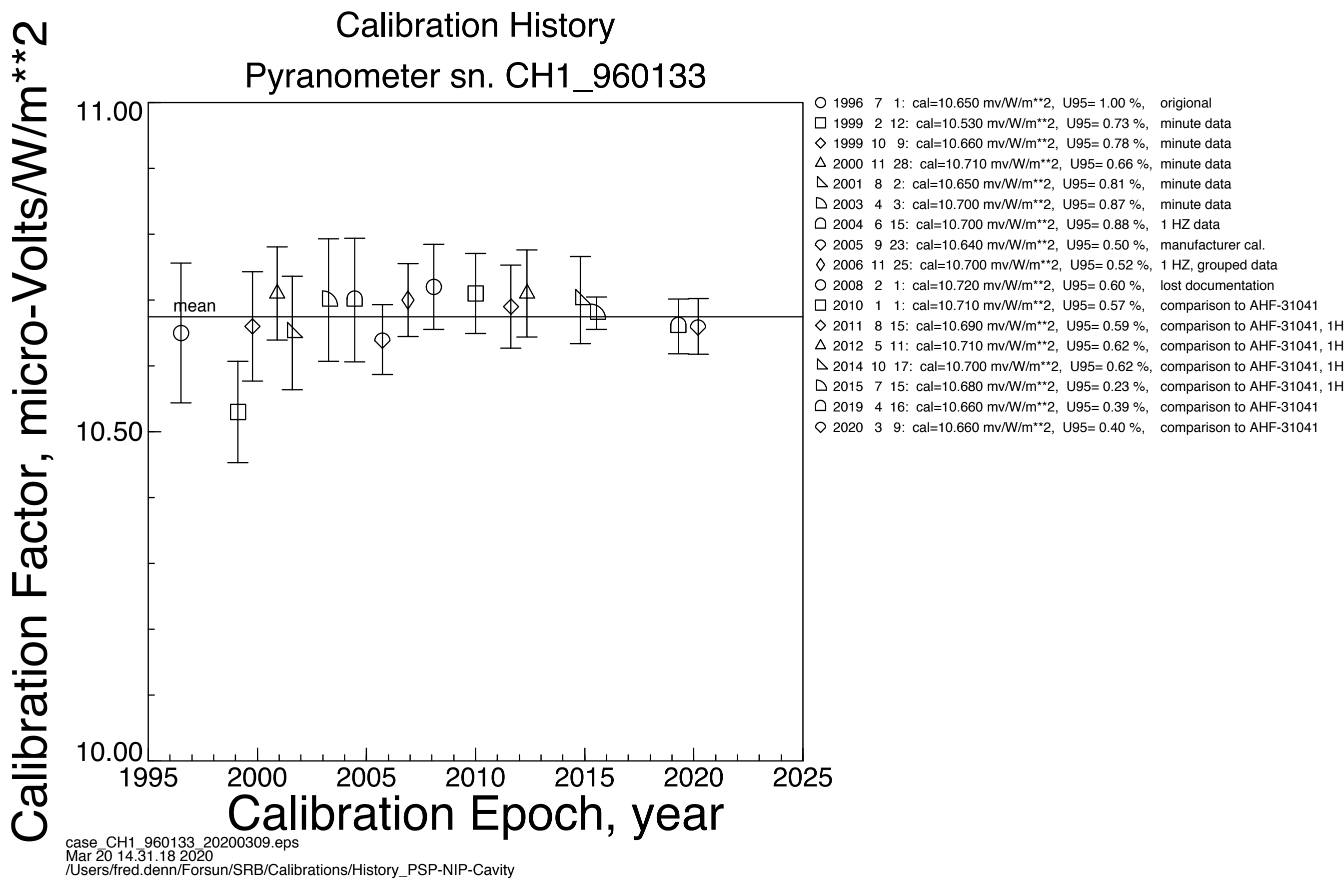
$$I = (\text{mV output})/S \pm \text{sqrt}(2)*U95\%$$

Where: I = the irradiance measured by the pyrheliometer
(mV output) = microvolt output of the pyrheliometer
S = calibration coefficient of the pyrheliometer
U95% = the 95 % confidence level of a field measurement.

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



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 pyrheliometer CH1-960133. 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 HISTORIES

Pyrheliometer: Kipp and Zonen CH1-960133.

date	day of year	S ($\mu V/(W/m^2)$)	U95 (%)	
2020 Mar 09	069	10.658	0.50	1HZ, ref. AHF-31041
2019 Apr 16	106	10.66	0.50	1HZ, ref. AHF-31041
2015 Jul 15	118	10.68	0.23	1HZ, ref. AHF-31041
2014 Nov 17	321	10.70	0.62	1HZ, ref. AHF-31041
2012 May 11	118	10.71	0.62	1HZ, ref. AHF-31041
2011 Sep 01	244	10.69	0.59	1HZ, ref. AHF-31041
2010 Jan 01	001	10.71	0.57	comparison to AHF-31041
2008 Feb 01	032	10.72	0.60	lost document
2006 Nov 25	329	10.70	0.58	(1 HZ grouped data)
2006 May 10	130			Setup error, no useable data.
2005 Sep 23	266	10.64	0.50	(manufacturer calibration)
2005 Jun 15	166	Failed, sent in for repairs.		
2004 Jul 15	197	10.70	0.88	(1 HZ data)
2003 Apr 02	093	10.70	0.87	(minute data)
2001 Aug 02	214	10.65	0.81	(minute data)
2000 Nov 28	333	10.71	0.66	(minute data)
1999 Oct 09	282	10.66	0.78	(minute data)
1999 Feb 12	043	10.53	0.73	(minute data)
1996 Jun 30	182	10.65	0.50	(manufacturer calibration)

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; etc. 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.