Third WMO Regional Pyrheliometer Comparison of RA II

(Tokyo, 23 January – 3 February 2012)

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FOREWORD

Traceability of observational data to recognized international standards is essential to ensure the accuracy and equivalence of measurements made at different locations around the globe, and it is ensuring such traceability that is one of the key objectives of the Commission for Instruments and Methods of Observation. In the case of solar radiation measurements, all measurements, no matter when or where they are made, must be traceable back to the World Radiometric Reference if we are to hold complete confidence in their veracity. This traceability is established through a hierarchy of instrument intercomparisons.

At the highest level, each five years, secondary standard pyrheliometers from all WMO Regions assemble at the World Radiation Centre in Davos, Switzerland, to undergo direct intercomparison with the World Standard Group during the WMO International Pyrheliometer Comparison (IPC), in order to establish the traceability of measurements from these secondary standard instruments to the WRR.

Having established the traceability of the secondary (regional) standards at IPC, regional intercomparisons are held in turn, wherein other instruments from around the region are intercompared directly with the regional standards, so transferring the traceability of measurements from all those participating instruments back to the WRR.

Many pyrheliometer intercomparisons have been held within Regional Association II over the last decades to establish the traceability of instruments from one country or another in the Asian region to the WRR. However the beginning of 2012 saw instruments from five Asian countries assemble together in Tsukuba, Japan to participate in the Third WMO Regional Pyrheliometer Intercomparison of RA II.

This report describes this latest RA II intercomparison: the participants (from WRC, Japan, Hong Kong, the Republic of Korea, and Thailand), the intercomparison itself and the results. That all participating instruments except one were found to be well-maintained and highly accurate is a credit to all those who participated, and we can now be confident that solar radiation measurements made in these Asian region countries are reliable and dependable.

I wish to express my sincere gratitude, particularly to the Japan Meteorological Agency and the staff of its Regional Radiation Centre in Tsukuba, but also to the participants from WRC, Hong Kong, the Republic of Korea and Thailand, for the success of this latest intercomparison. I also thank all of those in RA II who have worked to make these regional intercomparisons a regular occurrence in recent years and I wish them every success with their continuation in the years to come.

(Prof. B. Calpini)

President

Commission for Instruments and
Methods of Observation

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Part I

THIRD WMO REGIONAL PYRHELIOMETER COMPARISON OF RA II

(Tokyo, 23 January – 3 February, 2012)

1. INTRODUCTION

The third Regional Pyrheliometer Comparison (RPC-III) of the World Meteorological Organization (WMO) Regional Association (RA) II was held from 23 January to 3 February, 2012, in Tsukuba, Japan, with the participation of experts with pyrheliometers from Hong Kong, the Republic of Korea, Thailand, Japan and the World Radiation Centre (WRC) in Davos, Switzerland.

Through RRC Tokyo, the Japan Meteorological Agency (JMA) serves as a WMO RA II Regional Radiation Centre (RRC) together with RRC Pune in India, and maintains regional standard pyrheliometers to ensure the traceability of solar radiation measurements in RA II against the World Radiometric Reference (WRR). An expert from RRC Tokyo participated in the Eleventh International Pyrheliometer Comparison (IPC-XI) held from 27 September to 15 October, 2010, at the WRC (WMO, 2011). It was confirmed that RA II regional standard pyrheliometers had been maintained satisfactorily, and new WRR factors were determined for these instruments. IPC-XI simultaneously covered Regional Pyrheliometer Comparisons (RPCs) for all WMO Regional Associations. However, experts from only three Members (China, the Philippines and Thailand) other than the Pune (India) and Tokyo (Japan) RRCs participated from RA II.

At RRC Tokyo, RA II regional standard pyrheliometers are compared every year to check the stability of individual instruments in line with a recommendation made by the Commission for Instruments and Methods of Observation (CIMO). Together with this event in 2012, JMA offered RA II Members unable to attend IPC-XI the opportunity to compare their national standard pyrheliometers with the RA II regional standards to ensure traceability with the WRR. Experts from Hong Kong, the Republic of Korea and Thailand participated in this comparison, and the WRC also sent an expert to support related activities.

The session was a success, producing positive results thanks to the close collaboration and hard work of the participants. This report presents the results of intercomparisons conducted over a period of eight days with good weather conditions. On cloudy days, country reports, technical visits to JMA's auxiliary organs (the Meteorological Research Institute, the Meteorological Instruments Center and the Aerological Observatory) and training in radiation measurement were scheduled.

2. LOCATION OF COMPARISON SITE

RPC activities took place at the Tsukubasan Keisei Hotel located halfway up the southeast side of Mt. Tsukuba in Japan's Ibaraki Prefecture. This is an isolated 877-meter-high mountain about 70 km northeast of Tokyo. The site was selected as the venue for the first RPC of RA II/V (RPC-I) in 1989 (WMO, 1989) after consideration of the conditions necessary for pyrheliometer intercomparison by WMO experts.

Address: 1 Tsukuba, Tsukuba City, Ibaraki Prefecture, Japan
Longitude: 140° 7.5' E
Latitude: 36° 12.9' N
Altitude: 560 m above sea level

A map of the area around Mt. Tsukuba is shown in ***Appendix A***.

3 PARTICIPANTS

Representatives from three RA II countries (Hong Kong, the Republic of Korea and Thailand) and experts from the WRC and JMA (including RRC Tokyo) participated in the comparison.

Participants

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A list of main participants and contact addresses is shown in ***Appendix B***.

4 INSTRUMENTS

One absolute pyrheliometer from Thailand, two from Hong Kong and the Republic of Korea, three from the WRC and four (as regional and national standards) from JMA were compared. The model names, serial numbers, owners and instrument types were as follows:

Instrument

PMO6-CC	No. 0401 (WRC)	Absolute cavity radiometer (active type)
PMO6-CC	No. 0803 (WRC)	Absolute cavity radiometer (active type)
AHF	No. 32455 (WRC)	Absolute cavity radiometer (passive type)
PMO6-CC	No. 0403 (Japan)	Absolute cavity radiometer (active type)
AHF	No. 32446 (Japan)	Absolute cavity radiometer (passive type)

PMO6-CC	No. 0102 (Hong Kong)	Absolute cavity radiometer (active type)
PMO6-CC	No. 0809 (Hong Kong)	Absolute cavity radiometer (active type)
PMO6	No. 951202 (Republic of Korea)	Absolute cavity radiometer (active type)
AHF	No. 36014 (Republic of Korea)	Absolute cavity radiometer (passive type)
AHF	No. 34322 (Thailand)	Absolute cavity radiometer (passive type)
PMO6	No. 811107 (Japan)	Absolute cavity radiometer (active type)
PMO6	No. 960801 (Japan)	Absolute cavity radiometer (active type)

During the comparison, ancillary data (air temperature, relative humidity, atmospheric pressure and wind speed/direction) were obtained from an automatic weather station (AWS). A precision filter radiometer (PFR) was used to determine aerosol optical depth (AOD) at four wavelengths (368 nm, 412 nm, 500 nm and 862 nm). These data were used for screening in data evaluation procedures. The auxiliary instruments are listed below.

Auxiliary instruments

AutoMet466A	No. R7214	Automatic weather station
PFR	No. 37	Sunphotometer

5 OUTLINE OF COMPARISON

5.1. Equipment and Facilities

Flat benches, automatic active sun trackers, a data acquisition system, a voice-announcement and buzzer system (to indicate the start and end of measurements), an AWS (consisting of a thermometer, a hygrometer, a barometer, a wind vane and an anemometer) and a power supply (100/220 V, 50 Hz) were set up on the rooftop of the venue. The pyrheliometer and sunphotometer sensors were mounted on five sun trackers.

The layout of the equipment and facilities is shown in ***Appendix C***.

5.2. Data Acquisition Method

Digital data from the controllers of PMO6-CCs and AHFs were acquired by all members via a dedicated personal computer. Each member converted the data into the set format after daily observations and stored them on USB flash memory.

Analog signals from the controller of three PMO6s were acquired and stored immediately on a dedicated personal computer with a multi-channel analog data logger by JMA staff.

A block diagram of the data acquisition system and data flow is shown in ***Appendix D***.

5.3. Measurement Procedures

The sequence of measurements of a sample day is shown in ***Appendix E***. Each set of measurements, referred to as a series, was composed of 13 data readings taken at 90-second intervals. Accordingly, the collection of one series took 18 minutes. The data sampling cycle for each instrument is shown in ***Appendix F***, and the synchronization of measurements was performed by voice announcements and buzzers from a computer as shown in ***Appendix G***. The instruments were controlled and operated by the participants on their own as described below.

(a) PMO-type absolute pyrheliometers (PMO6, PMO6-CC)

Each series started when the shutter closed, and PMO-type absolute pyrheliometer measurement was then carried out by opening and closing the shutter every 90 seconds. PMO6s were operated manually by opening and closing the shutter in synchronization with voice announcements and buzzers. PMO6-CCs were synchronized at the beginning of data series measurement and operated automatically from that point onward.

Irradiance data were acquired from measurements taken in the open phase and in the closed phase immediately before and after the open phase. Six sets of data taken at intervals of three minutes were therefore acquired in one series.

(b) HF-type absolute pyrheliometers (AHFs)

Zero adjustment and self-calibration were carried out before each series. A zero-point reading was taken first while the shutter was closed, and the shutter was then opened to determine the irradiance level. After the reading of the thermopile output, the shutter was closed again. The heater was then turned on and its voltage/current and thermopile output were read when the current reached a level similar to that of the thermopile output. These operations were performed automatically via program control.

After the calibration, the heater was turned off and the shutter was opened for measurement. The thermopile output was read every 90 seconds, and 13 sets of irradiance data were acquired in each series.

5.4. Daily Comparison Schedule

Generally, the daily schedule was as follows:

06:30 – 08:20 The instruments were taken from the storage room to the rooftop, set up and connected. After inspection of the automatic active sun trackers, pyrheliometer alignment and the connection from the observation instruments to the data logger and computers etc., the instruments were allowed to warm up for at least 30 minutes.

08:30 – 15:30 Depending on suitable weather conditions, measurements were taken (see Section 5.3.). Pyrheliometer alignment was checked on an ongoing basis and fine adjustments were made using screws or similar where necessary.

15:30 – Measurement was ended and the instruments were returned to the storage room. The participants from Hong Kong, the Republic of Korea, Thailand and the WRC submitted measurement data, and the RRC distributed the preliminary results of measurement to the participants. The results were monitored every day to check the status of the instruments and the measurement procedures.

6 IRRADIANCE CALCULATION

The procedure used to calculate the irradiance of each instrument type is described below. The notations are as follows:

Symbols

S	direct solar irradiance [W m^{-2}]
V_{th}	output of thermopile [V]

U_H or U_I	voltage across the heater (H) or across the standard resistor (I) [V]
R_N	resistance of standard resistor [Ω]
C_1	calibration factor
C_2	correction factor for lead heating
P	electrical power in the active cavities [W]

Subscripts

irrad	value during irradiance measurement phase
cal	value during calibration phase
zero	value during zero adjustment in calibration phase
open	value during shutter-open phase
closed	value during shutter-closed phase

(a) PMO-type absolute pyrheliometers (PMO6, PMO6-CC)

PMO-type absolute pyrheliometers have a primary black body cavity for measurement under conditions of exposure to the sun and a secondary black body cavity for compensation. These cavities are thermally interconnected via a heat sink, and the difference in temperature between them is kept constant by an electrical heater attached to the cavity for measurement regardless of open or closed shutter status.

When the shutter is opened for exposure to the sun, the electrical power needed to maintain the temperature difference decreases because of irradiance heating. The irradiance is in proportion to the difference between the open and closed shutters, and is calculated using the following formula:

$$S = C_1 \, (P_{(\text{closed})} - P_{(\text{open})})$$

$P_{(\text{closed})}$ is averaged from the closed values recorded before and after the shutter is opened. Power calculation was performed based on the instrument type using the following formulas:

$$P = U_H^2 \quad \text{or} \quad P = U_H \, U_I \quad \textit{or} \quad P = U_H \, U_I / R_N$$

(b) HF-type absolute pyrheliometer (AHF)

HF-type absolute pyrheliometers have a black body cavity for measurement under conditions of exposure to the sun, as well as a thermopile and an electric heater.

Before each series, the shutter is closed, the heater current is turned on, and the voltage $U_{H(\text{cal})}$ across the heater, the voltage $U_{I(\text{cal})}$ across the standard resistor R_N and the thermopile output $V_{th(\text{cal})}$ are then measured. The zero value of $V_{th(\text{zero})}$ is also determined with the detector shaded and the electrical power switched off. After these procedures (namely zero adjustment and self-calibration) that is applied to obtain the proportional relationship between the quantity of heat added by the electrical heater and the thermopile output, the irradiance is retrieved continuously based on the thermopile output V_{th} according to the following formula:

$$S = C_1 \, \frac{V_{th(\text{irrad})} - V_{th(\text{zero})}}{V_{th(\text{cal})} - V_{th(\text{zero})}} \, \frac{U_{I(\text{cal})}}{R_N} \left(U_{H(\text{cal})} - \frac{U_{I(\text{cal})}}{R_N} C_2 \right)$$

7 DATA EVALUATION PROCEDURES

The data evaluation procedures were essentially the same as those used at the pervious RPC of RA II (WMO, 2009), the details of which can be found in WMO technical documents (WMO, 1985). Below is a summary of the comparison procedures.

Step 1: The reference irradiances used to calibrate the national standard pyrheliometers were calculated from the three WRC instruments (PMO6-CC: No. 0401, No. 0803; AHF: No. 32455) and the two regional standard instruments (PMO6-CC: No. 0403; AHF: No. 32446) which participated in IPC-XI.

Step 1-1: Data selection for the reference instruments

In each comparison series, six potential reference irradiances obtained at even running numbers of readings (i.e., j = 2, 4, 6, 8, 10 and 12; see ***Appendix F***) when irradiances could be measured by both reference instrument types were used for reference irradiance calculation. All of the irradiance values obtained were inspected carefully, and those deemed suspect due to instability or other influences relating to unpredictability were deleted.

The following criteria were additionally applied to the selected data to get the final results in RPC-III:

(1) No cloud or haze within 15 degrees of the sun

(2) Total cloud cover equal to or less than 1/8

(3) A solar elevation angle equal to or greater than 25 degrees

(4) A wind speed equal to or less than 4.5 m/s

(5) An AOD value at 500 nm equal to or less than 0.12

As for the wind speed, a criterion was determined so that the number of selected data was large enough and irradiance variability of them was small enough to produce reliable comparison results. For AOD, the criterion adopted in IPC-XI was applied. Scatter plots showing the relationship between wind speeds and standard deviations of reference irradiances with and without application of the AOD criterion for every reading time are shown in ***Appendix K***.

Step 1-2: Data selection for individual instruments in each series

If effective irradiances were obtained from more than two reference instruments in each series, all data were averaged into tentative reference irradiances for every measurement time. Data were selected only if those from each instrument were within 2% of the tentative reference irradiance values for each measurement time.

Step 1-3: Series selection to obtain reference irradiances

All effective data were averaged again into tentative reference irradiances for every reading time. Data evaluation was conducted for each reference instrument, and the data measured using the reference instrument in a series were selected only if all such measurement data in the series were within 0.2% of the tentative reference irradiance values for each measurement time.

Step 1-4: Calculation of reference irradiances

The individual reference irradiance of the selected series for each measurement time was the unweighted arithmetic mean of the effective reference instruments.

Step 2: The instruments used were calibrated according to the reference irradiances calculated as described in Step 1.

Step 2-1: Calculation of tentative mean irradiance ratios for the instruments used

Firstly, those irradiance data judged as doubtful by the participants were rejected. The individual irradiances to the reference value were then calculated for all instruments. Using these ratios, tentative mean ratios were calculated as follows:

$S_R(1), S_R(2), S_R(3), \cdots S_R(n)$	selected data group of reference irradiances
$S_a(1), S_a(2), S_a(3), \cdots S_a(n)$	selected data group of irradiances for instrument a
$\overline{S_a} = \frac{1}{n}\sum_{i=1}^{n} S_a(i) / S_R(i)$	tentative mean irradiance ratio $\overline{S_a}$ for instrument a The number of data depended on the instrument.

Step 2-2: Data selection for the instruments used

Individual data that differed by more than 0.2% from the tentative mean were rejected. It was considered that data deviations greater than 0.2% were excessive and that the instrument was not stable enough in the series for comparison.

Step 3: Calculation of new WRR reduction factors for the instruments used

The final mean irradiance ratio was calculated from a selected data group for each instrument used. The new WRR reduction factor $WRRf_{NEW}(X)$ should be equivalent to the inverse of the final irradiance ratio.

WRR reduction factors were calculated from the following formula:

$WRRf_{NEW}(X) = WRR/S_X$

where

WRR: World Radiometric Reference

S_X: irradiance measured using instrument X

8 COMPARISON RESULTS

A total of 70 series of measurements with 400 reference irradiances were obtained over a period of eight days. By applying the data selection criteria defined in Section 7 (Step 1-1) for reference values, 214 irradiances (39 series) representing the WRR were finally used. The comparison results are shown in ***Appendix H***, which lists observation times, irradiances by reference pyrheliometer group, reference irradiances (i.e., averages for each observation time), irradiance values and ratios to the reference irradiances for each national and regional standard pyrheliometer. Because a malfunction of output voltage was found for Japan's PMO6 (No. 811107) during the comparison, the WRR reduction factor was not calculated for this instrument.

Plot figures for the comparison results are shown in ***Appendix I.*** The scatter plots show the ratios to the reference irradiances, and the histograms show the distribution of these ratios for each national and regional standard pyrheliometer. The number of data along with the average and standard deviations of the ratios are also shown. The numbers in parentheses represent totals, including those rejected as described in Step 2 of Section 7.

Auxiliary data for each series of measurements are given in ***Appendix J***.

Results of pyrheliometer comparison (summary)

Instrument	Current WRR Reduction Factor	Ratio	Standard Deviation	Number of Data	New WRR Reduction Factor	Change Ratio of WRR Reduction factor
PMO6-CC No.0401 WRC	1.020979 C_1: 50000.0 W m^2 V^{-2} (IPC-XI, 2010)	0.999873	0.000490	208	—	—
PMO6-CC No.0803 WRC	1.000364 C_1: 51221.0 W m^2 V^{-2} (IPC-XI, 2010)	1.000239	0.000374	97	—	—
AHF No.32455 WRC	1.000276 C_1: 20009.2 m^2 C_2: 0.066 Ω (IPC-XI, 2010)	0.999777	0.000595	183	—	—
PMO6-CC No.0403 Regional Std.	1.000160 C_1: 50489.5 W m^2 V^{-2} (IPC-XI, 2010)	1.000201	0.000400	214	—	—
AHF No.32446 Regional Std.	1.000046 C_1: 19986.9 m^2 C_2: 0.066 Ω (IPC-XI, 2010)	1.000006	0.000606	208	—	—
PMO6-CC No.0102 Hong Kong	0.997262 C_1: 51213.4 W m^2 V^{-2} (RPC-RAII 2nd, 2007)	1.003003	0.000856	189(214)	0.997006	-0.03 %
PMO6-CC No.0809 Hong Kong	— C_1: 50752.0 W m^2 V^{-2} (PMOD/WRC, 2008)	1.001543	0.000862	206(214)	0.998459	—
PMO6 No.951202 Rep. of Korea	0.997014 C_1: 51669.5 W m^2 V^{-2} (RPC-RAII 2nd, 2007)	1.003201	0.000719	153(161)	0.996809	-0.02 %
AHF No.36014 Rep. of Korea	— C_1: 19945.2 m^2 C_2: 0.066 Ω (EPLAB, 2010)	1.003041	0.000606	126(127)	0.996968	—
AHF No.34322 Thailand	— C_1: 20009.2 m^2 C_2: 0.066 Ω (EPLAB, 2008)	1.000641	0.000654	145(150)	0.999360	—
PMO6 No.811107* Japan	0.999910 C_1: 24.0095 W m^2 V^{-2} (JMA, 2011)	—	—	—	—	—
PMO6 No.960801 Japan	0.999264 C_1: 24.1869 W m^2 V^{-2} (JMA, 2011)	1.000995	0.000783	174(184)	0.999006	-0.03 %
CMP22 No.090081 Rep. of Korea	— K: 0.00963 mV W^{-1} m^2 (Kipp&Zonen, 2009) See Part II	1.019105	0.000928	113(124)	0.981253	—

*As a malfunction was found in the PMO6 unit (No. 811107) during comparison, the WRR reduction factor was not calculated for this instrument.

9 CONCLUSIONS

The results of the regional pyrheliometer comparison can be summarized as follows:

(1) Within a given period, eight days worth of measurement data were acquired as necessary and appropriate in good weather conditions.

(2) It was confirmed that the pyrheliometers involved in the comparison were appropriately maintained and showed high accuracy except Japan's PMO6 (No. 811107).

(3) New WRR reduction factors for national standard instruments were determined as necessary to ensure the traceability of solar radiation measurements in each member country/region.

(4) During the comparison, participants exchanged and shared scientific and technological information on radiation measurement through country reports, technical visits and training courses.

REFERENCES

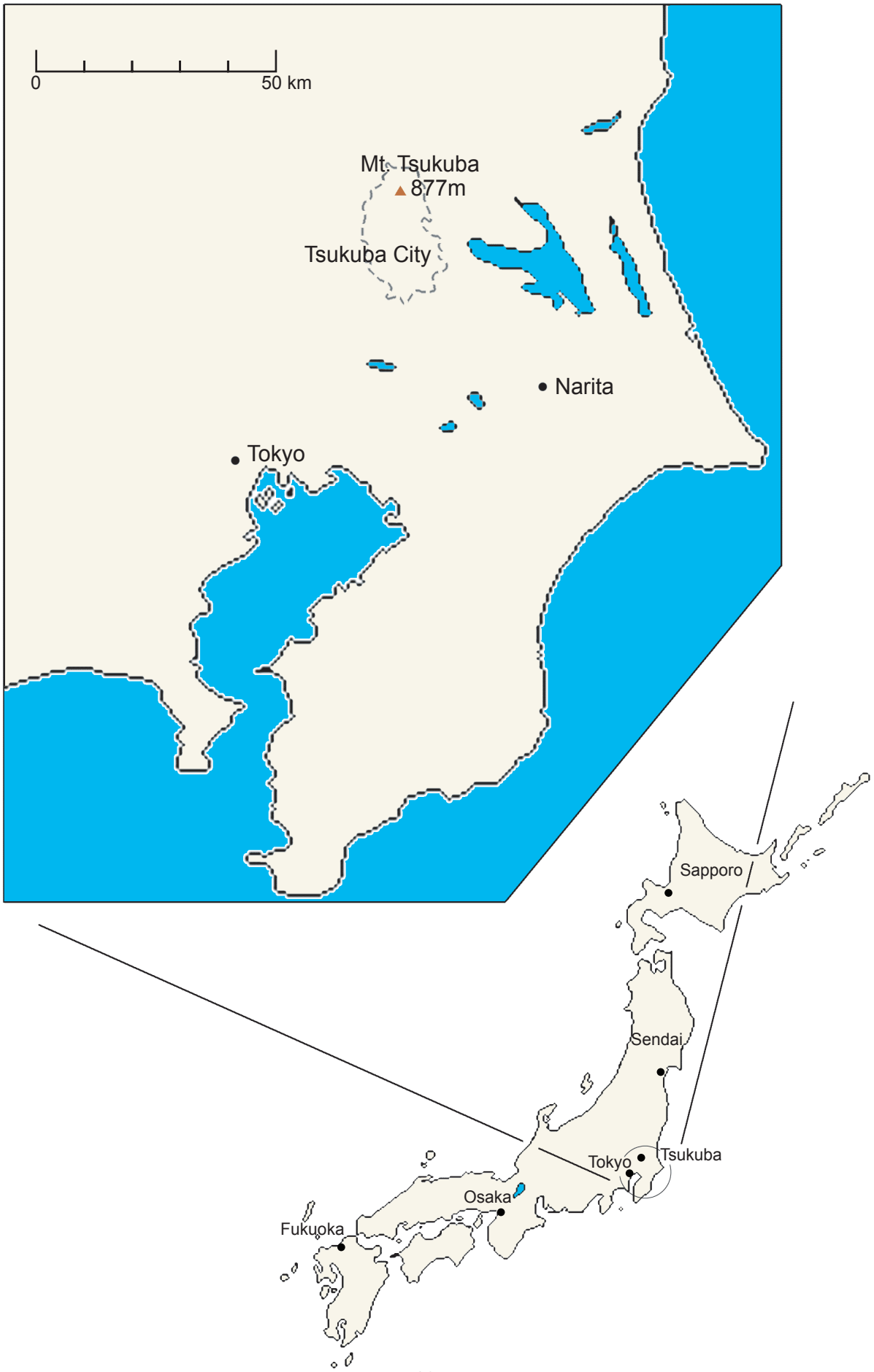
WMO (2011); International Pyrheliometer Comparison IPC-XI Final Report, *IOM report* **No. 108**, WMO.

WMO (2009); Second WMO Regional Pyrheliometer Comparison of RA II, *Instruments and Observing Methods report* **No. 97**, WMO TD-No. 1494.

WMO (1989); First WMO Regional Pyrheliometer Comparison of RA II and RA V, *Instruments and Observing Methods report* **No. 43**, WMO TD-No. 308.

WMO (1985); Keynote Papers presented at the Third WMO Technical Conference on Instruments and Methods of Observation (TECIMO-III), *Instruments and Observing Methods report* **No. 23**, WMO TD-No. 51, 65 – 84.

Area Map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50 km
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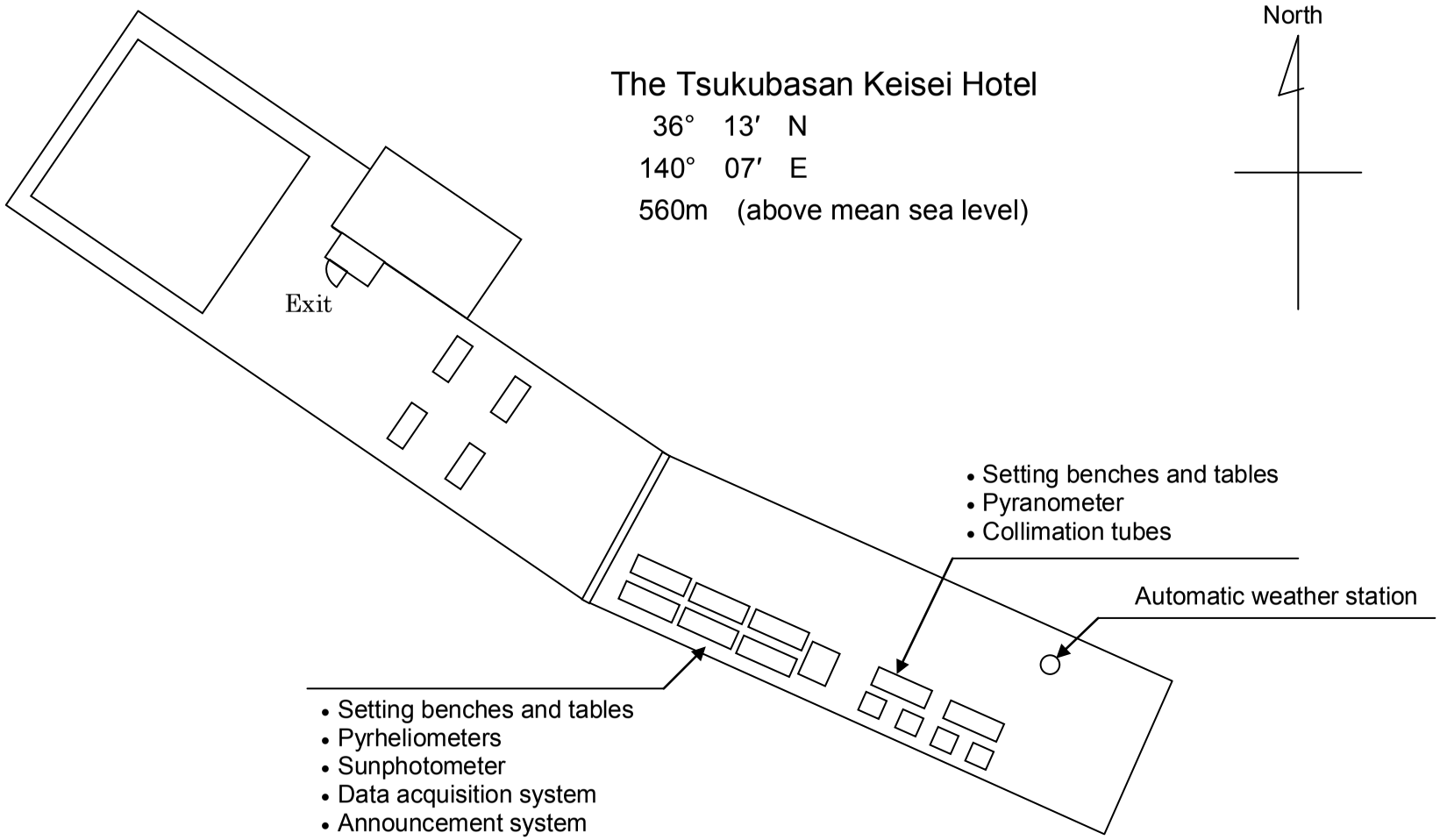
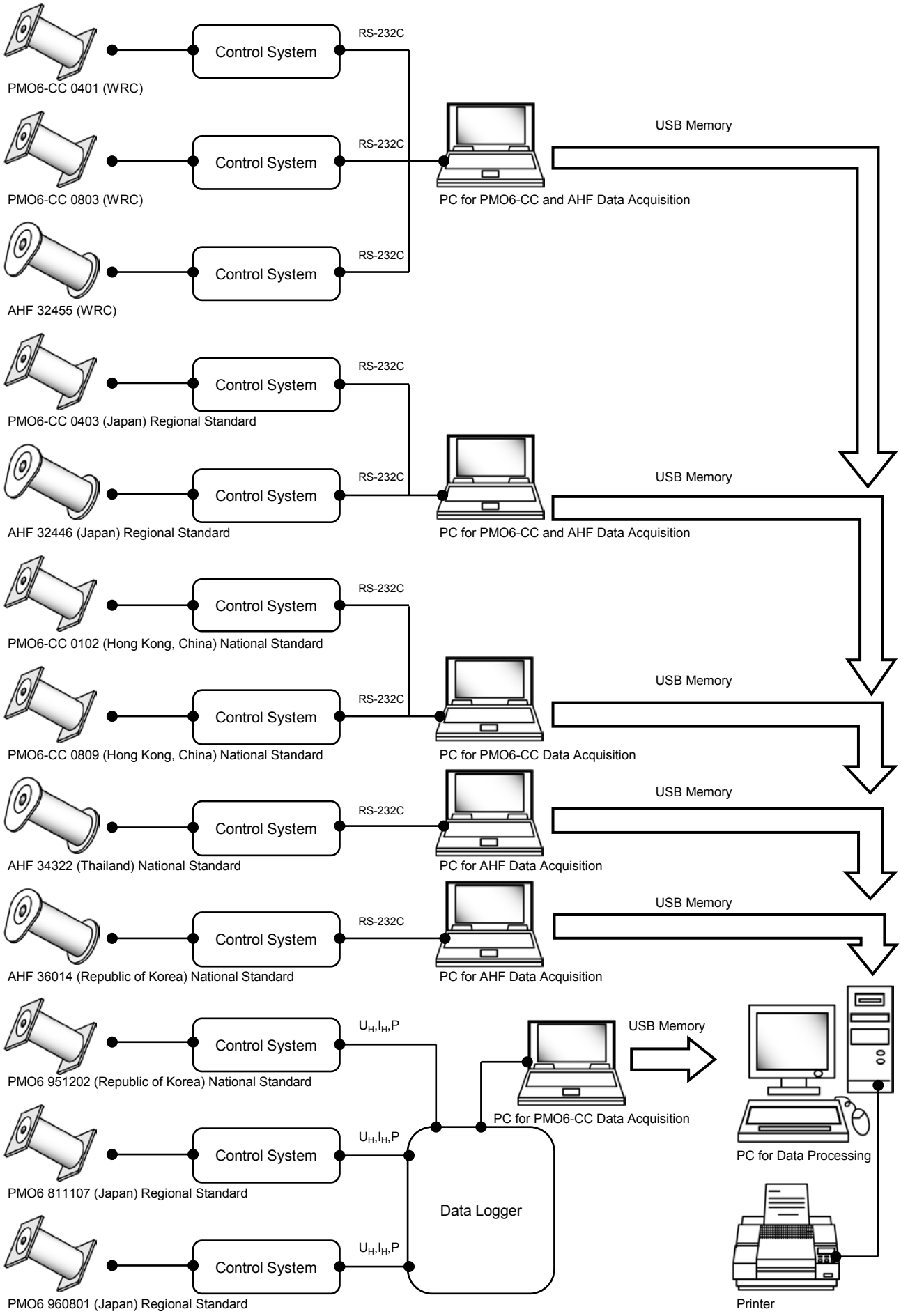
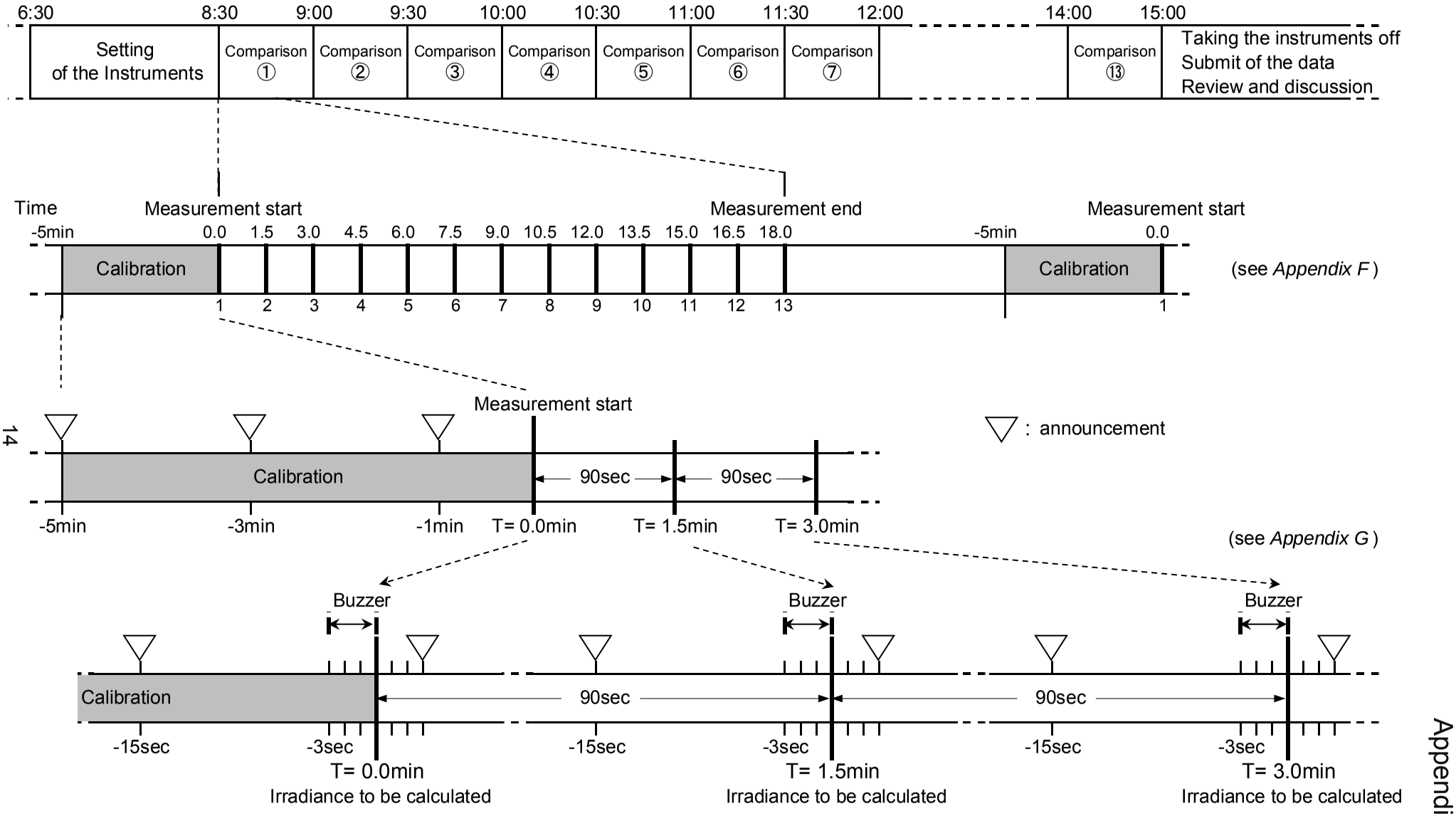


Layout of the Equipment and Facilities (Rooftop of the Tsukubasan Keisei Hotel)

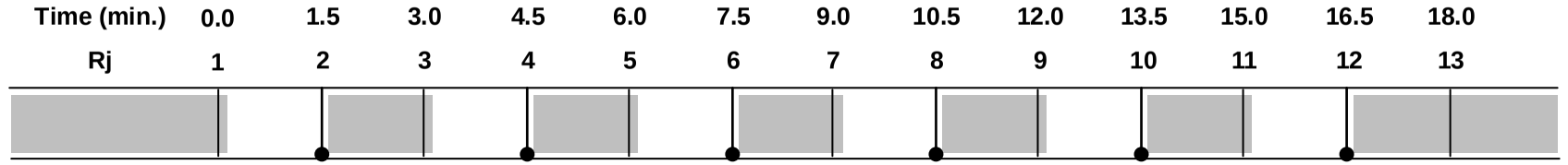
Block Diagram of Data Acquisition System



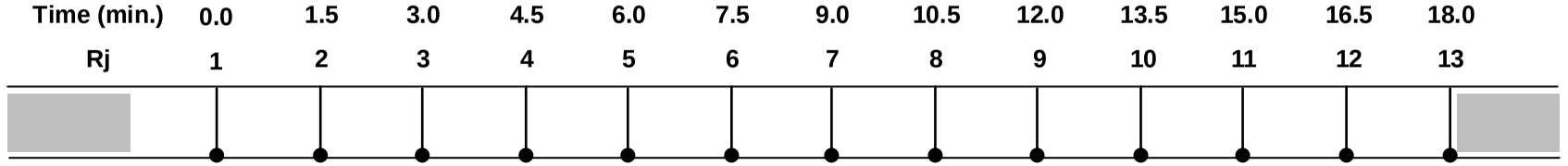


One-day Measurement Sequence

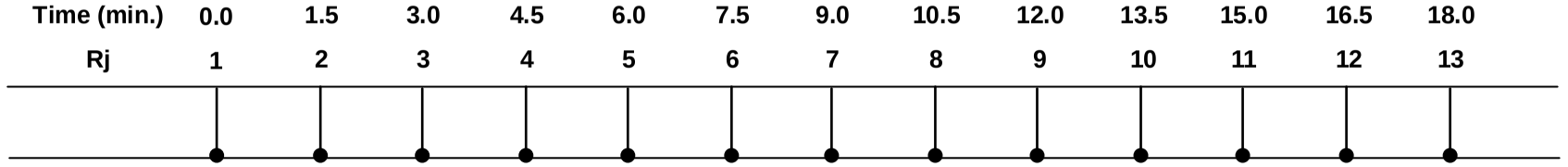
PMO Absolute Pyrheliometer (PMO6)



HF Absolute Pyrheliometer (AHF)



Other Instruments (CMP22)



Rj : Running number of reading

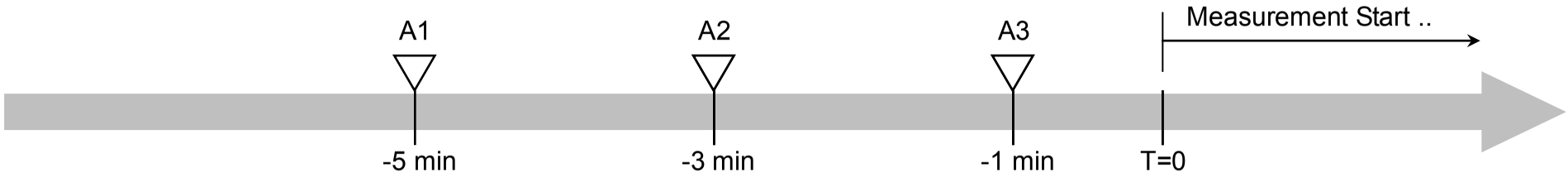
● : Irradiance to be calculated

: Read, then open

: Read, then close

Data Sampling Cycle

Signal of Start

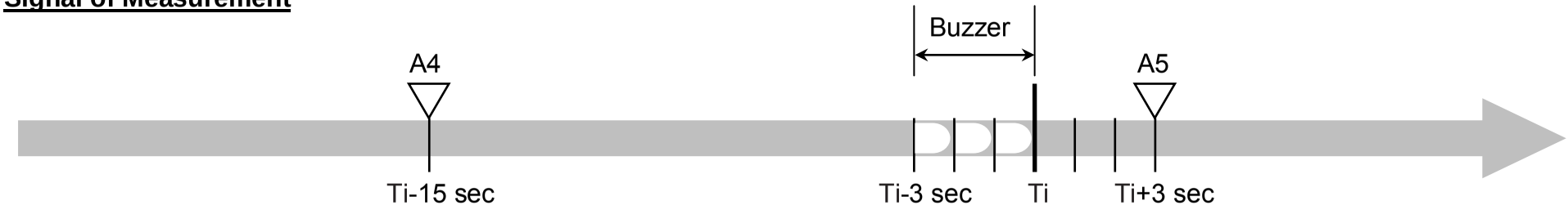


A1: "Measurement will start in five minutes."

A2: "Three minutes before measurement. Zero check and calibration start."

A3: "One minute before measurement."

Signal of Measurement



Ti = 0 sec, 90 sec, 180 sec, 270 sec, ... , 1080 sec (= 18 min)

A4: "Fifteen seconds before measurement."

A5: "Please open (close) the shutter."

Synchronization Diagram for Data Acquisition

Time	WRC & Regional Standard Pyrheliometers						National Standard Pyrheliometers					
	PMO6-CC 0401	PMO6-CC 0803	AHF 32455	PMO6-CC 0403	AHF 32446	Average	PMO6-CC 0102 Hong Kong, China		PMO6-CC 0809 Hong Kong, China		AHF 34322 Thailand	
(hh:mm:ss)	($W \cdot m^{-2}$)	($W \cdot m^{-2}$)	($W \cdot m^{-2}$)	($W \cdot m^{-2}$)	($W \cdot m^{-2}$)	($W \cdot m^{-2}$)	($W \cdot m^{-2}$)	Ratio	($W \cdot m^{-2}$)	Ratio	($W \cdot m^{-2}$)	Ratio
25 Jan 2012												
10:01:30	961.262	***	***	962.054	***	961.658	965.330	1.003818	963.160	1.001562	959.654	0.997916)
10:04:30	963.355	***	***	964.184	***	963.770	966.970	1.003321	966.880	1.003227	962.170	0.998340)
10:07:30	966.612	***	***	966.335	***	966.473	969.720	1.003359	969.210	1.002832	965.006	0.998482)
10:10:30	968.062	***	***	967.475	***	967.768	971.460	1.003815	969.460	1.001748	967.460	0.999682
10:13:30	970.471	***	***	971.025	***	970.748	972.780	1.002093	971.330	1.000599	970.102	0.999334
10:16:30	969.705	***	***	970.305	***	970.005	972.020	1.002077	970.260	1.000263	969.668	0.999652
10:31:30	980.191	***	979.459	979.707	979.131	979.622	984.640	1.005123)	982.550	1.002989	979.477	0.999852
10:34:30	984.152	***	983.118	984.107	983.344	983.681	985.200	1.001545	984.570	1.000904	984.076	1.000402
10:37:30	976.015	***	975.178	975.986	975.528	975.677	979.330	1.003744	977.580	1.001951	976.300	1.000639
10:40:30	974.729	***	973.793	974.346	975.013	974.470	979.060	1.004710	977.530	1.003140	975.443	1.000998
10:43:30	977.506	***	977.294	978.166	978.174	977.785	979.020	1.001263	977.870	1.000087	978.997	1.001239
10:46:30	977.781	***	976.915	977.836	976.117	977.163	982.050	1.005002)	980.320	1.003231	977.904	1.000759
11:01:30	***	***	***	986.788	987.297	987.042	988.130	1.001102	987.790	1.000757	987.113	1.000071
11:04:30	***	***	***	990.418	989.783	990.101	993.380	1.003312	991.930	1.001848	990.623	1.000528
11:07:30	***	***	***	990.368	988.306	989.337	986.070	0.996698)	986.560	0.997193)	989.826	1.000494
11:10:30	***	***	***	985.968	985.306	985.637	988.940	1.003351	988.470	1.002874	986.263	1.000635
11:13:30	***	***	***	989.418	988.199	988.809	994.140	1.005392)	992.050	1.003278	989.680	1.000881
11:16:30	***	***	***	996.169	995.932	996.051	997.050	1.001003	996.320	1.000270	996.462	1.000413
11:31:30	999.906	***	999.402	999.770	1000.678	999.939	1002.040	1.002101	1000.480	1.000541	1000.830	1.000891
11:34:30	1001.856	***	1001.530	1002.240	1001.817	1001.861	1004.090	1.002225	1002.900	1.001037	1002.314	1.000452
11:37:30	1001.295	***	1000.965	1001.660	1001.149	1001.267	1002.980	1.001711	1001.770	1.000502	1001.572	1.000304
11:40:30	1001.243	***	1000.648	1000.380	1000.631	1000.726	1004.280	1.003552	1002.750	1.002023	1001.287	1.000561
11:43:30	999.375	***	997.946	997.630	999.090	998.510	1004.280	1.005778)	1002.460	1.003956)	999.738	1.001230
11:46:30	994.005	***	993.595	993.719	995.080	994.100	995.620	1.001529	994.210	1.000111	995.222	1.001129
12:01:30	981.436	***	982.111	982.447	982.641	982.159	985.620	1.003524	982.880	1.000734	982.121	0.999961
12:04:30	982.131	***	984.067	982.767	983.177	983.036	986.690	1.003718	984.300	1.001286	982.253	0.999204
12:07:30	992.473	***	994.326	992.859	993.736	993.349	996.280	1.002951	994.650	1.001310	992.632	0.999279
12:10:30	990.727	***	992.329	990.919	991.337	991.328	993.890	1.002584	992.640	1.001323	990.467	0.999131
12:13:30	989.135	***	989.291	989.498	989.790	989.429	993.420	1.004034	991.030	1.001619	990.461	1.001044
12:16:30	987.940	***	990.092	988.358	989.617	989.002	989.480	1.000484)	988.260	0.999250)	988.894	0.999891
12:31:30	987.797	***	987.700	989.148	989.516	988.540	987.640	0.999089)	987.570	0.999019)	989.745	1.001219
12:34:30	988.553	***	989.176	988.508	987.663	988.475	992.720	1.004295	990.670	1.002221	988.658	1.000185
12:37:30	986.909	***	987.520	986.958	986.650	987.009	987.880	1.000882)	986.890	0.999879	986.970	0.999960
12:40:30	987.787	***	987.894	988.418	988.346	988.111	991.420	1.003349	989.590	1.001497	989.261	1.001164
12:43:30	988.420	***	988.017	988.528	986.508	987.868	991.510	1.003686	989.910	1.002067	989.303	1.001452
12:46:30	984.459	***	984.300	984.538	984.526	984.456	987.780	1.003377	985.530	1.001091	985.765	1.001330
13:01:30	971.063	***	972.199	971.635	970.695	971.398	974.680	1.003379	973.430	1.002092	971.215	0.999812
13:04:30	972.340	***	973.989	972.776	972.739	972.961	974.860	1.001952	974.010	1.001078	973.128	1.000172
13:07:30	971.268	***	972.486	972.306	971.745	971.951	974.230	1.002345	972.520	1.000585	972.451	1.000514
13:10:30	965.468	***	966.431	965.845	965.301	965.761	966.640	1.000910)	965.570	0.999802	965.836	1.000077
13:13:30	961.578	***	962.280	960.614	960.622	961.274	963.730	1.002555	962.760	1.001546	961.273	0.999999
13:16:30	954.003	***	956.179	954.853	954.607	954.910	955.000	1.000094)	953.560	0.998586)	955.401	1.000514
13:31:30	935.686	***	934.890	935.420	934.593	935.147	937.070	1.002056	936.100	1.001019	935.468	1.000343
13:34:30	923.465	***	922.490	923.008	922.348	922.828	925.230	1.002603	924.470	1.001780	923.304	1.000516
13:37:30	927.856	***	928.068	928.138	928.016	928.019	930.470	1.002641	929.620	1.001725	928.827	1.000870
13:40:30	930.183	***	929.979	930.189	929.825	930.044	933.910	1.004157	932.710	1.002867	930.502	1.000492

Time	WRC & Regional Standard Pyrheliometers						National Standard Pyrheliometers					
	PMO6-CC 0401	PMO6-CC 0803	AHF 32455	PMO6-CC 0403	AHF 32446	Average	PMO6-CC 0102 Hong Kong, China		PMO6-CC 0809 Hong Kong, China		AHF 34322 Thailand	
(hh:mm:ss)	(W·m^{-2})	(W·m^{-2})	(W·m^{-2})	(W·m^{-2})	(W·m^{-2})	(W·m^{-2})	(W·m^{-2})	Ratio	(W·m^{-2})	Ratio	(W·m^{-2})	Ratio
13:43:30	923.557	***	923.238	923.558	923.580	923.483	925.900	1.002617	924.770	1.001393	924.142	1.000713
13:46:30	915.828	***	915.827	916.167	915.554	915.844	919.170	1.003632	917.840	1.002179	916.414	1.000622
14:01:30	885.403	***	884.745	885.432	885.329	885.227	886.540	1.001483	885.600	1.000421	885.522	1.000333
14:04:30	878.808	***	878.135	879.481	880.154	879.144	880.630	1.001690	879.760	1.000700	879.442	1.000339
14:07:30	897.624	***	897.301	898.424	897.647	897.749	900.830	1.003432	899.340	1.001772	898.011	1.000292
14:10:30	885.658	***	884.545	885.402	886.568	885.543	889.170	1.004095	888.070	1.002853	886.922	1.001557
14:13:30	894.663	***	894.075	895.003	894.564	894.576	897.150	1.002877	896.670	1.002340	895.390	1.000910
26 Jan 2012												
10:01:30	934.461	***	933.886	935.080	934.309	934.434	936.000	1.001676	935.190	1.000809	934.847	1.000442
10:04:30	940.414	***	939.270	940.550	939.835	940.017	943.630	1.003843	942.460	1.002599	940.888	1.000926
10:07:30	943.476	***	942.551	944.261	944.310	943.650	946.600	1.003126	945.200	1.001643	944.807	1.001226
10:10:30	943.385	***	942.895	943.831	944.171	943.570	945.710	1.002268	944.130	1.000593	944.770	1.001271
10:13:30	951.624	***	950.318	951.842	951.207	951.248	953.290	1.002147	951.980	1.000770	952.403	1.001214
10:16:30	950.154	***	949.416	950.112	951.289	950.243	952.980	1.002881	951.370	1.001186	951.644	1.001475
10:31:30	962.814	***	961.422	963.254	961.808	962.324	965.060	1.002843	963.840	1.001575	962.956	1.000656
10:34:30	958.424	***	957.213	959.033	958.291	958.240	961.250	1.003141	959.920	1.001753	958.987	1.000779
10:37:30	965.305	***	964.543	965.975	965.760	965.396	968.210	1.002915	966.920	1.001579	966.499	1.001143
10:40:30	970.022	***	969.050	970.285	969.810	969.792	972.680	1.002978	971.500	1.001761	970.712	1.000949
10:43:30	969.940	***	969.100	970.095	969.614	969.687	972.560	1.002962	971.200	1.001560	970.257	1.000587
10:46:30	966.071	***	965.072	965.694	964.740	965.394	968.900	1.003631	967.650	1.002337	965.740	1.000358
11:01:30	964.937	***	964.825	965.374	965.182	965.080	967.800	1.002819	966.250	1.001213	***	***)
11:04:30	966.295	***	966.452	966.245	965.758	966.187	969.290	1.003211	967.690	1.001555	***	***)
11:07:30	966.193	***	966.257	966.155	965.530	966.034	969.590	1.003681	968.000	1.002036	***	***)
11:10:30	966.367	***	966.596	966.485	965.908	966.339	968.530	1.002268	967.230	1.000922	***	***)
11:13:30	960.966	***	961.347	960.384	960.347	960.761	965.280	1.004704	963.200	1.002539	***	***)
11:16:30	954.268	***	955.054	954.593	954.805	954.680	957.190	1.002629	955.540	1.000901	***	***)
12:01:30	957.454	***	956.963	957.483	957.737	957.409	962.190	1.004993)	960.220	1.002936	957.888	1.000500
12:04:30	950.052	***	949.292	950.092	949.641	949.769	952.790	1.003181	951.730	1.002065	949.521	0.999739
12:07:30	951.665	***	950.205	951.282	952.377	951.382	956.760	1.005653)	954.390	1.003162	952.409	1.001079
12:10:30	947.897	***	946.035	946.241	946.859	946.758	950.920	1.004396	949.460	1.002854	947.888	1.001193
12:13:30	954.462	***	954.091	955.243	955.739	954.884	957.500	1.002740	955.750	1.000907	956.471	1.001662
13:01:30	923.669	***	924.112	924.858	925.013	924.413	928.390	1.004302	925.260	1.000916	925.631	1.001317
13:07:30	922.271	***	921.975	922.378	922.984	922.402	926.500	1.004443	924.640	1.002427	924.638	1.002424
13:31:30	916.574	***	917.106	917.547	916.916	917.036	919.310	1.002480	917.530	1.000539	917.571	1.000584
13:34:30	924.537	***	924.020	924.828	924.660	924.511	927.650	1.003395	925.810	1.001405	925.648	1.001229
13:37:30	925.895	***	925.434	925.858	924.695	925.471	927.410	1.002096	926.590	1.001210	926.193	1.000781
13:40:30	920.719	***	920.330	920.787	920.845	920.670	923.210	1.002758	921.860	1.001292	922.055	1.001504
14:01:30	921.434	***	922.886	921.857	923.580	922.439	922.610	1.000185)	921.910	0.999426)	921.316	0.998782
14:07:30	929.203	***	930.455	929.519	932.037	930.303	929.830	0.999491)	929.560	0.999201)	929.602	0.999246
14:10:30	934.329	***	935.258	933.599	936.087	934.818	936.870	1.002195	935.430	1.000654	934.188	0.999326
14:13:30	931.878	***	930.157	931.349	932.612	931.499	933.830	1.002502	932.500	1.001075	931.364	0.999855
14:16:30	930.827	***	932.483	931.379	932.970	931.915	933.020	1.001186	931.890	0.999974	931.341	0.999385
27 Jan 2012												
11:10:30	936.667	***	935.756	936.430	935.722	936.144	938.800	1.002837	937.580	1.001534	936.117	0.999971
11:13:30	941.026	***	941.730	941.021	941.066	941.211	944.230	1.003208	942.950	1.001848	941.682	1.000501
11:16:30	945.018	***	945.162	944.631	944.783	944.898	947.750	1.003018	946.300	1.001483	945.415	1.000547

Time	WRC & Regional Standard Pyrheliometers						National Standard Pyrheliometers					
	PMO6-CC 0401	PMO6-CC 0803	AHF 32455	PMO6-CC 0403	AHF 32446	Average	PMO6-CC 0102 Hong Kong, China		PMO6-CC 0809 Hong Kong, China		AHF 34322 Thailand	
(hh:mm:ss)	(W·m^{-2})	(W·m^{-2})	(W·m^{-2})	(W·m^{-2})	(W·m^{-2})	(W·m^{-2})	(W·m^{-2})	Ratio	(W·m^{-2})	Ratio	(W·m^{-2})	Ratio
11:31:30	948.081	***	947.218	947.602	946.834	947.434	951.340	1.004123	949.890	1.002593	947.532	1.000104
11:34:30	948.357	***	947.653	947.402	946.562	947.493	950.510	1.003184	949.250	1.001854	948.423	1.000981
11:37:30	944.702	***	944.518	945.031	944.432	944.671	947.250	1.002730	945.970	1.001376	945.142	1.000499
11:40:30	947.836	***	947.571	947.642	947.135	947.546	950.940	1.003582	949.690	1.002263	947.986	1.000465
11:43:30	948.285	***	947.761	948.652	948.109	948.202	951.020	1.002972	949.730	1.001612	949.172	1.001023
11:46:30	950.460	***	949.882	950.702	950.501	950.386	952.840	1.002582	951.770	1.001456	951.861	1.001552
12:01:30	961.354	***	961.385	961.494	961.111	961.336	964.280	1.003063	962.950	1.001679	962.669	1.001387
12:04:30	962.089	***	962.066	962.634	962.741	962.382	963.940	1.001619	962.270	0.999883	962.759	1.000391
12:07:30	964.253	***	964.418	965.174	963.457	964.326	965.870	1.001601	964.560	1.000243	965.379	1.001092
12:10:30	963.600	***	963.445	963.424	962.811	963.320	966.280	1.003073	964.690	1.001422	963.730	1.000426
12:13:30	960.813	***	960.672	961.244	961.180	960.977	963.530	1.002657	962.280	1.001356	960.997	1.000021
12:16:30	958.648	***	958.351	958.403	958.578	958.495	960.770	1.002373	959.580	1.001132	958.263	0.999758
12:31:30	947.377	***	946.633	947.322	946.728	947.015	949.400	1.002519	947.940	1.000977	947.133	1.000125
12:34:30	948.224	***	947.760	948.272	947.318	947.893	949.620	1.001821	947.830	0.999933	948.071	1.000187
12:37:30	943.364	***	942.330	943.161	943.145	943.000	946.040	1.003224	944.760	1.001866	944.108	1.001175
12:40:30	935.666	***	***	935.380	935.783	935.610	938.990	1.003613	937.360	1.001871	936.691	1.001156
12:43:30	934.492	***	934.819	934.009	934.806	934.532	938.240	1.003968	936.190	1.001775	935.474	1.001008
12:46:30	935.084	***	933.886	934.700	934.086	934.439	937.450	1.003222	936.040	1.001713	934.894	1.000487
13:07:30	932.174	***	931.251	931.359	931.343	931.532	935.120	1.003852	933.330	1.001930	932.968	1.001542
13:10:30	934.257	***	933.860	933.979	932.881	933.744	935.910	1.002319	934.200	1.000488	934.481	1.000789
13:13:30	923.455	***	923.617	922.538	922.072	922.920	926.700	1.004095	924.940	1.002188	923.658	1.000799
13:16:30	920.933	***	920.721	920.707	919.752	920.528	923.010	1.002696	922.310	1.001936	921.467	1.001020
13:31:30	913.623	***	913.548	913.766	913.971	913.727	915.190	1.001601	913.470	0.999719	914.336	1.000666
13:34:30	909.580	***	908.471	908.835	908.054	908.735	912.040	1.003637	911.000	1.002492	909.111	1.000414
13:37:30	905.802	***	905.285	904.875	905.259	905.305	907.730	1.002678	906.140	1.000922	906.057	1.000830
13:40:30	907.814	***	907.881	907.985	907.660	907.835	909.820	1.002186	908.710	1.000964	908.215	1.000418
13:43:30	908.896	***	908.978	908.385	908.464	908.681	911.520	1.003124	910.360	1.001848	909.074	1.000433
28 Jan 2012												
11:01:30	939.005	939.192	938.773	938.480	938.599	938.810	941.760	1.003143	940.310	1.001598	938.825	1.000016
11:04:30	942.997	943.163	942.733	943.331	942.824	943.009	945.150	1.002270	943.970	1.001019	943.295	1.000303
11:07:30	946.601	946.634	947.083	946.641	946.433	946.678	949.530	1.003012	948.060	1.001459	946.964	1.000302
11:10:30	947.928	947.305	947.509	948.242	947.450	947.687	950.740	1.003222	948.970	1.001354	948.256	1.000601
11:13:30	948.204	948.235	947.627	947.452	946.622	947.628	950.040	1.002546	948.970	1.001416	948.029	1.000423
11:16:30	949.847	950.436	950.083	949.812	949.615	949.959	952.590	1.002770	951.430	1.001549	950.886	1.000976
11:31:30	950.501	950.666	949.350	950.372	949.955	950.169	952.540	1.002496	951.510	1.001412	950.366	1.000208
11:34:30	945.896	945.434	943.881	945.811	946.596	945.524	947.680	1.002281	946.660	1.001202	946.008	1.000512
11:37:30	941.945	942.103	941.205	941.891	941.479	941.725	945.190	1.003680	943.480	1.001864	941.827	1.000109
11:43:30	946.437	945.944	945.265	947.122	947.431	946.440	948.950	1.002652	947.460	1.001078	946.412	0.999971
11:46:30	946.621	946.064	945.988	946.251	946.328	946.250	950.370	1.004354	948.910	1.002811	945.546	0.999256
29 Jan 2012												
10:01:30	927.090	928.108	926.557	927.728	928.243	927.545	928.410	1.000932)	927.620	1.000081	927.386	0.999828
10:04:30	929.550	929.918	929.396	930.349	928.720	929.587	933.000	1.003672	931.300	1.001843	926.562	0.996746)
10:07:30	930.837	932.329	930.857	931.769	932.328	931.624	934.740	1.003345	932.960	1.001434	934.872	1.003486)
10:10:30	928.305	929.788	928.510	929.239	927.829	928.734	930.280	1.001665	928.790	1.000060	929.136	1.000433
30 Jan 2012												
09:31:30	939.005	939.412	***	939.340	938.728	939.121	941.190	1.002203	940.510	1.001479	939.053	0.999927

Time	WRC & Regional Standard Pyrheliometers						National Standard Pyrheliometers					
	PMO6-CC 0401	PMO6-CC 0803	AHF 32455	PMO6-CC 0403	AHF 32446	Average	PMO6-CC 0102 Hong Kong, China		PMO6-CC 0809 Hong Kong, China		AHF 34322 Thailand	
(hh:mm:ss)	($W \cdot m^{-2}$)	($W \cdot m^{-2}$)	($W \cdot m^{-2}$)	($W \cdot m^{-2}$)	($W \cdot m^{-2}$)	($W \cdot m^{-2}$)	($W \cdot m^{-2}$)	Ratio	($W \cdot m^{-2}$)	Ratio	($W \cdot m^{-2}$)	Ratio
09:34:30	941.138	942.093	***	942.571	941.128	941.733	944.360	1.002790	942.760	1.001091	942.175	1.000470
09:37:30	940.556	941.162	***	941.141	940.184	940.761	944.920	1.004421	943.190	1.002582	941.376	1.000654
09:40:30	939.086	939.472	***	940.921	940.323	939.950	943.700	1.003989	941.820	1.001989	940.793	1.000896
09:43:30	945.651	945.764	***	946.481	946.993	946.222	949.030	1.002967	947.440	1.001287	947.227	1.001062
09:46:30	945.365	945.524	***	944.901	944.069	944.965	949.460	1.004757	948.070	1.003286	945.664	1.000740
10:01:30	954.717	955.098	***	955.023	954.178	954.754	958.450	1.003871	956.950	1.002300	955.421	1.000699
10:04:30	949.255	949.906	***	950.502	949.870	949.883	952.640	1.002902	951.360	1.001555	950.877	1.001046
10:07:30	952.533	952.977	***	952.722	953.042	952.818	954.800	1.002080	953.520	1.000736	953.990	1.001230
10:10:30	959.322	960.089	***	959.503	958.862	959.444	962.190	1.002862	960.990	1.001611	960.771	1.001383
10:13:30	957.239	957.518	***	957.763	956.882	957.351	960.470	1.003258	959.170	1.001900	958.725	1.001435
10:16:30	945.845	946.744	***	946.241	947.026	946.464	946.780	1.000334)	946.540	1.000080	948.098	1.001726
10:31:30	953.819	953.847	***	953.893	953.080	953.660	955.740	1.002181	954.880	1.001280	954.488	1.000869
10:34:30	960.415	961.190	***	961.154	960.973	960.933	961.430	1.000517)	960.830	0.999893	961.937	1.001045
10:37:30	966.061	966.602	***	966.275	966.224	966.290	970.280	1.004129	968.410	1.002194	967.626	1.001382
10:40:30	968.092	968.652	***	968.385	967.563	968.173	970.430	1.002331	969.250	1.001112	969.419	1.001287
10:43:30	971.002	971.784	***	971.495	970.634	971.229	974.050	1.002905	972.910	1.001731	972.840	1.001659
10:46:30	972.462	972.734	***	971.795	972.039	972.258	976.140	1.003993	974.320	1.002121	974.157	1.001954
11:31:30	972.646	973.194	972.736	972.776	972.400	972.750	978.300	1.005705)	975.960	1.003300	973.496	1.000767
11:34:30	958.985	958.819	958.309	959.083	957.980	958.635	962.600	1.004136	961.170	1.002644	959.857	1.001274
11:37:30	968.062	969.323	968.550	970.355	970.247	969.307	971.550	1.002314	969.380	1.000075	971.265	1.002020
11:40:30	960.323	961.450	961.055	961.804	962.198	961.366	965.280	1.004071	963.290	1.002001	963.269	1.001980
11:43:30	983.438	984.268	983.981	984.297	983.650	983.927	985.960	1.002066	984.960	1.001050	985.456	1.001554
11:46:30	978.741	979.346	978.274	979.277	978.948	978.917	981.590	1.002730	980.540	1.001658	980.326	1.001439
31 Jan 2012												
09:31:30	928.672	929.278	928.069	929.409	929.039	928.893	931.110	1.002386	929.960	1.001148	928.741	***)
09:34:30	928.233	928.738	926.980	927.688	927.974	927.923	930.800	1.003101	929.480	1.001678	927.244	***)
09:37:30	930.857	931.179	930.379	932.179	931.609	931.241	935.000	1.004037	933.290	1.002201	930.477	***)
09:40:30	932.960	933.630	932.077	932.829	933.667	933.033	936.410	1.003620	934.760	1.001851	932.083	***)
09:43:30	934.931	935.280	933.794	934.920	934.763	934.737	936.940	1.002356	935.430	1.000741	934.195	***)
09:46:30	937.075	937.931	935.818	937.860	938.870	937.511	938.960	1.001546	937.870	1.000383	937.792	***)
10:01:30	950.746	951.976	952.027	952.232	952.123	951.821	955.190	1.003540	953.470	1.001733	951.495	***)
10:04:30	954.983	955.568	955.081	955.213	955.207	955.210	959.600	1.004596	958.110	1.003036	954.850	***)
10:07:30	957.331	957.999	957.920	958.483	958.870	958.121	959.780	1.001732	958.760	1.000667	957.876	***)
10:10:30	957.321	958.169	957.955	958.593	959.296	958.267	961.340	1.003207	959.760	1.001558	958.006	***)
10:13:30	963.243	963.281	963.393	963.854	963.648	963.484	966.340	1.002965	965.040	1.001615	962.570	***)
10:16:30	964.243	964.721	963.684	964.044	964.711	964.281	968.400	1.004272	967.060	1.002882	963.115	***)
10:31:30	965.203	965.841	965.632	965.845	965.792	965.663	970.320	1.004823	968.440	1.002876	965.754	***)
10:34:30	970.042	970.823	970.157	970.775	970.661	970.492	973.650	1.003254	972.130	1.001688	970.048	***)
10:37:30	972.146	972.634	972.255	972.326	972.377	972.347	975.100	1.002831	973.800	1.001494	971.842	***)
10:40:30	974.657	975.375	974.983	975.456	974.740	975.042	977.980	1.003013	976.490	1.001485	974.130	***)
10:43:30	973.136	973.594	972.511	973.446	973.638	973.265	977.860	1.004721	976.100	1.002913	973.130	***)
10:46:30	975.066	975.455	975.506	975.986	976.005	975.604	978.490	1.002959	977.280	1.001718	974.598	***)
11:01:30	980.324	980.917	981.059	981.187	981.247	980.947	984.700	1.003826	983.050	1.002144	980.096	***)
11:04:30	984.653	985.249	985.403	986.008	985.529	985.368	988.100	1.002772	986.750	1.001402	984.597	***)
11:07:30	984.796	985.339	984.446	984.918	984.444	984.788	990.030	1.005323)	988.330	1.003596)	983.829	***)
11:10:30	982.274	983.578	983.008	983.517	983.412	983.158	984.280	1.001141	983.000	0.999840	982.488	***)
11:13:30	986.286	986.969	986.769	987.448	987.918	987.078	988.870	1.001815	987.540	1.000468	986.828	***)

Time	WRC & Regional Standard Pyrheliometers						National Standard Pyrheliometers						
	PMO6-CC 0401	PMO6-CC 0803	AHF 32455	PMO6-CC 0403	AHF 32446	Average	PMO6-CC 0102 Hong Kong, China		PMO6-CC 0809 Hong Kong, China		AHF 34322 Thailand		
(hh:mm:ss)	($W \cdot m^{-2}$)	($W \cdot m^{-2}$)	($W \cdot m^{-2}$)	($W \cdot m^{-2}$)	($W \cdot m^{-2}$)	($W \cdot m^{-2}$)	($W \cdot m^{-2}$)	Ratio	($W \cdot m^{-2}$)	Ratio	($W \cdot m^{-2}$)	Ratio	
11:16:30	985.112	985.789	985.490	985.868	986.101	985.672	989.240	1.003620	987.390	1.001743	985.313	***	)
11:31:30	990.656	991.271	991.001	991.559	990.949	991.087	994.640	1.003585	992.940	1.001870	990.751	***	)
11:34:30	985.000	984.688	984.542	985.028	983.624	984.576	988.630	1.004117	987.370	1.002837	983.781	***	)
11:37:30	984.785	984.558	984.737	984.307	984.085	984.495	988.530	1.004099	987.470	1.003022	984.055	***	)
11:40:30	977.261	977.886	977.163	977.336	977.601	977.449	982.390	1.005055)	979.990	1.002599	976.772	***	)
11:43:30	976.025	976.855	976.262	977.506	978.643	977.058	978.570	1.001547	977.200	1.000145	976.762	***	)
11:46:30	981.957	982.758	981.595	982.737	982.316	982.273	985.400	1.003184	984.030	1.001789	981.432	***	)
12:01:30	983.213	984.818	981.812	985.148	983.697	983.738	986.550	1.002859	984.780	1.001060	983.605	***	)
12:04:30	980.640	981.337	981.434	981.757	981.204	981.274	983.980	1.002757	982.890	1.001646	980.420	***	)
12:07:30	984.224	984.338	984.125	984.507	982.956	984.030	986.690	1.002703	985.220	1.001209	982.496	***	)
12:10:30	982.335	982.357	982.513	983.037	983.640	982.777	986.330	1.003616	984.460	1.001713	982.176	***	)
12:13:30	977.169	977.726	977.674	977.896	978.037	977.700	982.610	1.005022)	980.570	1.002935	976.792	***	)
12:16:30	974.034	974.475	974.347	975.016	975.404	974.655	975.510	1.000877)	974.230	0.999564	973.973	***	)
12:31:30	973.677	974.765	976.548	974.876	974.835	974.940	976.920	1.002031	975.200	1.000267	973.568	***	)
12:34:30	975.525	975.855	976.404	976.736	977.477	976.400	979.520	1.003196	977.570	1.001199	975.515	***	)
12:37:30	977.557	977.766	979.021	977.856	978.350	978.110	981.410	1.003374	979.820	1.001748	976.784	***	)
12:40:30	983.080	983.188	983.247	982.407	981.670	982.718	984.900	1.002220	983.960	1.001263	981.675	***	)
12:43:30	980.967	982.167	983.919	982.087	982.607	982.350	983.180	1.000845)	982.100	0.999746	981.081	***	)
13:01:30	974.892	975.385	974.901	976.126	975.187	975.298	977.750	1.002514	976.240	1.000966	974.459	***	)
13:04:30	969.532	970.703	968.042	970.245	967.355	969.175	974.120	1.005102)	972.290	1.003214	966.874	***	)
13:07:30	974.136	974.034	973.440	974.066	973.180	973.771	976.200	1.002494	975.470	1.001744	971.704	***	)
13:10:30	967.306	968.182	967.612	968.695	967.280	967.815	970.280	1.002547	968.760	1.000976	968.321	***	)
13:13:30	967.010	967.392	966.768	967.455	967.031	967.131	971.420	1.004435	969.670	1.002625	964.740	***	)
13:16:30	967.827	968.742	967.995	967.905	967.671	968.028	971.130	1.003204	969.990	1.002027	965.483	***	)
13:31:30	951.746	951.856	952.132	952.602	952.259	952.119	956.440	1.004538	954.750	1.002763	951.476	***	)
13:34:30	948.735	949.025	948.429	950.022	949.001	949.042	952.690	1.003844	951.060	1.002126	948.503	***	)
13:40:30	947.234	947.905	947.922	947.472	947.483	947.603	952.440	1.005104)	950.360	1.002909	947.064	***	)
13:43:30	943.037	944.324	943.620	944.151	943.955	943.817	946.960	1.003330	945.460	1.001740	943.272	***	)
13:46:30	930.285	930.489	930.018	929.569	929.445	929.961	932.900	1.003160	931.660	1.001827	929.130	***	)
14:01:30	906.517	907.170	906.577	907.215	906.991	906.894	910.170	1.003612	909.090	1.002421	906.143	***	)
14:04:30	900.044	900.968	899.747	900.924	901.263	900.589	904.660	1.004520	902.580	1.002211	900.071	***	)
14:07:30	892.713	893.065	893.080	893.873	894.068	893.360	895.160	1.002015	893.710	1.000392	892.703	***	)
14:10:30	892.264	892.505	892.292	892.653	893.086	892.560	894.440	1.002106	893.410	1.000952	891.492	***	)
14:13:30	884.801	885.362	883.621	885.752	884.531	884.813	888.070	1.003681	886.780	1.002223	884.501	***	)
14:16:30	879.359	880.120	879.321	880.161	879.883	879.769	882.330	1.002911	881.330	1.001775	878.882	***	)

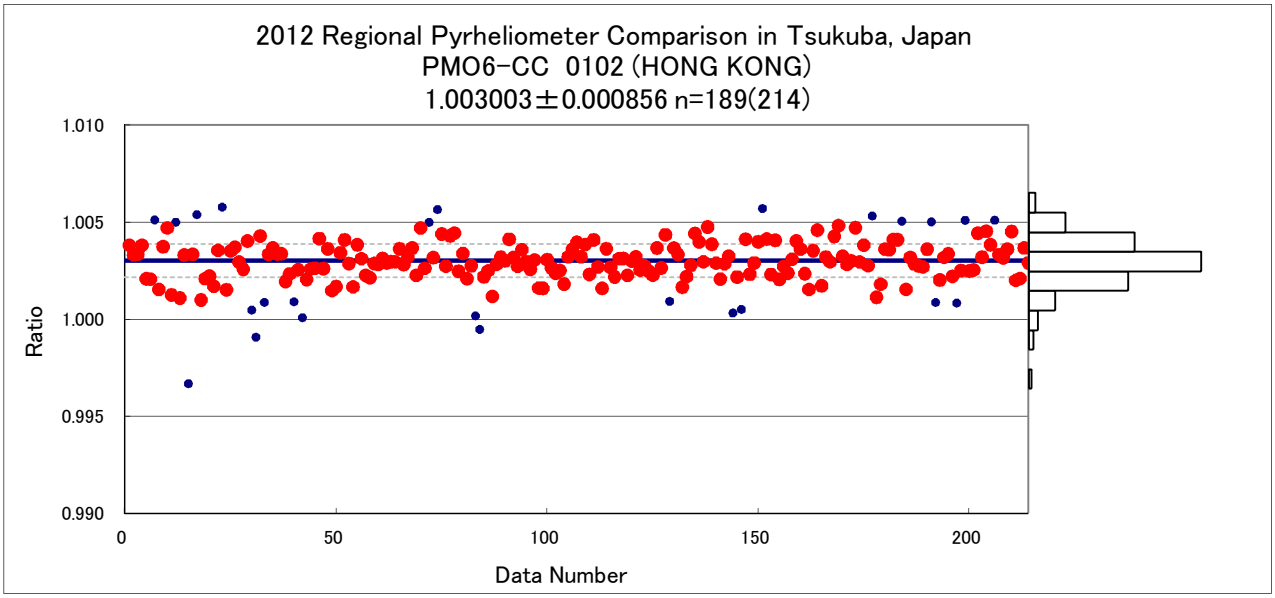
Time	WRC & Regional Standard Pyrheliometers						Regional & National Standard Pyrheliometers							
	PMO6-CC 0401	PMO6-CC 0803	AHF 32455	PMO6-CC 0403	AHF 32446	Average	PMO6 951202 Republic of Korea			AHF 36014 Republic of Korea			PMO6 960801 Japan	
(hh:mm:ss)	(W·m^{-2})	(W·m^{-2})	(W·m^{-2})	(W·m^{-2})	(W·m^{-2})	(W·m^{-2})	(W·m^{-2})	Ratio		(W·m^{-2})	Ratio		(W·m–2)	Ratio
25 Jan 2012														
10:01:30	961.262	***	***	962.054	***	961.658	0.051	***	)	***	***	)	961.141	0.999463
10:04:30	963.355	***	***	964.184	***	963.770	0.051	***	)	***	***	)	963.796	1.000027
10:07:30	966.612	***	***	966.335	***	966.473	0.051	***	)	***	***	)	967.438	1.000998
10:10:30	968.062	***	***	967.475	***	967.768	0.049	***	)	***	***	)	967.308	0.999524
10:13:30	970.471	***	***	971.025	***	970.748	0.049	***	)	***	***	)	971.894	1.001180
10:16:30	969.705	***	***	970.305	***	970.005	0.052	***	)	***	***	)	971.707	1.001754
10:31:30	980.191	***	979.459	979.707	979.131	979.622	0.052	***	)	***	***	)	981.150	1.001560
10:34:30	984.152	***	983.118	984.107	983.344	983.681	0.053	***	)	***	***	)	984.125	1.000452
10:37:30	976.015	***	975.178	975.986	975.528	975.677	0.052	***	)	***	***	)	976.726	1.001076
10:40:30	974.729	***	973.793	974.346	975.013	974.470	0.052	***	)	***	***	)	975.529	1.001086
10:43:30	977.506	***	977.294	978.166	978.174	977.785	0.052	***	)	***	***	)	977.595	0.999806
10:46:30	977.781	***	976.915	977.836	976.117	977.163	0.052	***	)	***	***	)	979.093	1.001976
11:01:30	***	***	***	986.788	987.297	987.042	0.053	***	)	988.310	***	)	987.393	1.000355
11:04:30	***	***	***	990.418	989.783	990.101	0.053	***	)	995.510	***	)	991.474	1.001387
11:07:30	***	***	***	990.368	988.306	989.337	0.053	***	)	990.850	***	)	990.101	1.000772
11:10:30	***	***	***	985.968	985.306	985.637	0.053	***	)	991.860	***	)	987.258	1.001644
11:13:30	***	***	***	989.418	988.199	988.809	0.053	***	)	991.920	***	)	991.314	1.002533
11:16:30	***	***	***	996.169	995.932	996.051	0.054	***	)	994.460	***	)	996.688	1.000639
11:31:30	999.906	***	999.402	999.770	1000.678	999.939	0.054	***	)	1002.140	***	)	1001.077	1.001139
11:34:30	1001.856	***	1001.530	1002.240	1001.817	1001.861	0.054	***	)	1003.770	***	)	1002.874	1.001012
11:37:30	1001.295	***	1000.965	1001.660	1001.149	1001.267	0.054	***	)	1000.050	***	)	1002.258	1.000990
11:40:30	1001.243	***	1000.648	1000.380	1000.631	1000.726	0.054	***	)	1002.440	***	)	1001.334	1.000608
11:43:30	999.375	***	997.946	997.630	999.090	998.510	0.054	***	)	1000.700	***	)	1000.170	1.001662
11:46:30	994.005	***	993.595	993.719	995.080	994.100	0.054	***	)	995.760	***	)	993.033	0.998927)
12:01:30	981.436	***	982.111	982.447	982.641	982.159	0.052	***	)	***	***	)	981.924	0.999761
12:04:30	982.131	***	984.067	982.767	983.177	983.036	0.052	***	)	976.230	***	)	983.301	1.000270
12:07:30	992.473	***	994.326	992.859	993.736	993.349	0.054	***	)	982.430	***	)	993.083	0.999733
12:10:30	990.727	***	992.329	990.919	991.337	991.328	0.053	***	)	992.130	***	)	990.876	0.999544
12:13:30	989.135	***	989.291	989.498	989.790	989.429	0.053	***	)	993.580	***	)	988.409	0.998969
12:16:30	987.940	***	990.092	988.358	989.617	989.002	0.053	***	)	987.420	***	)	988.422	0.999414
12:31:30	987.797	***	987.700	989.148	989.516	988.540	0.053	***	)	983.910	***	)	988.604	1.000065
12:34:30	988.553	***	989.176	988.508	987.663	988.475	0.053	***	)	995.460	***	)	990.487	1.002036
12:37:30	986.909	***	987.520	986.958	986.650	987.009	0.053	***	)	986.650	***	)	987.496	1.000493
12:40:30	987.787	***	987.894	988.418	988.346	988.111	0.053	***	)	991.700	***	)	986.966	0.998841)
12:43:30	988.420	***	988.017	988.528	986.508	987.868	0.053	***	)	986.080	***	)	989.972	1.002130
12:46:30	984.459	***	984.300	984.538	984.526	984.456	0.053	***	)	956.330	***	)	984.346	0.999889
13:01:30	971.063	***	972.199	971.635	970.695	971.398	0.051	***	)	975.120	***	)	973.518	1.002182
13:04:30	972.340	***	973.989	972.776	972.739	972.961	0.052	***	)	973.110	***	)	973.854	1.000918
13:07:30	971.268	***	972.486	972.306	971.745	971.951	0.052	***	)	974.050	***	)	971.211	0.999238
13:10:30	965.468	***	966.431	965.845	965.301	965.761	0.051	***	)	966.780	***	)	965.984	1.000231
13:13:30	961.578	***	962.280	960.614	960.622	961.274	0.051	***	)	962.880	***	)	958.852	0.997480)
13:16:30	954.003	***	956.179	954.853	954.607	954.910	0.050	***	)	956.010	***	)	954.623	0.999699
13:31:30	935.686	***	934.890	935.420	934.593	935.147	0.048	***	)	938.260	***	)	936.258	1.001188
13:34:30	923.465	***	922.490	923.008	922.348	922.828	0.047	***	)	928.580	***	)	923.632	1.000872
13:37:30	927.856	***	928.068	928.138	928.016	928.019	0.048	***	)	927.130	***	)	928.875	1.000921
13:40:30	930.183	***	929.979	930.189	929.825	930.044	0.048	***	)	939.750	***	)	932.576	1.002722

Time	WRC & Regional Standard Pyrheliometers						Regional & National Standard Pyrheliometers					
	PMO6-CC 0401	PMO6-CC 0803	AHF 32455	PMO6-CC 0403	AHF 32446	Average	PMO6 951202 Republic of Korea			AHF 36014 Republic of Korea			PMO6 960801 Japan	
(hh:mm:ss)	(W·m^{-2})	(W·m^{-2})	(W·m^{-2})	(W·m^{-2})	(W·m^{-2})	(W·m^{-2})	(W·m^{-2})	Ratio		(W·m^{-2})	Ratio		(W·m–2)	Ratio
13:43:30	923.557	***	923.238	923.558	923.580	923.483	0.048	***	)	928.540	***	)	924.298	1.000882
13:46:30	915.828	***	915.827	916.167	915.554	915.844	0.047	***	)	922.760	***	)	916.719	1.000955
14:01:30	885.403	***	884.745	885.432	885.329	885.227	0.126	***	)	894.910	***	)	885.693	1.000526
14:04:30	878.808	***	878.135	879.481	880.154	879.144	0.044	***	)	879.310	***	)	880.038	1.001016
14:07:30	897.624	***	897.301	898.424	897.647	897.749	0.046	***	)	900.890	***	)	898.800	1.001170
14:10:30	885.658	***	884.545	885.402	886.568	885.543	0.045	***	)	893.390	***	)	885.314	0.999741
14:13:30	894.663	***	894.075	895.003	894.564	894.576	0.045	***	)	894.780	***	)	896.511	1.002163
26 Jan 2012														
10:01:30	934.461	***	933.886	935.080	934.309	934.434	937.204	1.002964		936.430	***	)	934.585	1.000161
10:04:30	940.414	***	939.270	940.550	939.835	940.017	943.126	1.003307		941.750	***	)	941.705	1.001796
10:07:30	943.476	***	942.551	944.261	944.310	943.650	946.192	1.002694		944.700	***	)	945.129	1.001568
10:10:30	943.385	***	942.895	943.831	944.171	943.570	946.987	1.003621		945.440	***	)	944.509	1.000994
10:13:30	951.624	***	950.318	951.842	951.207	951.248	954.439	1.003355		950.870	***	)	952.938	1.001777
10:16:30	950.154	***	949.416	950.112	951.289	950.243	952.483	1.002358		954.550	***	)	950.320	1.000081
10:31:30	962.814	***	961.422	963.254	961.808	962.324	966.516	1.004356		965.070	***	)	964.078	1.001822
10:34:30	958.424	***	957.213	959.033	958.291	958.240	961.353	1.003249		961.390	***	)	959.832	1.001661
10:37:30	965.305	***	964.543	965.975	965.760	965.396	973.324	1.008212	)	967.580	***	)	967.820	1.002511
10:40:30	970.022	***	969.050	970.285	969.810	969.792	974.954	1.005323	)	972.760	***	)	971.249	1.001503
10:43:30	969.940	***	969.100	970.095	969.614	969.687	973.176	1.003598		972.210	***	)	971.355	1.001720
10:46:30	966.071	***	965.072	965.694	964.740	965.394	969.196	1.003938		969.330	***	)	966.351	1.000991
11:01:30	964.937	***	964.825	965.374	965.182	965.080	970.097	1.005199		969.820	***	)	964.772	0.999681
11:04:30	966.295	***	966.452	966.245	965.758	966.187	968.953	1.002862		969.390	***	)	966.538	1.000363
11:07:30	966.193	***	966.257	966.155	965.530	966.034	969.058	1.003130		968.270	***	)	967.577	1.001598
11:10:30	966.367	***	966.596	966.485	965.908	966.339	969.629	1.003405		968.000	***	)	967.496	1.001197
11:13:30	960.966	***	961.347	960.384	960.347	960.761	963.061	1.002394		968.780	***	)	962.582	1.001896
11:16:30	954.268	***	955.054	954.593	954.805	954.680	956.950	1.002378		959.380	***	)	955.486	1.000845
12:01:30	957.454	***	956.963	957.483	957.737	957.409	961.019	1.003771		***	***	)	959.456	1.002138
12:04:30	950.052	***	949.292	950.092	949.641	949.769	952.504	1.002879		954.690	***	)	951.509	1.001832
12:07:30	951.665	***	950.205	951.282	952.377	951.382	955.083	1.003890		953.340	***	)	952.873	1.001567
12:10:30	947.897	***	946.035	946.241	946.859	946.758	950.610	1.004068		952.920	***	)	947.862	1.001166
12:13:30	954.462	***	954.091	955.243	955.739	954.884	958.107	1.003375		956.350	***	)	955.650	1.000802
13:01:30	923.669	***	924.112	924.858	925.013	924.413	926.273	1.002012		937.500	***	)	926.148	1.001877
13:07:30	922.271	***	921.975	922.378	922.984	922.402	924.989	1.002805		924.910	***	)	923.897	1.001622
13:31:30	916.574	***	917.106	917.547	916.916	917.036	919.536	1.002726		922.500	***	)	916.887	0.999838
13:34:30	924.537	***	924.020	924.828	924.660	924.511	927.313	1.003031		922.630	***	)	925.054	1.000587
13:37:30	925.895	***	925.434	925.858	924.695	925.471	928.886	1.003690		926.270	***	)	926.186	1.000773
13:40:30	920.719	***	920.330	920.787	920.845	920.670	923.405	1.002970		923.690	***	)	921.242	1.000621
14:01:30	921.434	***	922.886	921.857	923.580	922.439	922.998	1.000606	)	916.540	***	)	922.425	0.999985
14:07:30	929.203	***	930.455	929.519	932.037	930.303	932.633	1.002504		928.770	***	)	930.935	1.000679
14:10:30	934.329	***	935.258	933.599	936.087	934.818	941.567	1.007220	)	934.590	***	)	934.718	0.999893
14:13:30	931.878	***	930.157	931.349	932.612	931.499	938.806	1.007844	)	932.480	***	)	932.891	1.001494
14:16:30	930.827	***	932.483	931.379	932.970	931.915	934.295	1.002555		933.990	***	)	931.560	0.999619
27 Jan 2012														
11:10:30	936.667	***	935.756	936.430	935.722	936.144	938.593	1.002616		937.631	1.001589		***	***)
11:13:30	941.026	***	941.730	941.021	941.066	941.211	944.207	1.003183		942.802	1.001691		***	***)
11:16:30	945.018	***	945.162	944.631	944.783	944.898	948.255	1.003552		946.622	1.001824		***	***)

Time	WRC & Regional Standard Pyrheliometers						Regional & National Standard Pyrheliometers					
	PMO6-CC 0401	PMO6-CC 0803	AHF 32455	PMO6-CC 0403	AHF 32446	Average	PMO6 951202 Republic of Korea		AHF 36014 Republic of Korea		PMO6 960801 Japan	
(hh:mm:ss)	(W·m^{-2})	(W·m^{-2})	(W·m^{-2})	(W·m^{-2})	(W·m^{-2})	(W·m^{-2})	(W·m^{-2})	Ratio	(W·m^{-2})	Ratio	(W·m–2)	Ratio
11:31:30	948.081	***	947.218	947.602	946.834	947.434	950.427	1.003159	950.029	1.002739	***	***)
11:34:30	948.357	***	947.653	947.402	946.562	947.493	949.822	1.002457	950.160	1.002814	***	***)
11:37:30	944.702	***	944.518	945.031	944.432	944.671	946.347	1.001775	946.855	1.002312	***	***)
11:40:30	947.836	***	947.571	947.642	947.135	947.546	950.221	1.002823	950.076	1.002670	***	***)
11:43:30	948.285	***	947.761	948.652	948.109	948.202	950.567	1.002495	951.258	1.003223	***	***)
11:46:30	950.460	***	949.882	950.702	950.501	950.386	953.415	1.003187	953.602	1.003384	***	***)
12:01:30	961.354	***	961.385	961.494	961.111	961.336	964.901	1.003708	964.087	1.002862	***	***)
12:04:30	962.089	***	962.066	962.634	962.741	962.382	964.901	1.002617	965.027	1.002748	***	***)
12:07:30	964.253	***	964.418	965.174	963.457	964.326	967.052	1.002827	966.918	1.002688	***	***)
12:10:30	963.600	***	963.445	963.424	962.811	963.320	966.652	1.003459	966.255	1.003047	***	***)
12:13:30	960.813	***	960.672	961.244	961.180	960.977	962.826	1.001924	963.679	1.002812	***	***)
12:16:30	958.648	***	958.351	958.403	958.578	958.495	960.666	1.002265	961.113	1.002731	***	***)
12:31:30	947.377	***	946.633	947.322	946.728	947.015	949.527	1.002653	949.120	1.002223	***	***)
12:34:30	948.224	***	947.760	948.272	947.318	947.893	950.356	1.002598	949.678	1.001883	***	***)
12:37:30	943.364	***	942.330	943.161	943.145	943.000	946.079	1.003265	946.140	1.003330	***	***)
12:40:30	935.666	***	***	935.380	935.783	935.610	937.771	1.002310	938.015	1.002571	***	***)
12:43:30	934.492	***	934.819	934.009	934.806	934.532	937.028	1.002672	936.994	1.002635	***	***)
12:46:30	935.084	***	933.886	934.700	934.086	934.439	937.280	1.003040	936.365	1.002061	***	***)
13:07:30	932.174	***	931.251	931.359	931.343	931.532	933.914	1.002557	933.794	1.002428	***	***)
13:10:30	934.257	***	933.860	933.979	932.881	933.744	936.241	1.002673	936.299	1.002736	***	***)
13:13:30	923.455	***	923.617	922.538	922.072	922.920	925.855	1.003180	925.464	1.002756	***	***)
13:16:30	920.933	***	920.721	920.707	919.752	920.528	923.136	1.002833	922.815	1.002484	***	***)
13:31:30	913.623	***	913.548	913.766	913.971	913.727	915.733	1.002195	916.605	1.003150	***	***)
13:34:30	909.580	***	908.471	908.835	908.054	908.735	911.710	1.003273	910.927	1.002412	***	***)
13:37:30	905.802	***	905.285	904.875	905.259	905.305	908.265	1.003269	907.322	1.002228	***	***)
13:40:30	907.814	***	907.881	907.985	907.660	907.835	910.077	1.002469	909.577	1.001919	***	***)
13:43:30	908.896	***	908.978	908.385	908.464	908.681	911.194	1.002765	908.272	0.999550)	***	***)
28 Jan 2012												
11:01:30	939.005	939.192	938.773	938.480	938.599	938.810	941.836	1.003224	941.894	1.003285	939.326	1.000550
11:04:30	942.997	943.163	942.733	943.331	942.824	943.009	945.903	1.003069	946.309	1.003499	943.338	1.000349
11:07:30	946.601	946.634	947.083	946.641	946.433	946.678	949.690	1.003181	949.970	1.003477	947.023	1.000364
11:10:30	947.928	947.305	947.509	948.242	947.450	947.687	951.032	1.003531	950.689	1.003168	948.979	1.001364
11:13:30	948.204	948.235	947.627	947.452	946.622	947.628	951.012	1.003572	950.845	1.003395	948.187	1.000590
11:16:30	949.847	950.436	950.083	949.812	949.615	949.959	958.130	1.008602)	953.174	1.003385	951.251	1.001360
11:31:30	950.501	950.666	949.350	950.372	949.955	950.169	953.935	1.003963	952.512	1.002466	951.356	1.001249
11:34:30	945.896	945.434	943.881	945.811	946.596	945.524	950.909	1.005695)	948.651	1.003307	946.257	1.000776
11:37:30	941.945	942.103	941.205	941.891	941.479	941.725	946.132	1.004680	944.646	1.003102	943.469	1.001852
11:43:30	946.437	945.944	945.265	947.122	947.431	946.440	948.880	1.002578	949.601	1.003340	948.283	1.001947
11:46:30	946.621	946.064	945.988	946.251	946.328	946.250	949.429	1.003359	949.000	1.002906	948.080	1.001934
29 Jan 2012												
10:01:30	927.090	928.108	926.557	927.728	928.243	927.545	930.084	1.002737	930.583	1.003275	927.304	0.999740
10:04:30	929.550	929.918	929.396	930.349	928.720	929.587	933.700	1.004425	931.874	1.002460	929.902	1.000339
10:07:30	930.837	932.329	930.857	931.769	932.328	931.624	934.225	1.002792	934.948	1.003568	932.822	1.001286
10:10:30	928.305	929.788	928.510	929.239	927.829	928.734	932.650	1.004216	931.258	1.002718	929.013	1.000300
30 Jan 2012												
09:31:30	939.005	939.412	***	939.340	938.728	939.121	942.649	1.003757	942.088	1.003159	939.922	1.000852

Time	WRC & Regional Standard Pyrheliometers						Regional & National Standard Pyrheliometers					
	PMO6-CC 0401	PMO6-CC 0803	AHF 32455	PMO6-CC 0403	AHF 32446	Average	PMO6 951202 Republic of Korea		AHF 36014 Republic of Korea		PMO6 960801 Japan	
(hh:mm:ss)	(W·m^{-2})	(W·m^{-2})	(W·m^{-2})	(W·m^{-2})	(W·m^{-2})	(W·m^{-2})	(W·m^{-2})	Ratio	(W·m^{-2})	Ratio	(W·m–2)	Ratio
09:34:30	941.138	942.093	***	942.571	941.128	941.733	944.690	1.003140	944.253	1.002676	943.049	1.001398
09:37:30	940.556	941.162	***	941.141	940.184	940.761	944.095	1.003544	943.535	1.002949	942.677	1.002036
09:40:30	939.086	939.472	***	940.921	940.323	939.950	942.564	1.002781	943.151	1.003405	940.993	1.001109
09:43:30	945.651	945.764	***	946.481	946.993	946.222	949.640	1.003611	949.703	1.003678	947.435	1.001281
09:46:30	945.365	945.524	***	944.901	944.069	944.965	948.949	1.004216	947.673	1.002866	946.867	1.002013
10:01:30	954.717	955.098	***	955.023	954.178	954.754	957.999	1.003399	957.685	1.003070	955.909	1.001210
10:04:30	949.255	949.906	***	950.502	949.870	949.883	953.561	1.003872	953.139	1.003428	951.576	1.001782
10:07:30	952.533	952.977	***	952.722	953.042	952.818	956.378	1.003736	956.432	1.003793	954.193	1.001443
10:10:30	959.322	960.089	***	959.503	958.862	959.444	963.286	1.004004	962.826	1.003525	961.083	1.001708
10:13:30	957.239	957.518	***	957.763	956.882	957.351	959.972	1.002739	961.435	1.004266	958.980	1.001701
10:16:30	945.845	946.744	***	946.241	947.026	946.464	949.537	1.003246	950.623	1.004394	946.062	0.999575
10:31:30	953.819	953.847	***	953.893	953.080	953.660	957.879	1.004424	956.433	1.002908	954.615	1.001001
10:34:30	960.415	961.190	***	961.154	960.973	960.933	964.399	1.003607	964.597	1.003813	961.169	1.000245
10:37:30	966.061	966.602	***	966.275	966.224	966.290	969.257	1.003070	969.598	1.003423	968.334	1.002115
10:40:30	968.092	968.652	***	968.385	967.563	968.173	970.500	1.002403	971.154	1.003079	970.173	1.002066
10:43:30	971.002	971.784	***	971.495	970.634	971.229	974.629	1.003501	974.282	1.003144	972.233	1.001034
10:46:30	972.462	972.734	***	971.795	972.039	972.258	976.999	1.004877	975.399	1.003231	972.683	1.000438
11:31:30	972.646	973.194	972.736	972.776	972.400	972.750	975.451	1.002777	976.250	1.003598	974.402	1.001698
11:34:30	958.985	958.819	958.309	959.083	957.980	958.635	961.842	1.003345	961.752	1.003251	959.513	1.000916
11:37:30	968.062	969.323	968.550	970.355	970.247	969.307	971.813	1.002585	973.235	1.004052	969.410	1.000106
11:40:30	960.323	961.450	961.055	961.804	962.198	961.366	964.189	1.002936	964.682	1.003449	962.343	1.001016
11:43:30	983.438	984.268	983.981	984.297	983.650	983.927	986.645	1.002762	986.997	1.003120	984.697	1.000783
11:46:30	978.741	979.346	978.274	979.277	978.948	978.917	982.495	1.003655	982.872	1.004040	979.582	1.000679
31 Jan 2012												
09:31:30	928.672	929.278	928.069	929.409	929.039	928.893	931.972	1.003315	932.033	1.003380	929.032	1.000149
09:34:30	928.233	928.738	926.980	927.688	927.974	927.923	931.038	1.003357	931.060	1.003381	929.054	1.001219
09:37:30	930.857	931.179	930.379	932.179	931.609	931.241	935.187	1.004238	933.930	1.002888	933.085	1.001980
09:40:30	932.960	933.630	932.077	932.829	933.667	933.033	936.607	1.003831	936.166	1.003358	934.397	1.001463
09:43:30	934.931	935.280	933.794	934.920	934.763	934.737	938.201	1.003706	938.207	1.003712	935.781	1.001117
09:46:30	937.075	937.931	935.818	937.860	938.870	937.511	940.700	1.003401	942.031	1.004821	938.440	1.000992
10:01:30	950.746	951.976	952.027	952.232	952.123	951.821	954.161	1.002458	955.614	1.003985	952.415	1.000624
10:04:30	954.983	955.568	955.081	955.213	955.207	955.210	957.274	1.002160	957.791	1.002702	956.794	1.001658
10:07:30	957.331	957.999	957.920	958.483	958.870	958.121	961.006	1.003011	961.705	1.003741	959.290	1.001220
10:10:30	957.321	958.169	957.955	958.593	959.296	958.267	961.528	1.003404	962.531	1.004450	959.538	1.001326
10:13:30	963.243	963.281	963.393	963.854	963.648	963.484	966.629	1.003265	966.900	1.003546	964.492	1.001046
10:16:30	964.243	964.721	963.684	964.044	964.711	964.281	967.846	1.003697	968.125	1.003987	964.900	1.000642
10:31:30	965.203	965.841	965.632	965.845	965.792	965.663	968.855	1.003306	968.059	1.002482	966.080	1.000432
10:34:30	970.042	970.823	970.157	970.775	970.661	970.492	973.296	1.002889	973.536	1.003137	970.930	1.000452
10:37:30	972.146	972.634	972.255	972.326	972.377	972.347	975.312	1.003049	975.659	1.003406	973.257	1.000936
10:40:30	974.657	975.375	974.983	975.456	974.740	975.042	979.199	1.004263	978.170	1.003208	976.041	1.001025
10:43:30	973.136	973.594	972.511	973.446	973.638	973.265	976.884	1.003719	976.345	1.003165	974.654	1.001427
10:46:30	975.066	975.455	975.506	975.986	976.005	975.604	978.508	1.002977	979.171	1.003657	976.634	1.001056
11:01:30	980.324	980.917	981.059	981.187	981.247	980.947	983.276	1.002374	983.984	1.003096	981.892	1.000964
11:04:30	984.653	985.249	985.403	986.008	985.529	985.368	988.123	1.002796	987.770	1.002438	986.398	1.001045
11:07:30	984.796	985.339	984.446	984.918	984.444	984.788	987.422	1.002675	986.475	1.001713	986.419	1.001656
11:10:30	982.274	983.578	983.008	983.517	983.412	983.158	985.280	1.002159	985.794	1.002681	982.316	0.999144
11:13:30	986.286	986.969	986.769	987.448	987.918	987.078	990.128	1.003090	990.650	1.003619	987.502	1.000430

Time	WRC & Regional Standard Pyrheliometers						Regional & National Standard Pyrheliometers					
	PMO6-CC 0401	PMO6-CC 0803	AHF 32455	PMO6-CC 0403	AHF 32446	Average	PMO6 951202 Republic of Korea		AHF 36014 Republic of Korea		PMO6 960801 Japan	
(hh:mm:ss)	(W·m^{-2})	(W·m^{-2})	(W·m^{-2})	(W·m^{-2})	(W·m^{-2})	(W·m^{-2})	(W·m^{-2})	Ratio	(W·m^{-2})	Ratio	(W·m–2)	Ratio
11:16:30	985.112	985.789	985.490	985.868	986.101	985.672	988.718	1.003091	988.773	1.003146	986.526	1.000866
11:31:30	990.656	991.271	991.001	991.559	990.949	991.087	995.173	1.004122	993.916	1.002854	991.781	1.000700
11:34:30	985.000	984.688	984.542	985.028	983.624	984.576	987.073	1.002536	986.843	1.002302	985.180	1.000613
11:37:30	984.785	984.558	984.737	984.307	984.085	984.495	987.615	1.003170	987.617	1.003172	985.186	1.000702
11:40:30	977.261	977.886	977.163	977.336	977.601	977.449	981.081	1.003715	981.211	1.003848	978.062	1.000627
11:43:30	976.025	976.855	976.262	977.506	978.643	977.058	980.301	1.003319	981.804	1.004857	977.267	1.000213
11:46:30	981.957	982.758	981.595	982.737	982.316	982.273	986.924	1.004735	985.129	1.002908	984.291	1.002055
12:01:30	983.213	984.818	981.812	985.148	983.697	983.738	986.912	1.003227	987.100	1.003418	985.322	1.001611
12:04:30	980.640	981.337	981.434	981.757	981.204	981.274	984.180	1.002961	983.859	1.002634	981.995	1.000734
12:07:30	984.224	984.338	984.125	984.507	982.956	984.030	987.217	1.003239	985.790	1.001788	985.894	1.001894
12:10:30	982.335	982.357	982.513	983.037	983.640	982.777	985.191	1.002457	985.663	1.002937	983.385	1.000619
12:13:30	977.169	977.726	977.674	977.896	978.037	977.700	980.862	1.003233	980.637	1.003004	979.594	1.001937
12:16:30	974.034	974.475	974.347	975.016	975.404	974.655	976.496	1.001889	977.565	1.002985	974.267	0.999601
12:31:30	973.677	974.765	976.548	974.876	974.835	974.940	977.359	1.002481	977.386	1.002509	976.074	1.001163
12:34:30	975.525	975.855	976.404	976.736	977.477	976.400	979.640	1.003318	979.740	1.003421	974.917	0.998482)
12:37:30	977.557	977.766	979.021	977.856	978.350	978.110	981.344	1.003307	980.788	1.002738	979.035	1.000946
12:40:30	983.080	983.188	983.247	982.407	981.670	982.718	985.759	1.003094	985.761	1.003096	983.121	1.000409
12:43:30	980.967	982.167	983.919	982.087	982.607	982.350	983.824	1.001501	984.910	1.002606	981.978	0.999621
13:01:30	974.892	975.385	974.901	976.126	975.187	975.298	978.077	1.002849	977.873	1.002640	975.074	0.999770
13:04:30	969.532	970.703	968.042	970.245	967.355	969.175	979.621	1.010778)	972.633	1.003568	971.268	1.002159
13:07:30	974.136	974.034	973.440	974.066	973.180	973.771	978.396	1.004750	976.210	1.002504	975.068	1.001332
13:10:30	967.306	968.182	967.612	968.695	967.280	967.815	971.970	1.004293	971.411	1.003715	969.985	1.002242
13:13:30	967.010	967.392	966.768	967.455	967.031	967.131	967.872	1.000766)	969.837	1.002798	968.642	1.001562
13:16:30	967.827	968.742	967.995	967.905	967.671	968.028	969.789	1.001819	971.182	1.003258	970.346	1.002395
13:31:30	951.746	951.856	952.132	952.602	952.259	952.119	954.524	1.002526	954.912	1.002933	957.405	1.005552)
13:34:30	948.735	949.025	948.429	950.022	949.001	949.042	953.715	1.004924	951.942	1.003055	954.199	1.005433)
13:40:30	947.234	947.905	947.922	947.472	947.483	947.603	950.601	1.003163	950.494	1.003051	946.615	0.998957)
13:43:30	943.037	944.324	943.620	944.151	943.955	943.817	945.905	1.002212	946.494	1.002836	944.530	1.000755
13:46:30	930.285	930.489	930.018	929.569	929.445	929.961	934.181	1.004538	932.036	1.002231	928.032	0.997926)
14:01:30	906.517	907.170	906.577	907.215	906.991	906.894	909.474	1.002845	909.060	1.002388	911.221	1.004771)
14:04:30	900.044	900.968	899.747	900.924	901.263	900.589	903.016	1.002695	903.051	1.002734	902.729	1.002376
14:07:30	892.713	893.065	893.080	893.873	894.068	893.360	896.768	1.003814	895.958	1.002908	893.855	1.000555
14:10:30	892.264	892.505	892.292	892.653	893.086	892.560	894.841	1.002556	895.072	1.002814	893.409	1.000952
14:13:30	884.801	885.362	883.621	885.752	884.531	884.813	888.947	1.004672	887.286	1.002795	886.963	1.002430
14:16:30	879.359	880.120	879.321	880.161	879.883	879.769	883.369	1.004092	882.032	1.002573	881.588	1.002068


2012 Regional Pyrheliometer Comparison in Tsukuba, Japan
PMO6-CC 0102 (HONG KONG)
1.003003±0.000856 n=189(214)
Ratio
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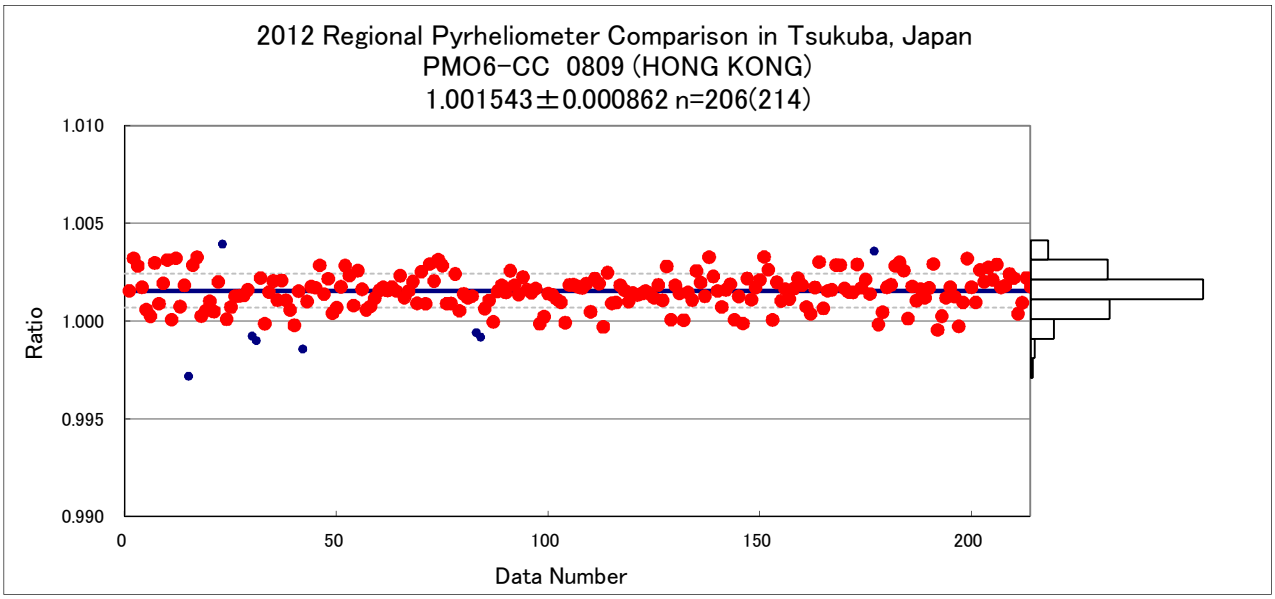
0.995
0.990
0
50
100
150
200
Data Number


2012 Regional Pyrheliometer Comparison in Tsukuba, Japan
PMO6-CC 0809 (HONG KONG)
1.001543±0.000862 n=206(214)
Ratio
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1.000
0.995
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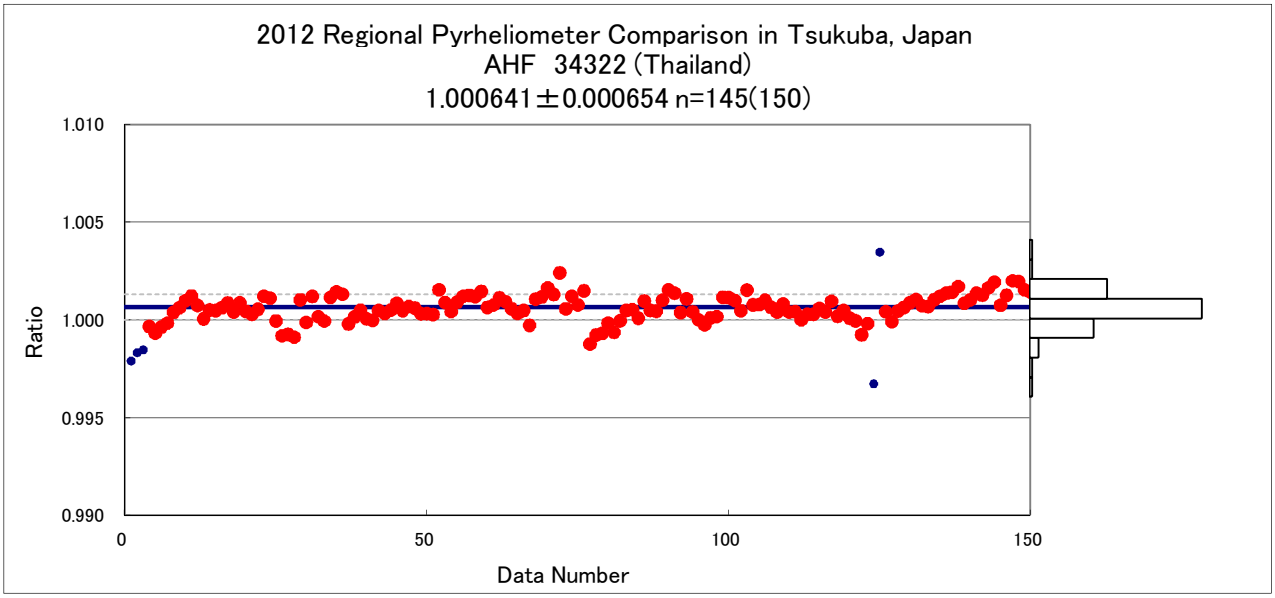
0
50
100
150
200
Data Number


2012 Regional Pyrheliometer Comparison in Tsukuba, Japan
AHF 34322 (Thailand)
1.000641±0.000654 n=145(150)
Ratio
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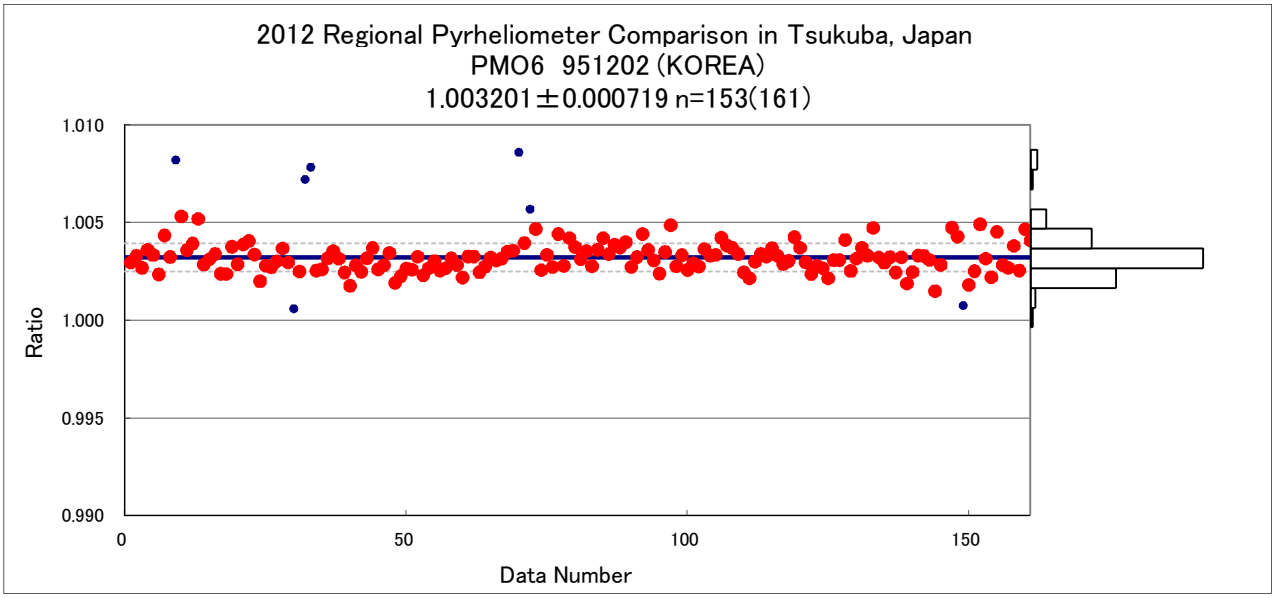
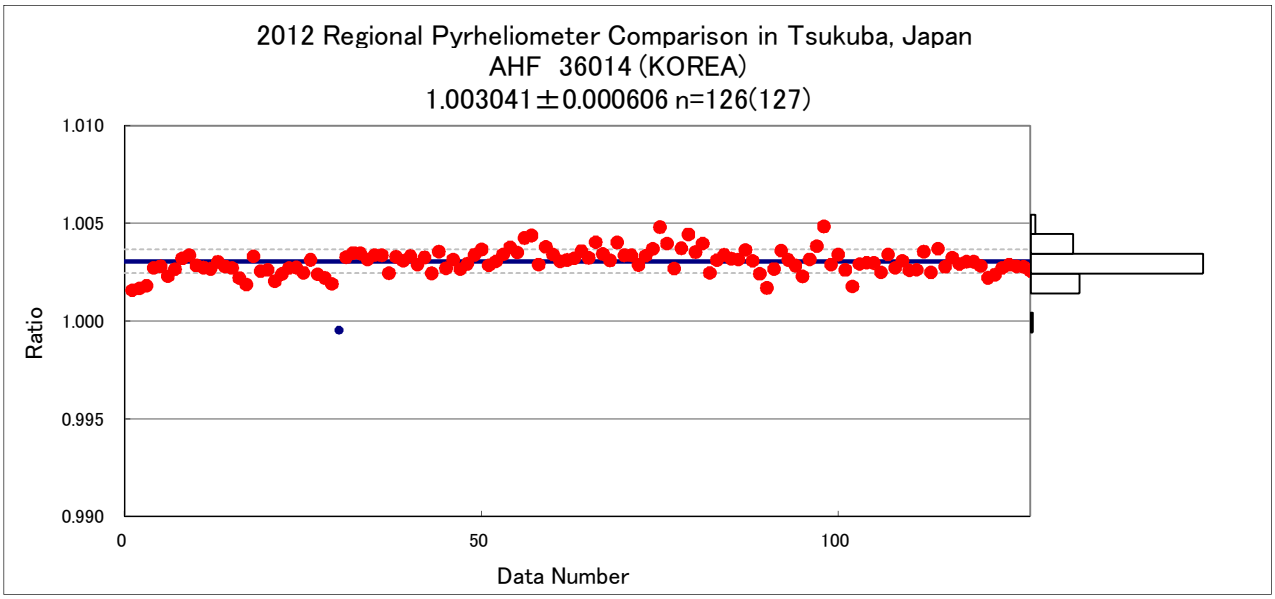
1.000
0.995
0.990
0
50
100
150
Data Number


2012 Regional Pyrheliometer Comparison in Tsukuba, Japan
PMO6 951202 (KOREA)
1.003201±0.000719 n=153(161)
Ratio
1.010
1.005
1.000
0.995
0.990
0
50
100
150
Data Number


2012 Regional Pyrheliometer Comparison in Tsukuba, Japan
AHF 36014 (KOREA)
1.003041±0.000606 n=126(127)
Ratio
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0.995
0.990
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50
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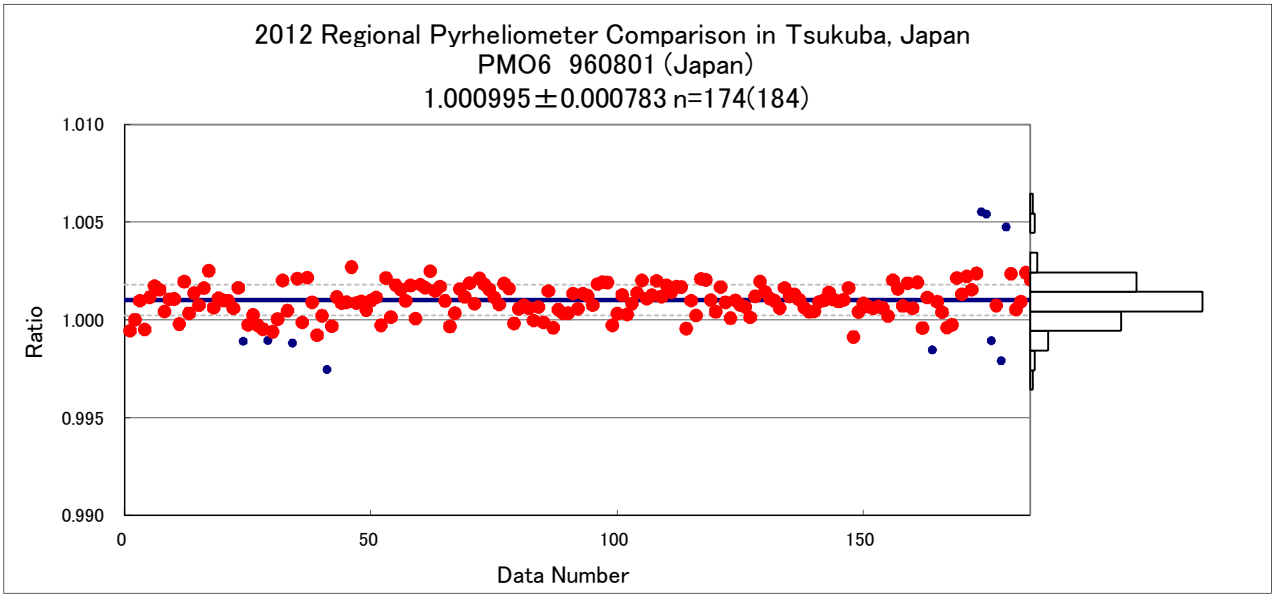
Data Number


2012 Regional Pyrheliometer Comparison in Tsukuba, Japan
PMO6 960801 (Japan)
1.000995±0.000783 n=174(184)
Ratio
1.010
1.005
1.000
0.995
0.990
0
50
100
150
Data Number

Meteorological Data

The table in this appendix shows meteorological data obtained during irradiance measurements.

1. Temperature (T), Relative Humidity (RH), Station Pressure (SP), Wind Direction (WD) and Wind Speed (WS)

Temperature, relative humidity, station pressure and wind direction/speed (instantaneous values) measured initially via an automatic weather station (AWS)

2. Irradiance (S) and Standard Deviation (σ)

Mean values calculated from six reference irradiances for each measurement series and the related standard deviation

3. Elevation Angle (θ), Optical Air Mass (m)

Mean values for each measurement series

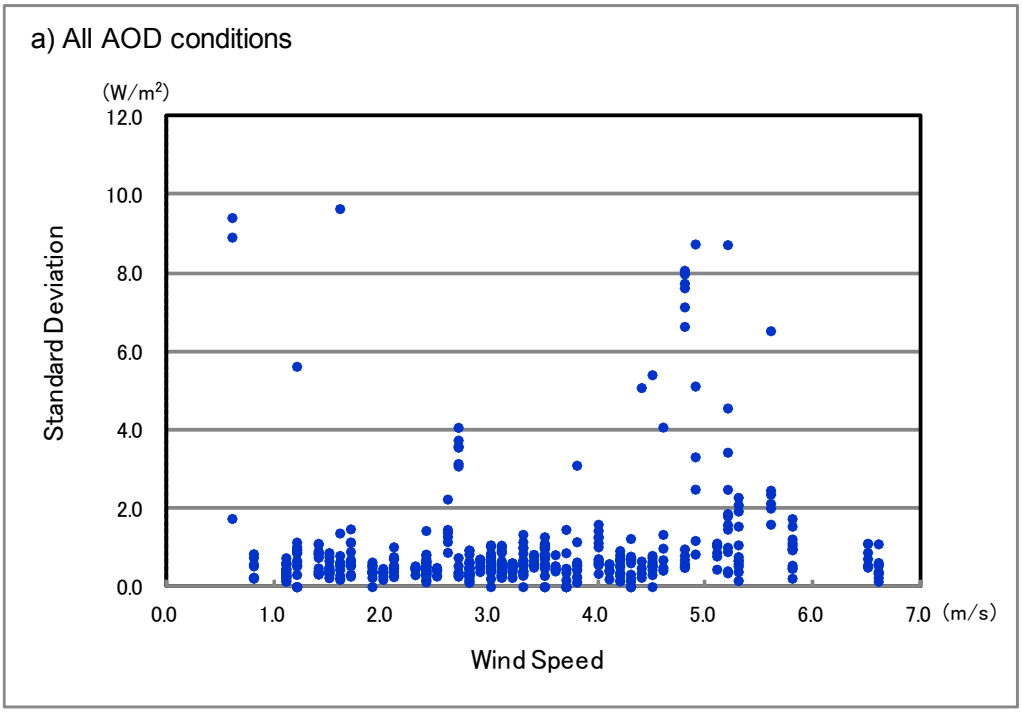
4. Aerosol Optical Depth (AOD)

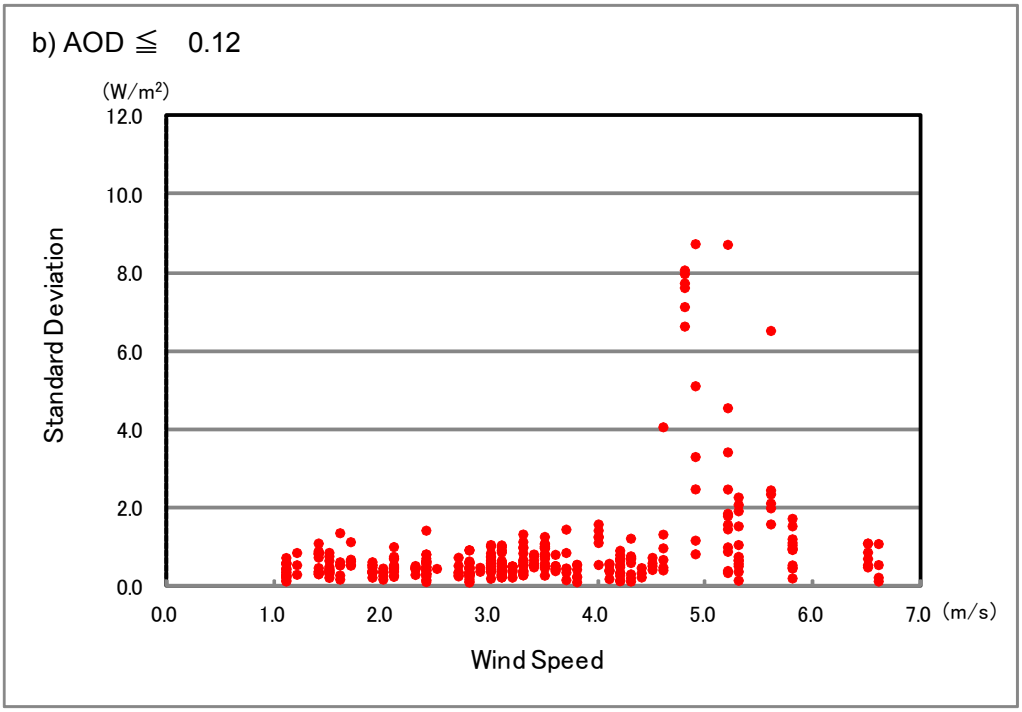
Mean values calculated from the aerosol optical depth at 500 nm in each measurement series based on data from a precision filter radiometer (PFR)

Date	Series No.	Time (start)	Time (end)	T (°C)	RH (%)	SP (hPa)	WS (m sec^{-1})	WD (degree)	S ± σ (W m^{-2})	θ (degree)	m	AOD
25 Jan 2012	1	9:00:00	9:18:00	2.1	44	941	5.8	280	891.3 ± 17.4	22.6	2.40	0.07
	2	9:30:00	9:48:00	2.4	42	942	5.3	300	941.1 ± 6.1	26.4	2.08	0.07
	3	10:00:00	10:18:00	2.8	43	942	4.1	290	966.7 ± 3.5	29.5	1.88	0.07
	4	10:30:00	10:48:00	3.6	49	941	3.6	270	978.1 ± 3.3	32.0	1.75	0.07
	5	11:00:00	11:18:00	3.7	51	942	3.7	270	989.5 ± 3.6	33.7	1.67	0.07
	6	11:30:00	11:48:00	4.4	43	941	3.3	260	999.4 ± 2.8	34.6	1.63	0.07
	7	12:00:00	12:18:00	4.6	44	941	3.5	290	988.1 ± 4.5	34.5	1.64	0.08
	8	12:30:00	12:48:00	5.1	42	940	2.8	290	987.4 ± 1.5	33.5	1.67	0.08
	9	13:00:00	13:18:00	5.1	37	940	4.2	260	966.4 ± 7.2	31.7	1.76	0.08
	10	13:30:00	13:48:00	5.4	39	940	2.4	280	925.9 ± 6.7	29.1	1.90	0.10
	11	14:00:00	14:18:00	5.6	42	940	1.4	60	887.8 ± 7.0	25.8	2.12	0.10
	12	14:30:00	14:48:00	6.0	38	940	1.6	10	836.8 ± 11.8	22.0	2.46	0.11
	13	15:00:00	15:18:00	5.9	40	941	1.1	280	769.1 ± 13.0	17.7	3.04	0.11
26 Jan 2012	14	8:30:00	8:48:00	-2.7	57	946	6.6	360	816.8 ± 3.8	18.5	2.92	0.10
	15	9:00:00	9:18:00	-2.4	55	946	5.2	350	867.3 ± 11.4	22.8	2.40	0.10
	16	9:30:00	9:48:00	-1.7	51	946	6.5	350	911.7 ± 5.0	26.6	2.08	0.10
	17	10:00:00	10:18:00	-0.9	53	947	3.4	360	943.9 ± 6.3	29.7	1.88	0.09
	18	10:30:00	10:48:00	-0.6	50	947	3.0	360	965.1 ± 4.4	32.2	1.75	0.09
	19	11:00:00	11:18:00	0.1	48	947	2.8	330	963.2 ± 4.7	34.0	1.67	0.10
	20	11:30:00	11:48:00	0.3	48	947	5.3	350	959.6 ± 2.8	34.8	1.63	0.11
	21	12:00:00	12:18:00	2.0	45	947	1.4	180	947.3 ± 12.1	34.7	1.64	0.12
	22	12:30:00	12:48:00	2.1	46	947	1.7	230	923.9 ± 9.1	33.8	1.68	0.14
	23	13:00:00	13:18:00	3.0	45	947	2.4	230	919.9 ± 3.4	32.0	1.76	0.12
	24	13:30:00	13:48:00	3.6	45	947	1.9	120	921.9 ± 3.9	29.4	1.90	0.10
	25	14:00:00	14:18:00	3.3	34	947	3.5	270	930.2 ± 4.6	26.1	2.12	0.08
	26	14:30:00	14:48:00	2.7	33	947	3.7	290	*** ± ***	22.2	2.46	0.07
	27	15:00:00	15:18:00	2.6	33	947	4.3	260	835.7 ± 11.2	17.9	3.02	0.07
27 Jan 2012	28	8:30:00	8:48:00	0.0	51	947	3.1	260	789.8 ± 12.8	18.6	2.90	0.10
	29	9:00:00	9:18:00	0.5	51	948	3.8	270	834.7 ± 6.8	22.9	2.39	0.11
	30	9:30:00	9:48:00	1.8	48	948	2.7	290	*** ± ***	26.7	2.07	0.17
	31	10:00:00	10:18:00	0.8	51	949	4.0	340	885.4 ± 4.9	30.0	1.87	0.13
	32	10:30:00	10:48:00	2.5	50	949	0.8	310	897.7 ± 6.5	32.5	1.74	0.21
	33	11:00:00	11:18:00	1.1	57	949	4.4	350	940.8 ± 4.4	34.2	1.66	0.21
	34	11:30:00	11:48:00	2.1	51	948	2.7	360	947.6 ± 1.8	35.0	1.62	0.11
	35	12:00:00	12:18:00	1.9	53	948	4.2	350	961.8 ± 2.0	35.0	1.63	0.09
	36	12:30:00	12:48:00	2.5	48	948	3.0	360	940.4 ± 6.3	34.0	1.67	0.11
	37	13:00:00	13:18:00	2.5	47	948	4.5	360	927.2 ± 6.4	32.2	1.75	0.12
	38	13:30:00	13:48:00	2.8	47	949	2.8	360	905.5 ± 8.7	29.6	1.89	0.11
	39	14:00:00	14:18:00	4.0	44	949	1.2	360	863.6 ± 10.7	26.3	2.10	0.13
	40	14:30:00	14:48:00	2.8	47	949	2.5	360	813.0 ± 14.9	22.5	2.44	0.13
28 Jan 2012	41	8:30:00	8:48:00	-2.4	54	949	5.1	360	*** ± ***	18.8	2.88	0.19
	42	9:00:00	9:18:00	-2.1	53	950	4.8	360	*** ± ***	23.1	2.37	0.18
	43	9:30:00	9:48:00	-1.4	51	950	4.5	10	847.4 ± 11.9	26.9	2.06	0.15
	44	10:00:00	10:18:00	-1.1	47	950	6.6	350	892.7 ± 6.8	30.2	1.86	0.13
	45	10:30:00	10:48:00	0.2	47	950	2.9	360	921.2 ± 4.9	32.7	1.73	0.13
	46	11:00:00	11:18:00	-0.3	44	950	3.1	10	945.6 ± 4.0	34.4	1.65	0.11

Date	Series No.	Time (start)	(end)	T (°C)	RH (%)	SP (hPa)	WS (m sec^{-1})	WD (degree)	S ± σ (W m^{-2})	θ (degree)	m	AOD
	47	11:30:00 –	11:48:00	0.8	40	950	3.1	350	944.8 ± 4.1	35.3	1.62	0.12
	48	12:00:00 –	12:18:00	1.4	36	950	2.8	330	937.3 ± 2.2	35.3	1.62	0.12
	49	12:30:00 –	12:48:00	1.5	38	950	2.4	360	915.6 ± 7.6	34.3	1.66	0.14
	50	13:00:00 –	13:18:00	3.8	35	950	0.8	330	878.6 ± 12.2	32.5	1.74	0.16
	51	13:30:00 –	13:48:00	3.6	36	950	1.2	330	*** ± ***	29.9	1.88	0.22
	52	14:00:00 –	14:18:00	2.3	38	950	3.8	10	*** ± ***	26.6	2.09	0.22
	53	14:30:00 –	14:48:00	2.5	37	950	1.6	350	*** ± ***	22.7	2.42	0.26
29 Jan 2012	54	8:30:00 –	8:48:00	-2.6	57	949	3.5	280	803.6 ± 9.4	19.0	2.86	0.09
	55	9:00:00 –	9:18:00	-1.9	53	949	3.3	310	868.1 ± 10.5	23.3	2.35	0.09
	56	9:30:00 –	9:48:00	-1.7	49	949	4.9	260	*** ± ***	27.2	2.04	0.09
	57	10:00:00 –	10:18:00	-0.8	48	948	4.3	280	929.4 ± 1.7	30.4	1.84	0.10
	58	10:30:00 –	10:48:00	0.2	46	949	3.2	280	912.0 ± 10.0	32.9	1.72	0.13
30 Jan 2012	59	8:30:00 –	8:48:00	-1.6	57	949	2.3	280	853.5 ± 11.8	19.2	2.83	0.06
	60	9:00:00 –	9:18:00	-0.8	55	949	1.5	230	908.4 ± 9.4	23.5	2.34	0.06
	61	9:30:00 –	9:48:00	-0.3	50	949	2.4	270	942.1 ± 2.9	27.4	2.03	0.06
	62	10:00:00 –	10:18:00	0.4	50	950	3.2	290	953.5 ± 4.8	30.6	1.83	0.08
	63	10:30:00 –	10:48:00	1.7	48	950	1.5	330	965.4 ± 7.0	33.2	1.71	0.08
	64	11:00:00 –	11:18:00	1.7	43	950	1.2	240	*** ± ***	34.9	1.63	0.10
	65	11:30:00 –	11:48:00	2.0	43	949	2.1	190	970.8 ± 9.8	35.8	1.60	0.09
	66	12:00:00 –	12:18:00	2.8	36	949	1.1	350	*** ± ***	35.8	1.60	0.12
	67	12:30:00 –	12:48:00	0.1	40	948	0.6	150	*** ± ***	34.8	1.63	1.69
31 Jan 2012	68	8:30:00 –	8:48:00	0.7	45	949	1.1	240	854.7 ± 12.9	19.3	2.81	0.07
	69	9:00:00 –	9:18:00	0.7	45	949	2.1	250	904.7 ± 6.9	23.7	2.32	0.07
	70	9:30:00 –	9:48:00	1.3	45	949	1.7	240	932.2 ± 3.6	27.6	2.02	0.08
	71	10:00:00 –	10:18:00	2.4	45	949	1.1	40	958.5 ± 4.8	30.9	1.82	0.08
	72	10:30:00 –	10:48:00	2.5	44	949	2.0	280	972.1 ± 3.6	33.4	1.70	0.08
	73	11:00:00 –	11:18:00	2.8	47	949	1.9	230	984.5 ± 2.2	35.2	1.62	0.08
	74	11:30:00 –	11:48:00	3.2	42	949	3.1	260	982.8 ± 5.2	36.1	1.59	0.09
	75	12:00:00 –	12:18:00	3.1	42	948	3.3	280	980.7 ± 3.8	36.1	1.59	0.09
	76	12:30:00 –	12:48:00	3.6	38	948	3.0	310	978.9 ± 3.5	35.1	1.62	0.08
	77	13:00:00 –	13:18:00	4.6	35	948	2.4	280	970.2 ± 3.5	33.3	1.70	0.08
	78	13:30:00 –	13:48:00	5.1	33	948	2.8	290	944.5 ± 8.7	30.7	1.83	0.08
	79	14:00:00 –	14:18:00	4.6	34	947	2.4	310	893.0 ± 9.9	27.3	2.03	0.11
	80	14:30:00 –	14:48:00	5.1	35	948	2.6	300	*** ± ***	23.4	2.34	0.13
2 Feb 2012	81	8:30:00 –	8:48:00	-2.2	42	938	4.0	320	853.4 ± 11.7	19.7	2.72	0.08
	82	9:00:00 –	9:18:00	-1.8	43	938	5.8	260	905.1 ± 9.0	24.1	2.25	0.09
	83	9:30:00 –	9:48:00	-1.1	36	938	4.6	290	941.7 ± 5.5	28.0	1.96	0.09
	84	10:00:00 –	10:18:00	-0.9	34	938	5.6	270	*** ± ***	31.3	1.77	0.09
	85	10:30:00 –	10:48:00	-0.4	37	938	3.9	300	*** ± ***	33.9	1.65	0.10
	86	11:00:00 –	11:18:00	0.3	36	938	5.2	280	*** ± ***	35.7	1.58	0.10
	87	11:30:00 –	11:48:00	0.8	33	937	4.8	280	*** ± ***	36.7	1.55	0.10

Relationship between Reference Irradiances and Auxiliary Data





The graphs show standard deviations of reference irradiances plotted against wind speed. Top: standard deviations of reference irradiances for all AOD conditions; bottom: cases in which AOD values were equal to or less than the adopted AOD criteria of 0.12 for calculation of reference irradiances.

Group Photo of Participants

Participants in the Regional Pyrheliometer Comparison of RA II (Tsukuba, Japan)

(front row left to right): H.TATSUMI*, Y.J.LEE, N.OHKAWARA*, K.ISHII*

(back row left to right): S.H.RYU, I.S.ZOO, S.SUDHIBRABHA, W.FINSTERLE, S.YAMADA*, J.K.W.CHAN, S.C.PARK, I.UESATO* (*: support stuff)

Activity of Regional Radiation Centre, Tokyo

1964 Pyrheliometer Intercomparison : India - Japan (Pune, India)

1965 **Regional Radiation Centre Establish** (RA II Res.20, CIMO IV Rec.1,3,9)

1968 Pyrheliometer Intercomparison : Thailand - Japan (Tsukuba, Japan)

1970 Join in IPC-III (WRC/Davos, Switzerland)

1975 Join in IPC-IV (WRC/Davos, Switzerland)
Pyrheliometer Intercomparison : China - Japan (Tsukuba, Japan)

1980 Join in IPC-V (WRC/Davos, Switzerland)

1983 Pyrheliometer Intercomparison : Hong Kong - Japan (Tsukuba, Japan)

1985 Join in IPC-VI (WRC/Davos, Switzerland)

1989 **RPC-I** : Regional Pyrheliometer Comparison of RA II & RA V (Tsukuba, Japan)

1990 Join in IPC-VII (WRC/Davos, Switzerland)

1994 Reference Pyranometer Calibration : Thailand (Tsukuba, Japan)

1995 Pyrheliometer Intercomparison : China - Japan (Tsukuba, Japan)
Reference Pyranometer Calibration : Korea (Tsukuba, Japan)
Join in IPC-VIII (WRC/Davos, Switzerland)

1996 Training for Calibration of Pyrheliometers : Korea (Tsukuba, Japan)

1997 Pyrheliometer Intercomparison : Hong Kong & Korea - Japan (Tsukuba, Japan)
Training for Reference Pyranometer Calibration : Philippines (Tsukuba, Japan)

2000 Join in IPC-IX (WRC/Davos, Switzerland)

2002 Pyrheliometer Intercomparison : Hong Kong, China & Korea - Japan (Tsukuba, Japan)

2005 Join in IPC-X (WRC/Davos, Switzerland)

2007 **RPC-II** : Regional Pyrheliometer Comparison of RA II (Tsukuba, Japan)

2010 Join in IPC-XI (WRC/Davos, Switzerland)

2012 **RPC-III** : Regional Pyrheliometer Comparison of RA II (Tsukuba, Japan)

Part II

CALIBRATION OF A REFERENCE PYRANOMETER FROM KOREA

1. BACKGROUND

At the request of the Korea Meteorological Administration, calibration of Korea's reference pyranometer (CMP22, No. 090081) was jointly carried out during the period of the Regional Pyrheliometer Comparison of RA II (27 January – 2 February, 2012).

2. METHOD OF CALIBRATION AND DATA ACQUISITION

Calibration was performed using the collimation tube method, in which the target pyranometer is attached to the bottom end of a long tube with diaphragms (i.e., a collimation tube) mounted on an automatic sun tracker (see Photo 1). As the optical geometry of the combined system involving the pyranometer and the collimation tube are adjusted to match that of an absolute cavity radiometer (a half opening angle of 2.5 degrees), both instruments can be compared directly using a common radiation source. The output voltages from the pyranometer were measured every 90 seconds. In each series, 13 sets of output data were acquired at these time intervals.

3. PYRANOMETER CALIBRATION FACTOR DEFINITION

In this study, the pyranometer calibration factor was defined as the irradiance sensitivity based on the following formula:

$S = V_{th}/K$

where:

S irradiance [W m^{-2}]

V_{th} output of pyranometer [mV]

Calibration factor K = 0.00963 [mV (W m^{-2})$^{-1}$] (Kipp & Zonen, 2009)

4. DATA EVALUATION PROCEDURE

The WRR reduction factor for the pyranometer was determined by applying the same evaluation procedures for pyrheliometers described in Section 7, Part I.

5. CALIBRATION RESULTS

A total of 124 comparison measurements were made for pyranometer calibration. Based on application of the data selection criteria described in Steps 1 and 2 of Part I, Section 7, 113 measurements were selected for final evaluation.

The new WRR reduction factor was determined as 0.981253.

The measurement values for each instrument are listed in ***Appendix N***. Data marked ")" on the right were rejected. A plot of the calibration results is shown in ***Appendix O***.

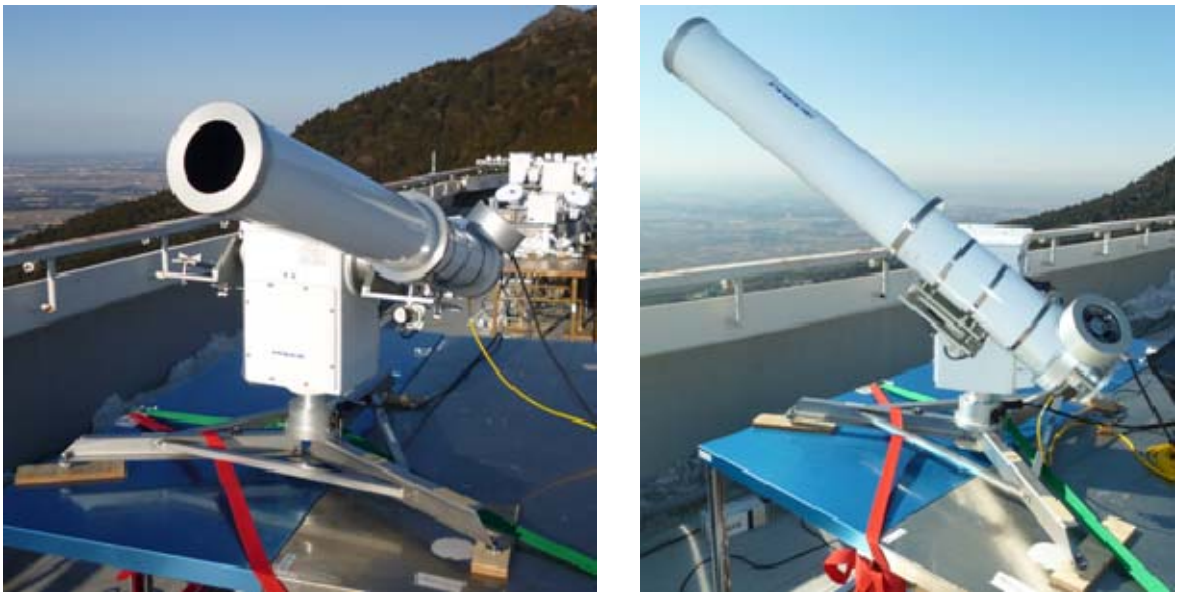


Photo 1 The collimation tube/pyranometer combination. A pyranometer with no sunscreen was attached to the bottom of the tube.

Time	WRC & Regional Standard Pyrheliometers						Pyranometer		
	PMO6-CC 0401	PMO6-CC 0803	AHF 32455	PMO6-CC 0403	AHF 32446	Average	CM21 090081 Rep. of Korea		
(hh:mm:ss)	($W \cdot m^{-2}$)	($W \cdot m^{-2}$)	($W \cdot m^{-2}$)	($W \cdot m^{-2}$)	($W \cdot m^{-2}$)	($W \cdot m^{-2}$)	($W \cdot m^{-2}$)	Ratio	
27 Jan 2012									
11:10:30	936.667	***	935.756	936.430	935.722	936.144	***	***	)
11:13:30	941.026	***	941.730	941.021	941.066	941.211	***	***	)
11:16:30	945.018	***	945.162	944.631	944.783	944.898	***	***	)
11:31:30	948.081	***	947.218	947.602	946.834	947.434	963.613	1.017077	
11:34:30	948.357	***	947.653	947.402	946.562	947.493	963.611	1.017011	)
11:37:30	944.702	***	944.518	945.031	944.432	944.671	960.812	1.017087	
11:40:30	947.836	***	947.571	947.642	947.135	947.546	964.345	1.017729	
11:43:30	948.285	***	947.761	948.652	948.109	948.202	964.730	1.017431	
11:46:30	950.460	***	949.882	950.702	950.501	950.386	967.188	1.017679	
12:01:30	961.354	***	961.385	961.494	961.111	961.336	978.422	1.017773	
12:04:30	962.089	***	962.066	962.634	962.741	962.382	977.760	1.015979	)
12:07:30	964.253	***	964.418	965.174	963.457	964.326	980.234	1.016496	)
12:10:30	963.600	***	963.445	963.424	962.811	963.320	979.208	1.016493	)
12:13:30	960.813	***	960.672	961.244	961.180	960.977	977.826	1.017533	
12:16:30	958.648	***	958.351	958.403	958.578	958.495	976.433	1.018714	
12:31:30	947.377	***	946.633	947.322	946.728	947.015	963.173	1.017062	
12:34:30	948.224	***	947.760	948.272	947.318	947.893	963.888	1.016873	)
12:37:30	943.364	***	942.330	943.161	943.145	943.000	959.677	1.017685	
12:40:30	935.666	***	***	935.380	935.783	935.610	951.272	1.016740	)
12:43:30	934.492	***	934.819	934.009	934.806	934.532	950.922	1.017538	
12:46:30	935.084	***	933.886	934.700	934.086	934.439	950.567	1.017260	
13:07:30	932.174	***	931.251	931.359	931.343	931.532	948.462	1.018175	
13:10:30	934.257	***	933.860	933.979	932.881	933.744	950.580	1.018030	
13:13:30	923.455	***	923.617	922.538	922.072	922.920	939.381	1.017835	
13:16:30	920.933	***	920.721	920.707	919.752	920.528	936.583	1.017441	
13:31:30	913.623	***	913.548	913.766	913.971	913.727	929.910	1.017711	
13:34:30	909.580	***	908.471	908.835	908.054	908.735	925.700	1.018668	
13:37:30	905.802	***	905.285	904.875	905.259	905.305	921.143	1.017494	
13:40:30	907.814	***	907.881	907.985	907.660	907.835	922.899	1.016593	)
13:43:30	908.896	***	908.978	908.385	908.464	908.681	924.648	1.017572	
28 Jan 2012									
11:01:30	939.005	939.192	938.773	938.480	938.599	938.810	957.016	1.019393	
11:04:30	942.997	943.163	942.733	943.331	942.824	943.009	960.521	1.018569	
11:07:30	946.601	946.634	947.083	946.641	946.433	946.678	964.040	1.018339	
11:10:30	947.928	947.305	947.509	948.242	947.450	947.687	966.141	1.019473	
11:13:30	948.204	948.235	947.627	947.452	946.622	947.628	964.741	1.018059	
11:16:30	949.847	950.436	950.083	949.812	949.615	949.959	968.250	1.019254	
11:31:30	950.501	950.666	949.350	950.372	949.955	950.169	968.963	1.019779	
11:34:30	945.896	945.434	943.881	945.811	946.596	945.524	963.356	1.018860	
11:37:30	941.945	942.103	941.205	941.891	941.479	941.725	960.552	1.019993	
11:43:30	946.437	945.944	945.265	947.122	947.431	946.440	964.752	1.019348	
11:46:30	946.621	946.064	945.988	946.251	946.328	946.250	965.456	1.020296	
29 Jan 2012									
10:01:30	927.090	928.108	926.557	927.728	928.243	927.545	945.075	1.018899	

Time	WRC & Regional Standard Pyrheliometers						Pyranometer	
	PMO6-CC 0401	PMO6-CC 0803	AHF 32455	PMO6-CC 0403	AHF 32446	Average	CM21 090081 Rep. of Korea	
(hh:mm:ss)	($W \cdot m^{-2}$)	($W \cdot m^{-2}$)	($W \cdot m^{-2}$)	($W \cdot m^{-2}$)	($W \cdot m^{-2}$)	($W \cdot m^{-2}$)	($W \cdot m^{-2}$)	Ratio
10:04:30	929.550	929.918	929.396	930.349	928.720	929.587	947.518	1.019289
10:07:30	930.837	932.329	930.857	931.769	932.328	931.624	949.635	1.019333
10:10:30	928.305	929.788	928.510	929.239	927.829	928.734	947.196	1.019879
30 Jan 2012								
09:31:30	939.005	939.412	***	939.340	938.728	939.121	957.234	1.019287
09:34:30	941.138	942.093	***	942.571	941.128	941.733	960.040	1.019440
09:37:30	940.556	941.162	***	941.141	940.184	940.761	958.989	1.019375
09:40:30	939.086	939.472	***	940.921	940.323	939.950	958.288	1.019510
09:43:30	945.651	945.764	***	946.481	946.993	946.222	964.590	1.019412
09:46:30	945.365	945.524	***	944.901	944.069	944.965	963.196	1.019292
10:01:30	954.717	955.098	***	955.023	954.178	954.754	972.990	1.019101
10:04:30	949.255	949.906	***	950.502	949.870	949.883	968.083	1.019160
10:07:30	952.533	952.977	***	952.722	953.042	952.818	970.875	1.018950
10:10:30	959.322	960.089	***	959.503	958.862	959.444	977.179	1.018485
10:13:30	957.239	957.518	***	957.763	956.882	957.351	976.481	1.019983
10:16:30	945.845	946.744	***	946.241	947.026	946.464	963.524	1.018024
10:31:30	953.819	953.847	***	953.893	953.080	953.660	970.961	1.018142
10:34:30	960.415	961.190	***	961.154	960.973	960.933	978.685	1.018474
10:37:30	966.061	966.602	***	966.275	966.224	966.290	984.310	1.018649
10:40:30	968.092	968.652	***	968.385	967.563	968.173	985.728	1.018132
10:43:30	971.002	971.784	***	971.495	970.634	971.229	989.938	1.019264
10:46:30	972.462	972.734	***	971.795	972.039	972.258	990.648	1.018915
11:31:30	972.646	973.194	972.736	972.776	972.400	972.750	991.801	1.019584
11:34:30	958.985	958.819	958.309	959.083	957.980	958.635	977.451	1.019628
11:37:30	968.062	969.323	968.550	970.355	970.247	969.307	987.934	1.019216
11:40:30	960.323	961.450	961.055	961.804	962.198	961.366	980.549	1.019954
11:43:30	983.438	984.268	983.981	984.297	983.650	983.927	1003.307	1.019697
11:46:30	978.741	979.346	978.274	979.277	978.948	978.917	998.382	1.019884
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09:31:30	928.672	929.278	928.069	929.409	929.039	928.893	947.488	1.020018
09:34:30	928.233	928.738	926.980	927.688	927.974	927.923	946.073	1.019560
09:37:30	930.857	931.179	930.379	932.179	931.609	931.241	948.868	1.018928
09:40:30	932.960	933.630	932.077	932.829	933.667	933.033	951.662	1.019966
09:43:30	934.931	935.280	933.794	934.920	934.763	934.737	953.394	1.019959
09:46:30	937.075	937.931	935.818	937.860	938.870	937.511	957.613	1.021442)
10:01:30	950.746	951.976	952.027	952.232	952.123	951.821	971.401	1.020571
10:04:30	954.983	955.568	955.081	955.213	955.207	955.210	973.905	1.019571
10:07:30	957.331	957.999	957.920	958.483	958.870	958.121	977.428	1.020151
10:10:30	957.321	958.169	957.955	958.593	959.296	958.267	978.519	1.021135)
10:13:30	963.243	963.281	963.393	963.854	963.648	963.484	982.059	1.019279
10:16:30	964.243	964.721	963.684	964.044	964.711	964.281	982.807	1.019212
10:31:30	965.203	965.841	965.632	965.845	965.792	965.663	986.126	1.021191)
10:34:30	970.042	970.823	970.157	970.775	970.661	970.492	989.663	1.019754
10:37:30	972.146	972.634	972.255	972.326	972.377	972.347	991.450	1.019646
10:40:30	974.657	975.375	974.983	975.456	974.740	975.042	993.918	1.019359

Time	WRC & Regional Standard Pyrheliometers						Pyranometer	
	PMO6-CC 0401	PMO6-CC 0803	AHF 32455	PMO6-CC 0403	AHF 32446	Average	CM21 090081 Rep. of Korea	
(hh:mm:ss)	($W \cdot m^{-2}$)	($W \cdot m^{-2}$)	($W \cdot m^{-2}$)	($W \cdot m^{-2}$)	($W \cdot m^{-2}$)	($W \cdot m^{-2}$)	($W \cdot m^{-2}$)	Ratio
10:43:30	973.136	973.594	972.511	973.446	973.638	973.265	993.237	1.020521
10:46:30	975.066	975.455	975.506	975.986	976.005	975.604	994.660	1.019533
11:01:30	980.324	980.917	981.059	981.187	981.247	980.947	1000.992	1.020435
11:04:30	984.653	985.249	985.403	986.008	985.529	985.368	1005.201	1.020127
11:07:30	984.796	985.339	984.446	984.918	984.444	984.788	1003.464	1.018964
11:10:30	982.274	983.578	983.008	983.517	983.412	983.158	1003.120	1.020304
11:13:30	986.286	986.969	986.769	987.448	987.918	987.078	1007.329	1.020516
11:16:30	985.112	985.789	985.490	985.868	986.101	985.672	1005.602	1.020220
11:31:30	990.656	991.271	991.001	991.559	990.949	991.087	1010.240	1.019325
11:34:30	985.000	984.688	984.542	985.028	983.624	984.576	1002.540	1.018245
11:37:30	984.785	984.558	984.737	984.307	984.085	984.495	1003.945	1.019757
11:40:30	977.261	977.886	977.163	977.336	977.601	977.449	996.929	1.019929
11:43:30	976.025	976.855	976.262	977.506	978.643	977.058	997.975	1.021408)
11:46:30	981.957	982.758	981.595	982.737	982.316	982.273	1001.128	1.019196
12:01:30	983.213	984.818	981.812	985.148	983.697	983.738	1003.962	1.020559
12:04:30	980.640	981.337	981.434	981.757	981.204	981.274	1000.457	1.019549
12:07:30	984.224	984.338	984.125	984.507	982.956	984.030	1001.154	1.017402
12:10:30	982.335	982.357	982.513	983.037	983.640	982.777	1002.563	1.020133
12:13:30	977.169	977.726	977.674	977.896	978.037	977.700	996.968	1.019707
12:16:30	974.034	974.475	974.347	975.016	975.404	974.655	994.517	1.020378
12:31:30	973.677	974.765	976.548	974.876	974.835	974.940	992.407	1.017916
12:34:30	975.525	975.855	976.404	976.736	977.477	976.400	995.558	1.019621
12:37:30	977.557	977.766	979.021	977.856	978.350	978.110	995.891	1.018179
12:40:30	983.080	983.188	983.247	982.407	981.670	982.718	1001.131	1.018736
12:43:30	980.967	982.167	983.919	982.087	982.607	982.350	1001.108	1.019096
13:01:30	974.892	975.385	974.901	976.126	975.187	975.298	994.039	1.019216
13:04:30	969.532	970.703	968.042	970.245	967.355	969.175	988.436	1.019873
13:07:30	974.136	974.034	973.440	974.066	973.180	973.771	992.627	1.019363
13:10:30	967.306	968.182	967.612	968.695	967.280	967.815	987.725	1.020572
13:13:30	967.010	967.392	966.768	967.455	967.031	967.131	985.269	1.018754
13:16:30	967.827	968.742	967.995	967.905	967.671	968.028	986.311	1.018887
13:31:30	951.746	951.856	952.132	952.602	952.259	952.119	970.511	1.019316
13:34:30	948.735	949.025	948.429	950.022	949.001	949.042	968.053	1.020031
13:40:30	947.234	947.905	947.922	947.472	947.483	947.603	966.643	1.020093
13:43:30	943.037	944.324	943.620	944.151	943.955	943.817	962.091	1.019361
13:46:30	930.285	930.489	930.018	929.569	929.445	929.961	947.727	1.019104
14:01:30	906.517	907.170	906.577	907.215	906.991	906.894	924.594	1.019517
14:04:30	900.044	900.968	899.747	900.924	901.263	900.589	919.003	1.020447
14:07:30	892.713	893.065	893.080	893.873	894.068	893.360	911.290	1.020071
14:10:30	892.264	892.505	892.292	892.653	893.086	892.560	909.183	1.018624
14:13:30	884.801	885.362	883.621	885.752	884.531	884.813	902.185	1.019633
14:16:30	879.359	880.120	879.321	880.161	879.883	879.769	897.279	1.019903

Plot of Measurement Values

This figure's plots show the ratios of the final calibration factor K to all individual calibration factors K(i). A corresponding histogram is shown on the right. The dashed horizontal lines represent standard deviations.

The average of the K ratios (representing the reciprocal of the WRR reduction factor) and the standard deviation are shown at the top of the plot along with the number of points used to determine these values (the number in parentheses is the total number of data).