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SECOND WMO REGIONAL PYRHELIOMETER COMPARISON OF RA II

(Tokyo, 22 January – 2 February 2007)

by

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NOTE

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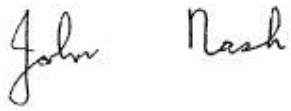
FOREWORD

The successful determination of the Earth's radiation budget, which is fundamental to understanding the Earth's climatic system, climate variability and climate change, is only possible with very homogeneous solar radiation data measured all over the world. The way to guarantee a desired level of quality of radiation data is to assure the traceability of solar radiation measurements to the World Radiometric Reference (WRR). This is achieved through the International Pyrheliometer Comparisons (IPCs) regularly held in 5 years cycles and Regional Pyrheliometer Comparisons (RPCs) that should be organized in all WMO Regions in the period from six months to 4 years following the completion of an IPC.

The present publication reports on the Second WMO Regional Pyrheliometer Comparison of RA II, which was held in Tokyo, Japan, from 22 January to 2 February 2007. This Intercomparison gave the opportunity to Members of RA II, who did not have the chance to participate in the IPC-X that was held at the World Radiation Centre in Davos, Switzerland in 2005, to obtain traceability of their instrumentation to the WRR and so supports world-wide homogeneity of solar irradiance measurements.

I wish to express my sincere appreciation for the efforts of the Regional Radiation Centre of Tsukuba, Japan, for organizing this intercomparison. This clearly demonstrate the possible implementation of the traceability chain that CIMO envisioned, as it proposed the establishment and roles of RRCs and should serve as an example for other RRCs to follow.



(Dr J. Nash)

President
Commission for Instruments and
Methods of Observation

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Part I

SECOND WMO REGIONAL PYRHELIOMETER COMPARISON OF RA II

(Tokyo, 22 January – 2 February 2007)

1. INTRODUCTION

This report gives information about the Regional Pyrheliometer Comparison of the World Meteorological Organization (WMO) Regional Association (RA) II, held from 22 January to 2 February 2007 in Tsukuba, Japan with the participation of experts and pyrheliometers from China, Hong Kong, the Republic of Korea, Japan and the World Radiation Centre (WRC) in Davos, Switzerland.

The Tenth International Pyrheliometer Comparison (IPC-X) was held from 26 September to 14 October 2005 at the WRC, and was attended by an expert from Tokyo's WMO RA II Regional Radiation Centre (RRC), which is operated by the Japan Meteorological Agency (JMA). It was confirmed that RA II Regional Standard Pyrheliometers had been maintained satisfactorily, and the new calibration factors were determined. The IPC-X simultaneously served the function of the Regional Pyrheliometer Comparisons (RPCs) of all WMO Regional Associations (RA I to RA VI). However, only two members (China and Thailand) participated from RA II other than Pune (India) and Tokyo (Japan), which serve as the RA II Regional Radiation Centers.

At the Tokyo RRC (operated by JMA), radiometer comparison is carried out in Tsukuba City every year to check the stability of regional RA II standards following a recommendation by the Commission for Instruments and Methods of Observation (CIMO). Together with this event, JMA offered an opportunity to RA II Members who could not attend IPC-X to compare their national standard pyrheliometers with the RA II regional standard ones. Experts from China, Hong Kong and the Republic of Korea participated in this comparison, and the WRC also sent an expert and an instrument of the World Standard Group (WSG) to support this comparison.

The session was successfully completed with positive results under close cooperation and with hard work by the participants. The results presented in this report are based on five days of measurement under good weather conditions. The cloudy days were used for country reports, visits to JMA's auxiliary organs (the Meteorological Research Institute, the Meteorological Instruments Center and the Aerological Observatory) and technical training.

2. LOCATION OF COMPARISON SITE

The Regional Pyrheliometer Comparison took place at the Tsukubasan Keisei Hotel, sited halfway up the southeast side of Mt. Tsukuba in Ibaraki prefecture. Mt. Tsukuba is an isolated mountain 877 m high, located about 70 km north east of Tokyo. The Tsukubasan Keisei Hotel was the venue of the first Regional Pyrheliometer Comparison for RA II/V (RPC-I) in 1989.

Address: 1 Tsukuba, Tsukuba city, Ibaraki prefecture, Japan

Longitude: 140° 7.5' E

Latitude: 36° 12.9' N

Altitude: 560 m above mean sea level

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

3 PARTICIPANTS

Experts from China, Hong Kong, the Republic of Korea and the WRC, the head of RRC Tokyo and three JMA staff participated in the comparison.

Participants

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(JMA Aerological Observatory / Japan, Member of the Expert Team on Meteorological Radiation and Atmospheric Composition Measurements, CIMO)

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

4 INSTRUMENTS

One absolute pyrheliometer each from China, Hong Kong and the Republic of Korea, three absolute pyrheliometers (including one from the World Standard Group) from the WRC, four absolute pyrheliometers (as regional and national standards) from JMA, and one thermoelectric pyrheliometer (as a working standard) from JMA were used in the comparison. The model name, serial number, owner and type of instruments were as follows:

Instruments

PMO5		(WRC)	absolute pyrheliometer (one of WSG)
PMO6	No.811107	(Japan)	absolute pyrheliometer (regional standard)
AHF	No.32446	(Japan)	absolute pyrheliometer (regional standard)
HF	No.20294	(China)	absolute pyrheliometer
PMO6	No.0102	(Hong Kong)	absolute pyrheliometer
PMO6	No.951202	(Republic of Korea)	absolute pyrheliometer
PMO6	No.0401	(WRC)	absolute pyrheliometer
AHF	No.32455	(WRC)	absolute pyrheliometer
PMO6	No.960801	(Japan)	absolute pyrheliometer (national standard)
HF	No.23738	(Japan)	absolute pyrheliometer (national standard)
CH1	No.970139	(Japan)	thermoelectric pyrheliometer

5 OUTLINE OF COMPARISON

5.1. Equipment and Facilities

Flat benches, automatic active sun trackers, a data acquisition system, voice announcement and a buzzer system to mark the start and end of measurement, a meteorological station (thermometer, hygrometer, barometer, wind vane and anemometer) and a power supply (100/220 V, 50 Hz) were set on the rooftop of the Tsukubasan Keisei Hotel. The pyrheliometer sensors were mounted on four sun trackers.

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

5.2. Method of Data Acquisition

The digital data from the controller of HF (No.20294, China), PMO6 (No.0102, Hong Kong), PMO5 (WRC), PMO6 (No.0401, WRC), AHF (No.32455, WRC) and AHF (No.32446, Japan) were acquired by all members each with a dedicated personal computer. Each member converted these data into the appointed format after daily observation and reported it collectively using USB flash memory.

Analog signals from the controller of PMO6 (No.951202, Republic of Korea), PMO6 (No.811107, Japan), PMO6 (No.960801, Japan) and HF (No.23738, Japan), and outputs from CH1 (No.970139, Japan) were acquired and stored immediately as digital data by JMA staff using a dedicated personal computer with a multi-channel analog data logger.

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

5.3. Measurement Procedures

A unit measurement, referred to as a series, was composed of 13 data readings at 90-second intervals. Accordingly, one series takes 18 minutes. The data sampling cycle for each instrument is shown in ***Appendix E***, and the synchronization of measurements was ensured by voice announcements and buzzers from a computer as shown in ***Appendix F***. The instruments were operated by the participants themselves. Each instrument was controlled and operated as follows:

(a) PMO-type absolute pyrheliometer

A series started when the shutter closed, and the measurement of PMO6 pyrheliometers was then carried out by opening and closing the shutter every 90 seconds. PMO6 (No.951202), PMO6 (No.811107) and PMO6 (No.960801) were operated manually by opening and closing the shutter in synchronization with the voice announcements and buzzers. The other PMO-type absolute pyrheliometers were synchronized at the beginning of the series and operated automatically from that point.

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

(b) HF-type absolute pyrheliometer

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 find the irradiance level. After reading the thermopile output, the shutter was closed again. The heater was then turned on so that the current became almost the same as the thermopile output when the heater voltage / current and thermopile output were read. After this calibration, the heater was turned off and measurement was started.

The above operations were performed manually in the case of HF and automatically by program control in case of AHF. Thirteen sets of irradiance data at intervals of 90 seconds were acquired in one series.

(c) CH1 thermoelectric pyrheliometer

The thermopile outputs were measured every 90 seconds. In one series, thirteen sets of irradiance data were acquired at intervals of 90 seconds.

5.4. Daily Schedule of Comparison

Generally, the daily schedule was as follows:

07:30 - 08:20	Carry the instruments from the storage room to the rooftop, set them up and connect the cables. After inspecting the automatic active sun trackers, pyrheliometer alignment and the connection from the observation instruments to the data logger and personal computers etc., warm up the instruments for at least 30 minutes.
08:30 - 15:30	As long as weather conditions are suitable, continue measurements (see Section 5.3.). Inspections of pyrheliometer alignment are made at all times, with fine adjustments by screw etc. if necessary.
15:30 -	Finish the measurements and return the instruments to the storage room. The participants from China, Hong Kong and the WRC submit measurement data. The RRC distributes the preliminary results of measurements to the participants. The results are checked every day to confirm the status of the instruments and measurement procedures.

6 CALCULATION OF IRRADIANCES

This section describes the calculation methods of irradiances. The following notations are used here:

Symbols

S	direct solar irradiance [W m^{-2}]
V_{th}	output of thermopile [V]
U_H or U_R	voltage across heater (U_H) or standard resistor (U_R) [V]
I_H	current through heater [A] (output converted to voltage in case of PMO6 [V])
P	electrical power on heater [W] or value proportional to electrical power on heater [W]
R_N	resistance of standard resistor [Ω]
R_L	resistance of heater leads [Ω]
K	calibration factor
C_{RAD}	factor to convert power to irradiance [m^{-2}]
a, b	factors to control circuits
t	ambient temperature [°C]

Subscripts

irrad	value during irradiance measurement phase
calib	value during calibration phase

zero	value during zero adjustment in calibration phase
open	value during shutter opened phase
close	value during shutter closed phase

(a) PMO-type absolute pyrheliometer

PMO-type absolute pyrheliometers have a primary black body cavity for measurement to be exposed to the sun and a secondary black body cavity for compensation. These cavities are connected to each other thermally through a heat sink, and the difference in temperature between them is always 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 keep the difference in temperature decreases because of irradiance heating. The irradiance is in proportion to the difference between the open and closed shutters, and is calculated by the following formula:

(1) PMO5 World Standard Group (WRC)

$S = C_{RAD} \, (P_{(close)} - P_{(open)})$

with

$C_{RAD} = 2565.14 \; [m^{-2}]$

$P = U_H \; I_H$

WRR factor = 0.998982 (IPC-X, 2005)

(2) PMO6 No.811107 regional standard (Japan)

$S = K \, (P_{(close)} - P_{(open)})$

with

$K = 24.0095 \; [W \, m^{-2} \, V^{-2}]$ (IPC-X, 2005)

$P = U_H \; I_H$

(3) PMO6 No.0102 (Hong Kong, China)

$S = C_{RAD} \, (P_{(close)} - P_{(open)})$

with

$P = (a_U + ta_U \, t + (b_U + tb_U \, t) \, U_H) \cdot (a_I + ta_I \, t + (b_I + tb_I \, t) \, I_H) \, / \, R_N$

and

$C_{RAD} = 51213.4 \; [m^{-2}]$ (Davos, 2001)

$R_N = 90.0 \; [\Omega]$

$a_U = -0.000035618$

$ta_U = -0.000000050$

$b_U = 0.200496455$

$tb_U = -0.000004070$

$a_I = -0.000040313$

ta_I = 0.000000258

b_I = 0.200471361

tb_I = – 0.000003565

(4) PMO6 No.951202 (Republic of Korea)

$$S = C_{RAD} [b_U b_I (U_{H(\text{close})} I_{H(\text{close})} - U_{H(\text{open})} I_{H(\text{open})}) + b_U a_I (U_{H(\text{close})} - U_{H(\text{open})}) + b_I a_U (I_{H(\text{close})} - I_{H(\text{open})})] / R_N$$

with

C_{RAD} = 51669.5 [m^{-2}] (Davos, 1996)

R_N = 85.0 [Ω]

A_u = 0.000118 + 0.000001 t

b_U = 0.199978 + 0.000004 t

a_I = 0.000103 + 0.000001 t

b_I = 0.199933 + 0.000006 t

(5) PMO6 No.0401 (WRC)

$$S = C_{RAD} (P_{(\text{close})} - P_{(\text{open})})$$

with

C_{RAD} = 50000 [m^{-2}]

$P = U_H \ I_H$

(6) PMO6 No.960801 (Japan)

$$S = K (P_{(\text{close})} - P_{(\text{open})})$$

with

K = 24.1869 + 0.000616 (t – 20) [W m^{-2} V^{-2}] (Davos, 1996)

$P = U_H \ I_H$

$P_{(\text{close})}$ is linearly interpolated at the instant of the open shutter reading from the closed shutter readings before and after the shutter open.

(b) HF-type absolute pyrheliometer

HF and AHF absolute pyrheliometers have a black body cavity for measurement to be exposed to the sun, a thermopile and an electric heater.

Before each series, the shutter is closed, the heater current is turned on, and then voltage $U_{H(\text{calib})}$ across the heater, voltage $U_{R(\text{calib})}$ across the standard resistor R_N and thermopile output $V_{th(\text{calib})}$ are measured. Further, the zero of the $V_{th(\text{zero})}$ is determined with the detector shaded and the electrical power switched off. After this procedure (self-calibration) to obtain the proportional relationship between the quantity of heat added by the electrical heater and the thermopile output, the irradiance is acquired continuously by the thermopile output V_{th} and the following formula:

$$S = K \frac{V_{th(\text{irrad})} - V_{th(\text{zero})}}{V_{th(\text{calib})} - V_{th(\text{zero})}} \frac{U_{R(\text{calib})}}{R_N} \left(U_{H(\text{calib})} - \frac{U_{R(\text{calib})}}{R_N} R_L \right)$$

However, the formula below is used for the National Standard instrument HF (No.23738) in Japan with a predetermined resistor R_H for the heater, because the behavior of the standard resistor is doubtful.

$$S = K \frac{V_{th(\text{irrad})} - V_{th(\text{zero})}}{V_{th(\text{calib})} - V_{th(\text{zero})}} \frac{U_{H(\text{calib})}}{R_H} \left(U_{H(\text{calib})} - \frac{U_{H(\text{calib})}}{R_H} R_L \right)$$

(c) CH1 thermoelectric pyrheliometer

The irradiance is directly calculated from the thermopile output using the formula:

$$S = K V_{th(\text{irrad})}$$

7 DATA EVALUATION PROCEDURES (see reference 3, WMO TD-No.51)

The following procedures were taken to obtain the final results of the comparison:

Step 1: The reference irradiances to calibrate the national standard pyrheliometers were calculated from WSG instrument (PMO-5) and two regional standard instruments (PMO-6 : No.811107, A-HF : No.32446).

Step 1-1: Data selection for the reference instruments

Within the measurement time of the three standard instruments (applied to the data j = 2, 4, 6, 8, 10, 12, see ***Appendix E***), doubtful values caused by irradiance instability and other unpredictable sources were deleted.

Step 1-2: Data selection for each instrument in each series

Individual data of each instrument was selected according to 2% criteria.

Step 1-3: Series selection to obtain the reference irradiances

An individual series for final evaluation was selected according to 0.2% criteria.

Step 1-4: Calculation of the reference irradiances

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

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

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

First, irradiance data judged as doubtful by the participants were rejected. The individual irradiance ratio to the reference value was then calculated for each instrument. Using these ratios, tentative mean ratios were calculated.

$S_R(1), S_R(2), S_R(3), \cdots, S_R(n)$ 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.

$\overline{S_a} = \frac{1}{n} \sum_{i=1}^{n} S_a(i) / S_R(i)$ The tentative mean irradiance ratio $\overline{S_a}$ for instrument *a*.

The data number way depends on the instrument.

Step 2-2: Selection of data for the instruments used

Individual data that differed more than 0.2% from the tentative mean was rejected.

Step 3: World Radiometric Reference (WRR) reduction factors of the instruments used were calculated.

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. The new calibration factor $Cf_{NEW}(X)$ is a product of the new WRR reduction factor and the previous (old) calibration factor $Cf_{OLD}(X)$.

WRR reduction factors and new calibration factors were calculated from the following formula:

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

$$Cf_{NEW}(X) = WRRf_{NEW}(X)\ Cf_{OLD}(X)$$

where

WRR : World Radiometric Reference

S_X : irradiance measured by instrument *X*

8 COMPARISON RESULTS

A total of 57 series of measurements with 339 reference irradiances were made during the five days. By applying the data selection criteria in Section 7 for the reference value, 237 irradiances (38 series) representing the WRR were adopted. The comparison results are listed in ***Appendix G***. The data number in parentheses represents the total, including those rejected in Step 2 of Section 7.

HF (No.23738) of Japan was found to be abnormal in zero adjustment during the calibration phase. The WRR reduction factor was therefore not calculated.

Plot figures of the comparison results are shown in ***Appendix H***, and meteorological data etc. for each measurement series are given in ***Appendix I***.

Results of Pyrheliometer comparison (Summary)

Instrument	Current Calibration Factor	Ratio	Standard Deviation	Number of Data	WRR Reduction Factor	New Calibration Factor
PMO5 WSG WRC	2565.14 m^{-2} WRR factor 0.998982 (IPC-X, 2005)	0.999790	0.000859	233		Current Calibration Factor
PMO6 No.811107 Regional Std.	24.0095 W m^{-2} V^{-2} (IPC-X, 2005)	1.000287	0.000920	215		Current Calibration Factor
AHF No.32446 Regional Std.	19964.4 m^{-2} (IPC-X, 2005)	1.000003	0.000699	236		Current Calibration Factor
HF No.20294 China	20040.0 m^{-2} (Beijing, 2000)	1.000802	0.001108	132(235)	0.999199	20023.9 m^{-2}
PMO6 No.0102 Hong Kong	See Note (Davos, 2001)	1.002746	0.000942	177(233)	0.997262	See Note
PMO6 No.951202 Rep. of Korea	See Note (Davos, 1996)	1.002995	0.000922	186(226)	0.997014	See Note
PMO6 No.0401 WRC	50000.0 m^{-2}	0.979215	0.000864	200(224)	1.021226	51061.3 m^{-2}
AHF No.32455 WRC	20009.2 m^{-2}	1.000202	0.000833	208(235)	0.999798	20005.2 m^{-2}
PMO6 No.960801 Japan	See Note (Davos, 1996)	1.001285	0.000969	201(234)	0.998717	See Note
HF No.23738 Japan	20073 m^{-2} (Tsukuba, 2002)					
CH1 No.970139 Japan	77.646 W m^{-2} mV^{-1} (Tsukuba, 2002)	1.001599	0.000943	173(237)	0.998404	77.522 W m^{-2} mV^{-1}
CM21 No.990609 Rep. of Korea	85.756 W m^{-2} mV^{-1} (Tsukuba, 2002) See Part II	0.999935	0.001026	183(237)	1.000065	85.762 W m^{-2} mV^{-1}

Note : Calibration factor is given as a function of ambient temperature as described in section 6.

9 CONCLUSIONS

The results of the pyrheliometer comparison are summarized as follows:

(1) Within a given period, a necessary and sufficient amount of data was acquired in five days of measurement under good weather conditions.

(2) The pyrheliometers used were found to be properly maintained and of a good level of accuracy (HF (No.23738) of Japan is excluded).

(3) New WRR reduction and calibration factors for the instruments used were determined. These are necessary to standardize instruments for the solar radiation network in each member country/region.

(4) The participants exchanged and shared scientific and technological knowledge on the measurement of radiation.

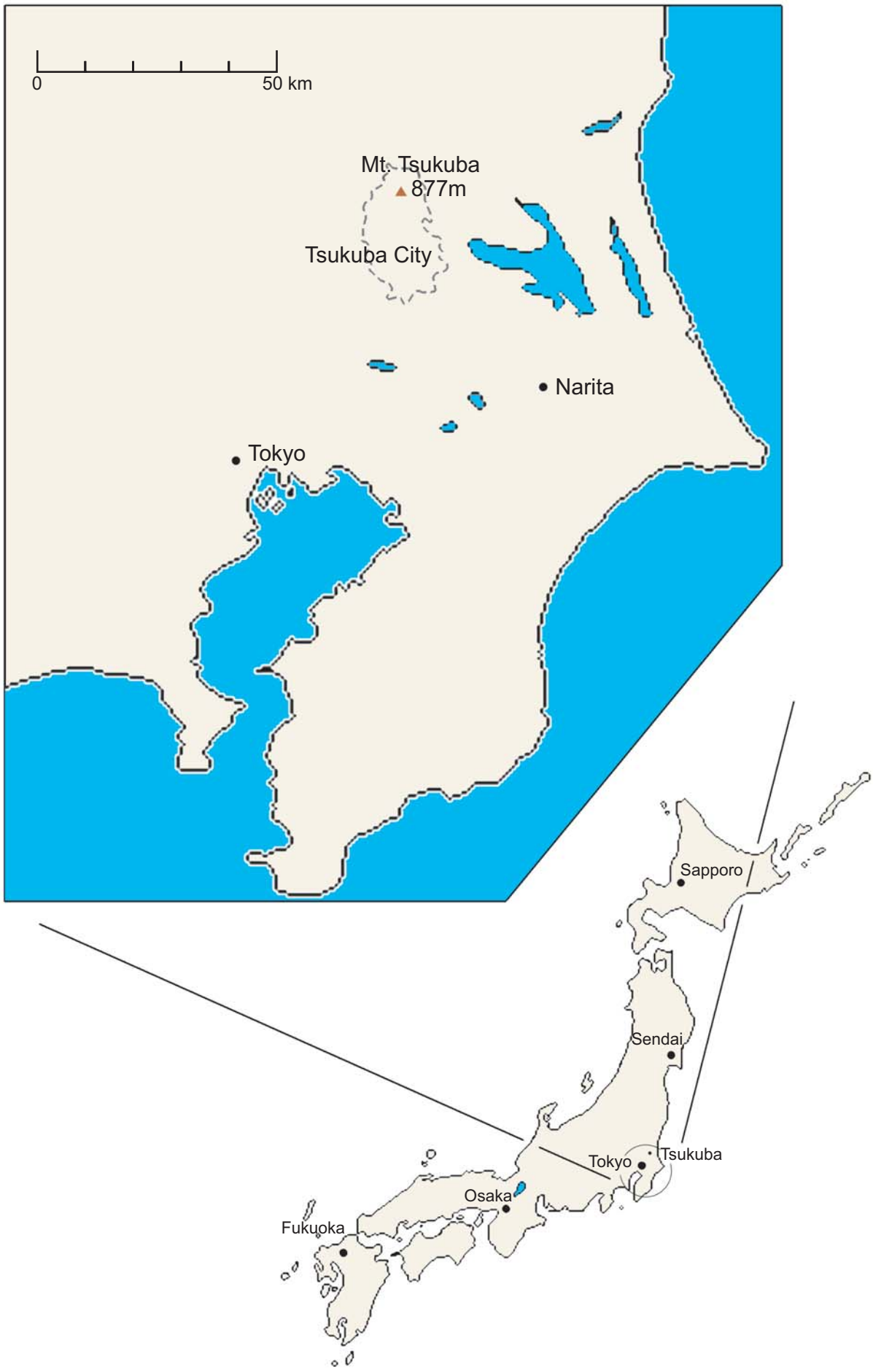
References

WMO (2006); International Pyrheliometer Comparison IPC-X Final Report, *IOM report* **No.91**, WMO TD NO.1320.

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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877m
Tsukuba City
Narita
Tokyo
Sapporo
Sendai
Tokyo
Tsukuba
Osaka
Fukuoka

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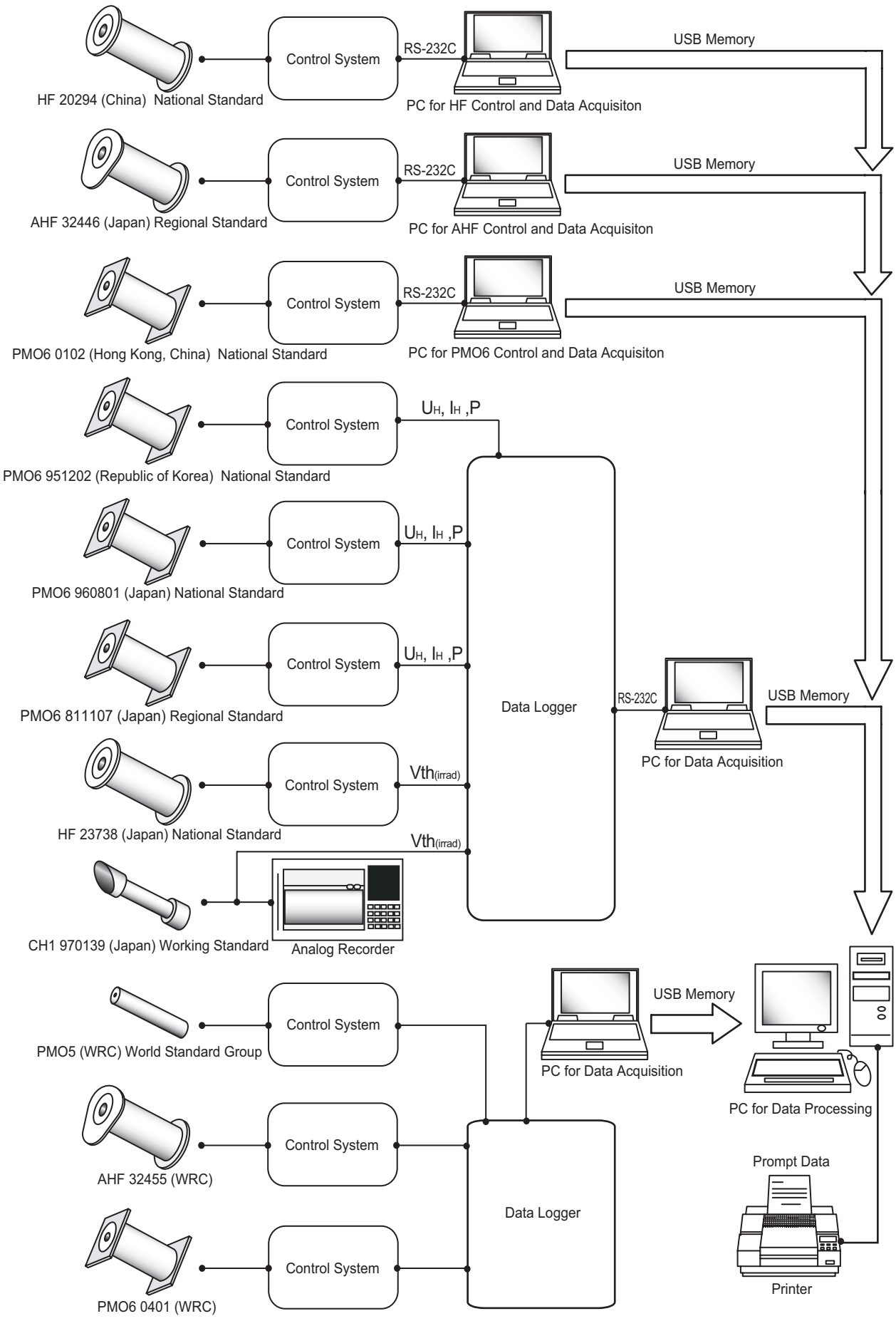
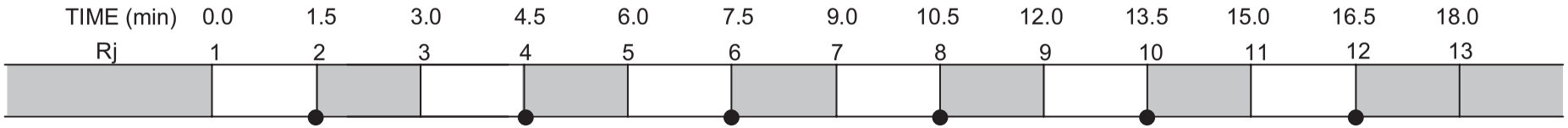
Layout of the Equipment and Facilities (Rooftop of the Tsukubasan Keisei Hotel)

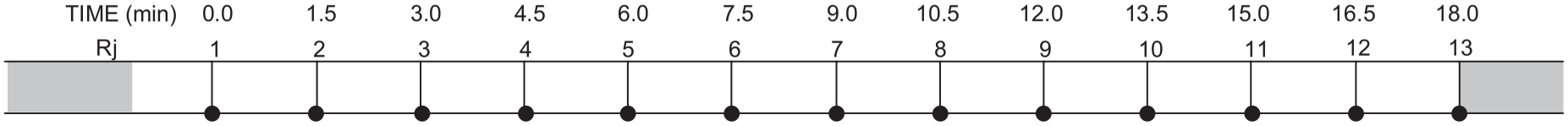
Block Diagram of Data Acquisition System



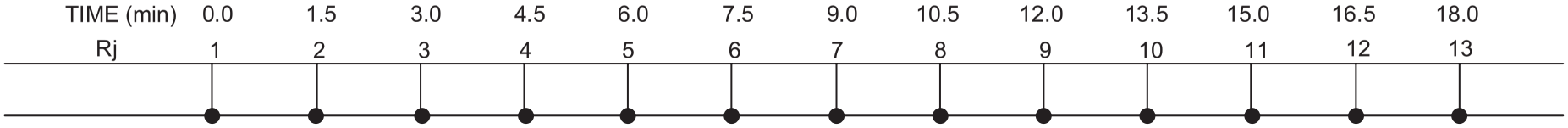
PMO Absolute Pyrheliometer (PMO5, PMO6)



HF Absolute Pyrheliometer (HF, AHF)



Thermoelectric Pyrheliometer (CH1)



Rj Running number of reading

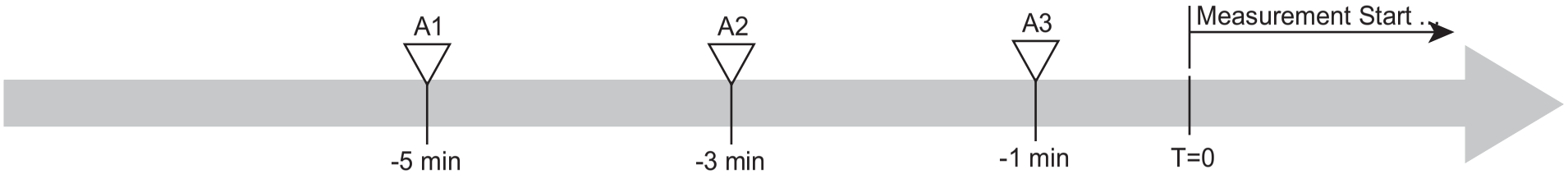
● Irradiance to be calculated

Read, then open

Read, then close

Data Sampling Cycle

Signal of Start

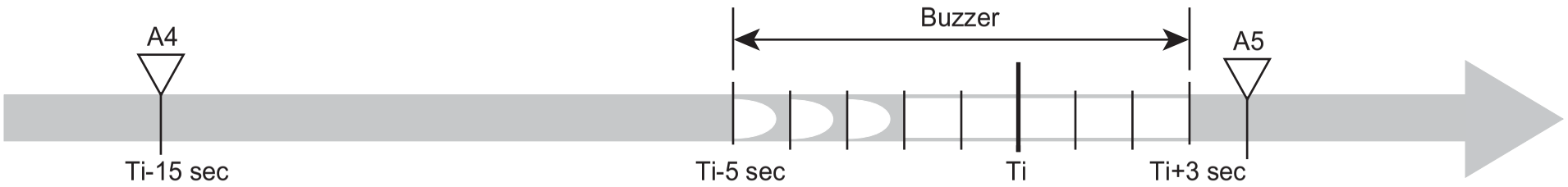


A1: "Measurement will start in five minutes."

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

	WSG & Regional Standard Pyrheliometers				National Standard Pyrheliometers							
	PMO5	PMO6	AHF		HF 20294		PMO6 0102		PMO6 951202		PMO6 0401	
Time	WSG	811107	32446	Average	China		Hong Kong, China		Republic of Korea		WRC	
(hh:mm:ss)	(W m^{-2})	(W m^{-2})	(W m^{-2})	(W m^{-2})	(W m^{-2})	Ratio	(W m^{-2})	Ratio	(W m^{-2})	Ratio	(W m^{-2})	Ratio
25 Jan 2007												
08:31:31	***	743.910	745.071	744.491	746.965	1.003323)	747.910	1.004592	747.718	1.004334	***	***
08:34:31	***	756.661	756.126	756.394	759.661	1.004319)	757.690	1.001713	759.043	1.003502	***	***
08:37:31	770.131	770.422	769.827	770.127	770.300	1.000225	771.340	1.001575	772.134	1.002606	***	***
08:40:31	767.848	765.734	767.739	767.107	766.724	0.999501	770.350	1.004228	769.963	1.003723	751.240	0.979316
08:43:31	759.683	758.268	760.263	759.405	757.426	0.997394)	762.550	1.004141	762.918	1.004626	744.880	0.980873
08:46:31	743.719	744.274	746.384	744.792	748.396	1.004839)	746.010	1.001635	747.547	1.003699	729.070	0.978891
09:34:30	***	823.499	825.895	824.697	822.777	0.997672)	827.750	1.003702	827.796	1.003758	807.940	0.979681
09:37:30	***	828.324	827.750	828.037	825.818	0.997320)	828.510	1.000571)	829.937	1.002295	810.020	0.978241
09:40:30	835.334	834.871	837.157	835.787	833.421	0.997169)	839.000	1.003844	839.773	1.004769	818.640	0.979484
09:43:30	843.893	845.982	845.361	845.079	841.560	0.995836)	845.320	1.000285)	846.591	1.001789	826.810	0.978382
09:46:30	842.369	841.447	844.609	842.808	840.755	0.997564)	845.790	1.003538	845.968	1.003749	826.400	0.980532
10:01:30	874.781	871.199	873.484	873.155	873.358	1.000232	876.250	1.003545	876.200	1.003487	***	***
10:04:30	871.295	873.185	873.458	872.646	872.374	0.999688	874.920	1.002606	874.712	1.002367	853.770	0.978369
10:07:30	876.884	879.685	877.711	878.093	876.671	0.998381)	878.770	1.000771)	880.444	1.002677	858.570	0.977767
10:10:30	880.856	880.677	879.927	880.487	880.163	0.999632	882.550	1.002343	883.077	1.002942	861.880	0.978867
10:13:30	880.466	881.258	881.054	880.926	882.222	1.001471	882.900	1.002241	883.776	1.003235	862.490	0.979072
10:16:30	875.328	876.731	876.298	876.119	878.551	1.002776	877.570	1.001656	877.919	1.002055	857.010	0.978189
10:31:30	883.670	883.696	***	883.683	883.826	1.000162	886.390	1.003063	886.623	1.003327	***	***
10:34:30	882.513	883.679	883.856	883.349	883.466	1.000132	885.480	1.002412	885.313	1.002223	864.690	0.978877
10:37:30	888.044	886.737	886.499	887.093	886.798	0.999667	890.670	1.004032	890.243	1.003551	869.120	0.979739
10:40:30	893.764	894.881	894.243	894.296	891.932	0.997357)	895.190	1.001000	896.080	1.001995	875.030	0.978457
10:43:30	892.301	892.028	892.174	892.168	890.851	0.998524)	894.290	1.002378	893.597	1.001602	873.590	0.979177
11:06:30	886.349	886.384	886.066	886.266	888.555	1.002583	888.040	1.002002	887.979	1.001933	***	***
11:09:30	892.835	895.587	894.993	894.472	903.997	1.010649)	895.920	1.001619	896.395	1.002150	875.190	0.978443
11:12:30	897.242	898.150	898.657	898.016	903.009	1.005560)	901.080	1.003412	900.388	1.002641	878.960	0.978780
11:15:30	901.219	901.694	902.134	901.682	906.331	1.005156)	903.970	1.002537	904.529	1.003157	883.250	0.979558
11:18:30	900.616	904.278	904.057	902.984	903.368	1.000425	906.130	1.003484	905.702	1.003010	884.920	0.979995
11:21:30	905.102	908.901	908.727	907.577	910.641	1.003376)	910.350	1.003055	910.211	1.002902	889.100	0.979641
11:36:30	925.977	922.044	921.195	923.072	920.719	0.997451)	924.160	1.001179	924.053	1.001063)	***	***
11:39:30	915.096	910.896	912.166	912.719	909.289	0.996242)	913.730	1.001108	913.735	1.001113)	891.630	0.976894)
11:42:30	916.590	917.036	916.540	916.722	918.559	1.002004	918.410	1.001841	***	***	898.180	0.979774
11:45:30	933.570	932.440	934.075	933.362	935.120	1.001884	935.160	1.001926	***	***	914.550	0.979845
11:48:30	921.246	926.816	923.506	923.856	925.219	1.001475	924.390	1.000578)	924.590	1.000795)	902.500	0.976884)
11:51:30	914.617	915.839	916.836	915.764	915.049	0.999219	917.990	1.002431	918.252	1.002717	896.580	0.979051
12:06:30	924.858	925.267	925.404	925.176	927.255	1.002247	928.820	1.003939	927.793	1.002829	***	***
12:09:30	919.537	919.285	919.058	919.293	922.750	1.003760)	922.770	1.003782	921.284	1.002166	900.330	0.979372
12:12:30	921.766	921.537	921.588	921.630	924.462	1.003073)	923.360	1.001877	923.393	1.001913	902.580	0.979330
12:15:30	929.217	929.370	929.670	929.419	931.759	1.002518	931.410	1.002142	931.542	1.002284	909.720	0.978805
12:18:30	928.081	928.436	928.172	928.230	929.057	1.000891	930.090	1.002004	929.895	1.001794	908.360	0.978594
12:21:30	926.578	925.341	924.971	925.630	928.786	1.003410)	928.380	1.002971	928.075	1.002641	906.880	0.979744

	WSG & Regional Standard Pyrheliometers				National Standard Pyrheliometers							
	PMO5	PMO6	AHF		HF 20294		PMO6 0102		PMO6 951202		PMO6 0401	
Time	WSG	811107	32446	Average	China		Hong Kong, China		Republic of Korea		WRC	
(hh:mm:ss)	(W m^{-2})	(W m^{-2})	(W m^{-2})	(W m^{-2})	(W m^{-2})	Ratio	(W m^{-2})	Ratio	(W m^{-2})	Ratio	(W m^{-2})	Ratio
13:01:30	913.811	912.596	912.482	912.963	915.686	1.002983)	914.900	1.002122	915.146	1.002391	***	***
13:04:30	917.500	917.205	917.566	917.424	922.262	1.005273)	921.200	1.004116	920.729	1.003602	899.140	0.980070
13:07:30	916.916	917.179	917.481	917.192	920.370	1.003465)	920.170	1.003247	919.100	1.002080	898.290	0.979391
13:10:30	913.816	910.124	913.607	912.516	917.037	1.004954)	915.670	1.003456	916.095	1.003922	895.010	0.980816
13:13:30	914.661	914.686	915.557	914.968	917.037	1.002261	918.020	1.003336	917.716	1.003003	896.410	0.979717
13:16:30	907.148	907.755	907.480	907.461	913.434	1.006582)	910.070	1.002875	910.046	1.002849	887.960	0.978510
13:31:30	904.305	905.570	904.877	904.917	906.222	1.001442	907.310	1.002644	906.305	1.001534	***	***
13:34:30	906.612	906.936	907.444	906.997	908.205	1.001332	909.150	1.002374	909.128	1.002349	888.370	0.979463
13:37:30	905.884	906.410	906.355	906.216	905.592	0.999311	907.280	1.001174	908.294	1.002293	887.080	0.978884
13:40:30	905.456	905.749	906.077	905.761	908.295	1.002798	907.720	1.002163	908.805	1.003361	886.900	0.979177
13:43:30	894.014	894.595	894.060	894.223	894.239	1.000018	896.040	1.002032	896.379	1.002411	875.830	0.979431
13:46:30	895.410	895.842	894.431	895.228	899.645	1.004934)	898.540	1.003700	897.372	1.002395	877.280	0.979951
14:01:30	887.834	889.474	889.309	888.872	889.411	1.000606	890.630	1.001978	891.381	1.002823	***	***
14:04:30	892.409	892.101	891.233	891.914	894.628	1.003043)	893.580	1.001868	893.841	1.002161	872.910	0.978693
14:07:30	878.794	880.531	879.933	879.753	882.396	1.003004)	882.280	1.002872	882.743	1.003399	861.980	0.979798
14:10:30	875.647	876.103	875.058	875.603	876.100	1.000568	877.810	1.002521	877.001	1.001597	856.330	0.977989
14:13:30	873.184	874.076	872.820	873.360	874.931	1.001799	875.170	1.002072	875.505	1.002456	855.050	0.979035
14:16:30	877.065	879.143	878.398	878.202	879.878	1.001908	880.960	1.003141	881.328	1.003560	860.630	0.979991
14:31:30	843.187	842.114	843.263	842.855	843.582	1.000863	845.670	1.003340	845.472	1.003105	***	***
14:34:30	836.127	835.892	836.080	836.033	835.780	0.999697	838.280	1.002688	838.019	1.002375	818.130	0.978586
14:37:30	817.739	818.671	818.440	818.283	813.089	0.993653)	821.130	1.003479	819.913	1.001992	801.240	0.979172
14:40:30	809.322	809.178	808.733	809.078	803.941	0.993651)	810.780	1.002104	810.797	1.002125	792.440	0.979436
14:43:30	802.251	803.302	802.040	802.531	801.071	0.998181)	805.910	1.004210	***	***	785.680	0.979003
14:46:30	796.563	796.508	796.596	796.556	792.013	0.994297)	798.230	1.002101	***	***	779.360	0.978412
15:01:30	765.247	***	766.072	765.660	765.859	1.000260	767.190	1.001998	***	***	***	***
15:04:30	753.894	754.774	753.332	754.000	753.279	0.999044	755.770	1.002348	***	***	738.510	0.979456
15:07:30	734.628	735.371	734.749	734.916	735.667	1.001022	738.230	1.004509	737.882	1.004036	719.740	0.979350
15:10:30	727.878	728.215	728.481	728.191	734.589	1.008786)	731.050	1.003926	730.908	1.003731	713.310	0.979564
15:13:30	722.150	722.937	722.751	722.613	727.849	1.007246)	724.320	1.002362	725.048	1.003370	707.120	0.978560
15:16:30	714.662	716.426	715.106	715.398	720.571	1.007231)	717.210	1.002533	717.828	1.003397	700.230	0.978798
26 Jan 2007												
09:01:30	733.422	741.201	737.195	737.273	733.477	0.994851)	738.530	1.001705	739.880	1.003536	722.020	0.979312
09:04:30	741.721	737.743	742.644	740.703	740.114	0.999205	745.640	1.006665)	745.459	1.006421)	728.070	0.982945)
09:07:30	735.239	734.326	736.137	735.234	734.374	0.998830)	740.120	1.006645)	738.635	1.004626	721.030	0.980681
09:10:30	739.749	746.333	740.217	742.100	738.590	0.995270)	742.870	1.001038	742.892	1.001067)	725.620	0.977793
09:13:30	736.894	739.051	740.316	738.754	735.809	0.996014)	743.980	1.007074)	742.543	1.005129	723.720	0.979649
09:16:30	752.497	755.906	754.788	754.397	751.774	0.996523)	753.720	0.999103)	757.933	1.004687	739.570	0.980346
10:31:30	837.272	835.869	838.476	837.206	837.493	1.000343	839.970	1.003301	841.933	1.005646)	821.460	0.981192)
10:34:30	834.551	836.094	837.988	836.211	837.583	1.001641	839.830	1.004328	840.272	1.004856	820.380	0.981068
10:37:30	828.328	829.700	828.926	828.985	826.796	0.997359)	832.110	1.003770	830.082	1.001323	810.450	0.977641

	WSG & Regional Standard Pyrheliometers				National Standard Pyrheliometers							
	PMO5	PMO6	AHF		HF 20294		PMO6 0102		PMO6 951202		PMO6 0401	
Time	WSG	811107	32446	Average	China		Hong Kong, China		Republic of Korea		WRC	
(hh:mm:ss)	(W m^{-2})	(W m^{-2})	(W m^{-2})	(W m^{-2})	(W m^{-2})	Ratio	(W m^{-2})	Ratio	(W m^{-2})	Ratio	(W m^{-2})	Ratio
10:40:30	823.037	824.036	823.500	823.524	823.739	1.000261	827.480	1.004804)	827.594	1.004942	807.570	0.980627
10:43:30	796.526	797.094	794.831	796.150	795.781	0.999536	802.690	1.008215)	801.221	1.006369)	781.620	0.981750)
10:46:30	828.826	828.887	827.827	828.513	828.773	1.000314	831.250	1.003304	831.058	1.003072	813.210	0.981530)
11:01:30	835.173	836.172	835.754	835.700	836.263	1.000674	838.900	1.003829	839.368	1.004389	818.980	0.979993
11:04:30	826.876	828.415	827.737	827.676	828.012	1.000406	830.400	1.003291	829.823	1.002594	810.840	0.979659
11:07:30	831.106	832.638	832.548	832.097	831.151	0.998863	833.510	1.001698	835.136	1.003652	815.590	0.980162
11:10:30	814.224	815.026	813.621	814.290	813.395	0.998901	817.960	1.004507	816.074	1.002191	798.560	0.980683
11:13:30	818.530	823.476	819.953	820.653	819.672	0.998805)	823.700	1.003713	821.130	1.000581)	803.420	0.979001
11:16:30	813.743	815.087	814.545	814.458	813.664	0.999025	817.880	1.004202	818.471	1.004927	798.880	0.980873
27 Jan 2007												
09:31:30	779.762	788.201	784.596	784.186	782.764	0.998187)	784.580	1.000502)	785.790	1.002045	764.710	0.975164)
09:34:30	784.587	784.522	783.206	784.105	781.779	0.997034)	788.920	1.006141)	786.840	1.003488	768.290	0.979831
09:37:30	793.003	797.039	795.354	795.132	795.390	1.000324	794.320	0.998979)	798.824	1.004643	778.090	0.978567
09:40:30	806.351	810.088	808.079	808.173	806.674	0.998145)	804.270	0.995171)	811.205	1.003752	791.170	0.978961
09:43:30	800.688	796.210	795.349	797.416	793.420	0.994989)	800.410	1.003755	805.021	1.009537)	783.220	0.982197)
09:46:30	822.657	825.208	823.738	823.868	819.032	0.994130)	818.260	0.993193)	827.537	1.004453	805.910	0.978203
10:01:30	851.799	848.989	850.008	850.265	851.068	1.000944	854.110	1.004522	851.620	1.001594	832.030	0.978554
10:04:30	862.203	861.002	862.258	861.821	865.441	1.004200)	869.100	1.008446)	863.959	1.002481	843.760	0.979043
10:07:30	846.735	855.157	857.512	853.135	845.408	0.990943)	854.640	1.001764	855.744	1.003058	830.760	0.973773)
10:10:30	846.432	843.794	848.056	846.094	846.666	1.000676	857.620	1.013623)	848.150	1.002430	827.740	0.978307
10:13:30	873.111	862.320	870.507	868.646	867.417	0.998585)	879.750	1.012783)	880.070	1.013152)	850.250	0.978822
10:16:30	880.980	883.669	881.821	882.157	879.634	0.997140)	870.860	0.987194)	884.947	1.003163	865.460	0.981073
10:31:31	900.392	900.367	897.337	899.365	899.833	1.000520	906.190	1.007589)	896.690	0.997026)	878.120	0.976378)
10:34:31	891.803	887.005	883.457	887.422	886.442	0.998896	894.470	1.007942)	885.404	0.997726)	870.720	0.981179)
10:37:31	899.342	909.061	906.738	905.047	901.270	0.995827)	904.120	0.998976)	910.529	1.006057)	882.600	0.975198)
10:40:31	910.365	905.797	907.621	907.928	908.819	1.000981	912.210	1.004716	910.348	1.002665	890.930	0.981278)
10:43:31	897.833	908.113	901.380	902.442	898.754	0.995913)	900.900	0.998291)	902.215	0.999748)	879.440	0.974511)
10:46:31	934.327	929.505	931.010	931.614	931.286	0.999648	932.470	1.000919	934.306	1.002890	914.480	0.981608)
11:01:30	924.675	927.765	925.323	925.921	924.910	0.998908	928.610	1.002904	925.867	0.999942)	904.620	0.976995)
11:04:30	910.985	917.553	915.581	914.706	912.383	0.997460)	909.360	0.994155)	916.316	1.001760	893.270	0.976565)
11:07:30	920.432	915.182	924.630	920.081	921.936	1.002016	926.870	1.007379)	927.340	1.007890)	902.020	0.980370
11:10:30	913.588	910.963	911.741	912.097	913.465	1.001500	916.090	1.004378	914.891	1.003063	894.570	0.980784
11:13:30	914.339	918.065	917.975	916.793	919.052	1.002464	913.820	0.996757)	916.282	0.999443)	894.820	0.976033)
11:16:30	891.479	887.000	893.705	890.728	894.540	1.004280)	896.140	1.006076)	892.461	1.001946	872.640	0.979693
11:31:30	890.426	888.815	887.677	888.973	889.636	1.000746	898.190	1.010368)	890.597	1.001827	869.780	0.978410
11:34:30	887.499	890.716	888.031	888.749	886.846	0.997859)	880.460	0.990673)	890.103	1.001523	869.510	0.978353
11:37:30	877.401	877.084	873.261	875.915	877.128	1.001385	879.780	1.004413	877.836	1.002193	858.470	0.980084
11:40:30	894.743	893.903	894.773	894.473	895.214	1.000828	900.110	1.006302)	897.776	1.003693	876.050	0.979403
11:43:30	884.224	883.556	882.167	883.316	883.877	1.000635	892.020	1.009854)	885.779	1.002788	866.370	0.980815
11:46:30	895.552	895.285	890.713	893.850	897.284	1.003842)	898.410	1.005102)	895.297	1.001619	876.600	0.980701

	WSG & Regional Standard Pyrheliometers				National Standard Pyrheliometers							
	PMO5	PMO6	AHF		HF 20294		PMO6 0102		PMO6 951202		PMO6 0401	
Time	WSG	811107	32446	Average	China		Hong Kong, China		Republic of Korea		WRC	
(hh:mm:ss)	(W m^{-2})	(W m^{-2})	(W m^{-2})	(W m^{-2})	(W m^{-2})	Ratio	(W m^{-2})	Ratio	(W m^{-2})	Ratio	(W m^{-2})	Ratio
12:01:30	868.402	867.323	869.095	868.273	870.003	1.001992	874.590	1.007275)	870.678	1.002770	850.360	0.979369
12:04:30	853.039	853.064	852.537	852.880	853.032	1.000178	858.610	1.006718)	855.119	1.002625	834.430	0.978367
12:07:30	853.021	853.469	852.241	852.910	857.881	1.005828)	855.740	1.003318	855.244	1.002737	834.870	0.978849
12:10:30	877.486	879.806	879.254	878.849	879.701	1.000969	876.230	0.997020)	880.836	1.002261	859.520	0.978006
12:13:30	876.204	882.637	880.296	879.712	888.231	1.009684)	875.250	0.994928)	882.421	1.003079	860.340	0.977979
12:16:30	899.918	894.842	901.133	898.631	903.227	1.005114)	903.030	1.004895)	905.210	1.007321)	882.230	0.981749)
12:31:30	874.592	875.620	876.958	875.723	874.061	0.998102)	880.230	1.005147)	877.607	1.002151	856.070	0.977558
12:34:30	880.774	884.208	883.625	882.869	882.786	0.999906	884.120	1.001417	884.831	1.002222	863.400	0.977948
12:37:30	856.683	***	858.171	857.427	***	***	862.320	1.005707)	857.661	1.000273)	838.260	0.977646
12:40:30	864.933	862.727	864.329	863.996	***	***	869.090	1.005896)	867.239	1.003754	846.330	0.979553
12:43:30	873.407	877.219	875.144	875.257	878.738	1.003977)	877.040	1.002037	877.930	1.003054	855.580	0.977519
12:46:30	868.372	868.842	861.941	866.385	867.676	1.001490	870.830	1.005131)	869.139	1.003179	850.160	0.981273)
13:01:30	879.631	***	879.677	879.654	879.004	0.999261	882.560	1.003304	880.937	1.001459	860.750	0.978510
13:04:30	872.910	***	873.200	873.055	872.722	0.999619	875.500	1.002801	874.318	1.001447	854.250	0.978461
13:07:30	876.704	***	876.251	876.478	874.248	0.997456)	877.830	1.001543	879.725	1.003705	856.900	0.977663
13:10:30	864.148	***	863.945	864.047	862.940	0.998719)	865.580	1.001774	866.735	1.003111	844.190	0.977019)
13:13:30	851.626	***	850.757	851.192	850.825	0.999569	854.320	1.003675	854.906	1.004363	832.520	0.978064
13:16:30	840.449	***	840.426	840.438	838.441	0.997624)	843.660	1.003834	846.191	1.006845)	823.050	0.979311
13:31:30	843.724	***	843.293	843.509	845.786	1.002699	846.940	1.004068	844.960	1.001720	825.010	0.978069
13:34:30	834.311	***	831.986	833.149	833.100	0.999941	835.760	1.003134	834.530	1.001658	813.960	0.976968)
13:37:30	813.281	***	813.040	813.161	815.107	1.002393	815.210	1.002520	814.345	1.001456	795.640	0.978453
13:40:30	815.260	***	814.464	814.862	816.906	1.002508	819.870	1.006146)	819.779	1.006034)	798.550	0.979982
13:43:30	819.785	***	819.270	819.527	820.595	1.001303	822.650	1.003811	823.370	1.004689	803.150	0.980017
13:46:30	799.192	***	800.692	799.942	800.442	1.000625	800.260	1.000398)	804.549	1.005759)	783.600	0.979571
14:01:30	792.709	***	792.227	792.468	794.082	1.002037	803.390	1.013782)	792.402	0.999917)	776.490	0.979838
14:04:30	794.339	***	795.367	794.853	795.707	1.001074	796.420	1.001971	798.032	1.003999	778.720	0.979703
14:07:30	799.879	***	798.970	799.425	799.768	1.000429	799.440	1.000019)	802.843	1.004276	783.200	0.979704
14:10:30	801.071	***	800.304	800.688	802.475	1.002232	802.530	1.002301	801.933	1.001555	783.480	0.978508
14:13:30	802.646	***	802.430	802.538	804.731	1.002733	803.650	1.001386	805.445	1.003622	784.840	0.977947
14:16:30	800.010	***	801.071	800.541	802.836	1.002867)	802.150	1.002010	803.908	1.004206	784.400	0.979837
14:34:30	773.686	***	773.781	773.734	777.451	1.004804)	776.240	1.003239	774.064	1.000427)	756.000	0.977080)
14:37:30	765.920	***	765.247	765.584	766.016	1.000564	***	***	768.038	1.003205	748.430	0.977594
14:40:30	727.037	726.264	729.159	727.487	730.178	1.003699)	***	***	731.270	1.005200)	713.600	0.980911
14:43:30	734.371	734.900	733.626	734.299	735.220	1.001254	***	***	737.015	1.003699	718.620	0.978648
14:46:30	735.019	732.657	732.281	733.319	734.860	1.002101	***	***	736.842	1.004804	718.510	0.979806
15:01:30	721.490	722.486	724.497	722.824	723.644	1.001134	725.350	1.003495	725.860	1.004200	707.110	0.978260
15:04:30	712.323	709.472	715.263	712.353	712.418	1.000091	714.790	1.003421	716.632	1.006007)	698.230	0.980174
15:07:30	705.036	707.692	706.201	706.310	708.826	1.003562)	706.700	1.000552)	707.620	1.001855	690.680	0.977871
15:10:30	690.555	693.410	690.572	691.512	694.727	1.004649)	698.380	1.009932)	693.287	1.002567	676.350	0.978074
15:13:30	674.264	668.569	677.066	673.300	673.264	0.999947	673.870	1.000847	678.284	1.007402)	660.450	0.980915
15:16:30	679.915	682.812	681.685	681.471	684.669	1.004693)	681.440	0.999955)	683.283	1.002659	666.690	0.978310

	WSG & Regional Standard Pyrheliometers				National Standard Pyrheliometers							
	PMO5	PMO6	AHF		HF 20294		PMO6 0102		PMO6 951202		PMO6 0401	
Time	WSG	811107	32446	Average	China		Hong Kong, China		Republic of Korea		WRC	
(hh:mm:ss)	(W m^{-2})	(W m^{-2})	(W m^{-2})	(W m^{-2})	(W m^{-2})	Ratio	(W m^{-2})	Ratio	(W m^{-2})	Ratio	(W m^{-2})	Ratio
30 Jan 2007												
08:31:31	797.862	800.199	798.449	798.837	799.707	1.001089	800.420	1.001982	***	***	782.170	0.979136
08:34:31	803.741	801.914	803.802	803.152	804.993	1.002292	805.910	1.003434	***	***	787.420	0.980412
08:37:31	810.680	803.184	809.976	807.947	811.803	1.004773)	811.720	1.004670	***	***	793.810	0.982503)
08:40:31	816.316	817.515	816.207	816.679	814.581	0.997431)	818.940	1.002769	***	***	800.040	0.979626
08:43:31	826.435	827.732	826.218	826.795	829.813	1.003650)	828.940	1.002594	***	***	810.070	0.979771
08:46:31	826.795	829.561	828.206	828.187	831.784	1.004343)	830.290	1.002539	***	***	811.330	0.979646
09:01:30	857.864	859.633	858.005	858.501	862.168	1.004271)	859.850	1.001571	864.103	1.006525)	841.370	0.980045
09:04:30	860.214	862.841	861.781	861.612	858.482	0.996367)	863.680	1.002400	868.197	1.007643)	844.070	0.979640
09:07:30	870.363	870.515	869.594	870.157	868.280	0.997843)	872.120	1.002256	877.706	1.008675)	852.310	0.979490
09:10:30	874.266	874.637	873.738	874.214	870.078	0.995269)	875.420	1.001380	875.376	1.001329	856.210	0.979406
09:13:30	871.449	872.765	872.691	872.302	868.730	0.995905)	876.320	1.004606	875.062	1.003164	854.400	0.979477
09:16:30	876.192	876.295	876.501	876.329	873.315	0.996561)	878.010	1.001918	881.295	1.005667)	858.940	0.980157
09:31:30	899.407	899.468	899.596	899.490	900.548	1.001176	901.530	1.002268	903.954	1.004963	881.060	0.979511
09:34:30	903.215	904.063	903.339	903.539	903.966	1.000473	904.990	1.001606	911.659	1.008987)	886.080	0.980677
09:37:30	909.288	910.875	909.465	909.876	911.971	1.002303	910.390	1.000565)	912.169	1.002520	891.170	0.979441
09:40:30	909.376	908.526	909.699	909.200	912.151	1.003246)	912.090	1.003179	912.504	1.003634	890.610	0.979553
09:43:30	915.392	913.936	916.214	915.181	918.807	1.003962)	918.000	1.003080	918.987	1.004159	897.610	0.980800
09:46:30	917.682	917.791	917.158	917.544	917.907	1.000396	917.830	1.000312)	920.571	1.003299	898.430	0.979168
10:01:30	929.197	932.344	929.718	930.420	926.655	0.995953)	932.450	1.002182	933.970	1.003815	909.920	0.977967
10:04:30	930.900	932.625	931.273	931.599	930.787	0.999128	933.820	1.002384	933.668	1.002221	911.810	0.978758
10:07:30	917.530	919.249	918.409	918.396	917.941	0.999505	920.430	1.002215	919.558	1.001265	897.890	0.977672
10:10:30	934.186	935.188	934.030	934.468	934.649	1.000194	936.300	1.001960	937.818	1.003585	914.300	0.978418
10:13:30	944.845	945.781	945.164	945.263	944.351	0.999035	947.180	1.002028	947.828	1.002714	925.740	0.979346
10:16:30	945.731	945.413	945.740	945.628	945.967	1.000358	948.490	1.003027	948.238	1.002760	925.960	0.979201
10:31:30	953.765	953.376	953.742	953.628	955.511	1.001975	955.940	1.002424	955.865	1.002346	933.610	0.979009
10:34:30	951.063	954.313	953.073	952.816	951.909	0.999048	954.190	1.001442	954.464	1.001730	932.620	0.978804
10:37:30	958.161	960.699	959.816	959.559	960.374	1.000849	959.880	1.000335)	961.852	1.002390	939.010	0.978585
10:40:30	959.678	959.272	959.138	959.363	961.544	1.002273	961.780	1.002519	961.663	1.002397	939.570	0.979369
10:43:30	957.391	957.623	957.961	957.658	960.104	1.002554	961.190	1.003688	961.231	1.003731	937.830	0.979295
10:46:30	955.629	954.158	957.838	955.875	959.924	1.004236)	958.220	1.002453	961.159	1.005528)	935.810	0.979009
11:01:30	953.264	956.019	954.042	954.442	955.780	1.001402	955.990	1.001622	956.073	1.001709	933.380	0.977933
11:04:30	963.088	961.480	964.317	962.962	963.709	1.000776	964.300	1.001389	965.998	1.003153	943.120	0.979395
11:07:30	962.240	962.163	962.252	962.218	963.800	1.001644	964.410	1.002278	964.220	1.002081	941.660	0.978635
11:10:30	961.855	963.473	961.783	962.370	963.619	1.001298	964.410	1.002120	963.418	1.001089)	940.830	0.977618
11:13:30	960.649	958.829	961.269	960.249	962.718	1.002571	963.130	1.003000	963.914	1.003817	940.610	0.979548
11:16:30	964.080	963.248	963.745	963.691	969.296	1.005816)	965.430	1.001805	966.454	1.002867	943.460	0.979007
15:01:30	847.614	849.959	849.434	849.002	847.823	0.998611)	851.850	1.003354	852.660	1.004309	832.480	0.980539
15:04:30	843.699	845.351	843.930	844.327	843.698	0.999255	847.260	1.003474	846.980	1.003142	825.670	0.977903
15:07:30	826.516	826.405	825.750	826.224	824.690	0.998143)	828.430	1.002670	828.680	1.002973	809.110	0.979286

	WSG & Regional Standard Pyrheliometers				National Standard Pyrheliometers							
	PMO5	PMO6	AHF		HF 20294		PMO6 0102		PMO6 951202		PMO6 0401	
Time	WSG	811107	32446	Average	China		Hong Kong, China		Republic of Korea		WRC	
(hh:mm:ss)	(W m^{-2})	(W m^{-2})	(W m^{-2})	(W m^{-2})	(W m^{-2})	Ratio	(W m^{-2})	Ratio	(W m^{-2})	Ratio	(W m^{-2})	Ratio
15:10:30	816.973	816.239	816.653	816.622	815.993	0.999230	819.060	1.002985	818.662	1.002498	799.510	0.979045
15:13:30	810.703	810.145	809.182	810.010	809.000	0.998753)	812.830	1.003481	813.073	1.003781	793.670	0.979827
15:16:30	799.549	799.763	798.888	799.400	796.896	0.996868)	802.630	1.004041	801.952	1.003192	782.710	0.979122
15:31:30	741.306	741.450	741.085	741.280	741.515	1.000317	743.890	1.003521	743.917	1.003557	725.770	0.979077
15:34:30	729.136	727.473	727.370	727.993	727.841	0.999791	730.670	1.003677	730.005	1.002764	713.000	0.979405
15:37:30	718.978	719.402	718.452	718.944	718.036	0.998737)	720.810	1.002596	721.623	1.003726	704.040	0.979270
15:40:30	703.520	703.049	702.201	702.923	703.643	1.001024	705.320	1.003410	705.295	1.003374	687.680	0.978315
15:43:30	691.520	691.574	690.209	691.101	690.419	0.999013	693.330	1.003225	693.141	1.002952	676.790	0.979292
15:46:30	675.150	676.030	675.880	675.687	677.286	1.002366	678.050	1.003497	678.237	1.003774	662.470	0.980439
31 Jan 2007												
08:31:31	746.209	746.753	746.303	746.422	749.617	1.004280)	749.070	1.003548	748.887	1.003302	730.580	0.978776
08:34:31	753.369	752.964	752.488	752.940	756.907	1.005269)	755.280	1.003108	755.185	1.002982	737.540	0.979547
08:37:31	762.971	763.682	763.646	763.433	766.537	1.004066)	765.680	1.002943	766.311	1.003770	746.840	0.978265
08:40:31	765.941	766.462	763.923	765.442	767.797	1.003077)	767.800	1.003081	766.135	1.000905)	749.580	0.979277
08:43:31	784.255	782.921	783.948	783.708	786.247	1.003240)	787.840	1.005272)	788.236	1.005778)	768.310	0.980352
08:46:31	801.584	803.237	800.707	801.843	803.617	1.002212	803.700	1.002316	803.728	1.002351	784.400	0.978246
09:01:28	837.793	839.903	838.003	838.566	838.550	0.999981	840.190	1.001937	840.650	1.002485	820.920	0.978957
09:04:28	844.148	846.206	843.896	844.750	844.121	0.999255	845.330	1.000687)	846.880	1.002521	826.740	0.978680
09:07:28	843.045	845.751	845.096	844.631	845.739	1.001312	847.240	1.003089	849.599	1.005882)	827.240	0.979410
09:10:28	852.950	849.818	852.178	851.649	853.736	1.002451	854.660	1.003535	855.388	1.004390	834.810	0.980228
09:13:28	856.227	855.887	856.532	856.215	856.791	1.000673	858.880	1.003113	861.326	1.005969)	839.000	0.979894
09:16:28	863.638	864.116	863.310	863.688	865.148	1.001690	865.740	1.002376	865.532	1.002135	844.920	0.978270
09:31:30	881.770	883.835	882.747	882.784	882.091	0.999215	883.600	1.000924	887.256	1.005066	863.490	0.978144
09:34:30	888.151	884.546	887.526	886.741	887.066	1.000366	889.840	1.003495	890.625	1.004380	868.920	0.979903
09:37:30	885.487	888.817	886.598	886.967	888.241	1.001436	888.760	1.002022	888.731	1.001989	867.610	0.978176
09:40:30	894.149	895.680	894.996	894.942	895.748	1.000901	897.690	1.003071	897.235	1.002562	875.100	0.977829
09:43:30	896.552	895.907	896.674	896.378	897.195	1.000911	898.900	1.002814	900.119	1.004173	877.840	0.979319
09:46:30	904.184	907.888	903.773	905.282	905.245	0.999959	904.260	0.998871)	905.094	0.999792)	885.360	0.977994
10:01:30	911.941	915.099	916.299	914.446	916.746	1.002515	914.590	1.000158)	916.894	1.002677	896.740	0.980637
10:04:30	930.039	928.075	929.628	929.247	929.681	1.000467	930.790	1.001660	932.028	1.002993	911.160	0.980536
10:07:30	922.951	922.800	922.619	922.790	923.034	1.000264	924.600	1.001961	925.430	1.002861	903.440	0.979031
10:10:30	916.948	916.681	916.827	916.819	919.081	1.002467	918.860	1.002226	919.498	1.002922	898.190	0.979681
10:13:30	914.698	914.228	915.509	914.812	916.477	1.001820	915.900	1.001189	918.093	1.003587	895.170	0.978529
10:16:30	925.977	925.202	924.650	925.276	926.447	1.001266	929.510	1.004576	928.476	1.003458	906.540	0.979751
11:01:30	934.868	936.888	937.116	936.291	940.619	1.004622)	937.280	1.001056	939.615	1.003550	916.440	0.978798
11:04:30	940.298	939.580	940.464	940.114	946.664	1.006967)	942.220	1.002240	943.536	1.003640	921.320	0.980009
11:07:30	941.702	942.043	942.270	942.005	946.032	1.004275)	945.190	1.003381	943.549	1.001639	922.130	0.978901
11:10:30	945.974	941.931	944.826	944.244	949.280	1.005333)	949.420	1.005482)	947.918	1.003891	926.060	0.980742
11:13:30	945.276	942.999	943.512	943.929	948.559	1.004905)	946.540	1.002766	946.532	1.002758	924.630	0.979555
11:16:30	949.314	947.787	951.560	949.554	955.054	1.005792)	951.520	1.002070	952.806	1.003425	930.480	0.979913

	WSG & Regional Standard Pyrheliometers				National Standard Pyrheliometers				Support Pyrheliometers	
	PMO5	PMO6	AHF		AHF 32455		PMO6 960801		CH1 970139	
Time	WSG	811107	32446	Average	WRC		Japan		Japan	
(hh:mm:ss)	(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 2007										
08:31:31	***	743.910	745.071	744.491	***	***	746.138	1.002212	747.574	1.004141)
08:34:31	***	756.661	756.126	756.394	***	***	756.083	0.999589	758.289	1.002505
08:37:31	770.131	770.422	769.827	770.127	770.408	1.000365	770.796	1.000869	771.644	1.001970
08:40:31	767.848	765.734	767.739	767.107	768.122	1.001323	769.308	1.002869	769.547	1.003181
08:43:31	759.683	758.268	760.263	759.405	760.630	1.001613	760.617	1.001596	762.404	1.003949)
08:46:31	743.719	744.274	746.384	744.792	744.570	0.999702	745.514	1.000969	747.807	1.004048)
09:34:30	***	823.499	825.895	824.697	825.320	1.000755	825.852	1.001400	826.151	1.001763
09:37:30	***	828.324	827.750	828.037	827.618	0.999494	827.813	0.999729	828.403	1.000442
09:40:30	835.334	834.871	837.157	835.787	835.451	0.999598	837.799	1.002407	838.031	1.002685
09:43:30	843.893	845.982	845.361	845.079	844.838	0.999715	845.312	1.000276	846.106	1.001215
09:46:30	842.369	841.447	844.609	842.808	843.325	1.000613	845.205	1.002844	845.252	1.002900
10:01:30	874.781	871.199	873.484	873.155	873.810	1.000750	874.463	1.001498	874.602	1.001657
10:04:30	871.295	873.185	873.458	872.646	872.179	0.999465	874.300	1.001895	874.214	1.001797
10:07:30	876.884	879.685	877.711	878.093	877.672	0.999521	877.643	0.999488	878.795	1.000799
10:10:30	880.856	880.677	879.927	880.487	880.343	0.999836	880.714	1.000258	881.668	1.001341
10:13:30	880.466	881.258	881.054	880.926	881.265	1.000385	881.871	1.001073	882.522	1.001812
10:16:30	875.328	876.731	876.298	876.119	875.705	0.999527	876.495	1.000429	877.475	1.001548
10:31:30	883.670	883.696	***	883.683	883.727	1.000050	884.992	1.001481	885.162	1.001674
10:34:30	882.513	883.679	883.856	883.349	883.120	0.999741	884.772	1.001611	884.541	1.001349
10:37:30	888.044	886.737	886.499	887.093	887.371	1.000313	887.995	1.001017	888.734	1.001850
10:40:30	893.764	894.881	894.243	894.296	893.726	0.999363	894.264	0.999964	895.489	1.001334
10:43:30	892.301	892.028	892.174	892.168	892.186	1.000020	892.464	1.000332	892.305	1.000154
11:06:30	886.349	886.384	886.066	886.266	885.572	0.999217	887.173	1.001023	886.792	1.000594
11:09:30	892.835	895.587	894.993	894.472	894.510	1.000043	895.956	1.001659	895.489	1.001137
11:12:30	897.242	898.150	898.657	898.016	897.698	0.999646	899.815	1.002003	899.216	1.001336
11:15:30	901.219	901.694	902.134	901.682	901.895	1.000236	902.805	1.001245	903.176	1.001657
11:18:30	900.616	904.278	904.057	902.984	903.606	1.000689	904.372	1.001537	904.030	1.001158
11:21:30	905.102	908.901	908.727	907.577	907.298	0.999693	909.136	1.001718	909.077	1.001653
11:36:30	925.977	922.044	921.195	923.072	921.038	0.997796)	923.239	1.000181	921.500	0.998297)
11:39:30	915.096	910.896	912.166	912.719	910.523	0.997594)	912.235	0.999470	911.794	0.998987)
11:42:30	916.590	917.036	916.540	916.722	917.235	1.000560	916.449	0.999702	916.764	1.000046
11:45:30	933.570	932.440	934.075	933.362	932.852	0.999454	933.854	1.000527	932.759	0.999354)
11:48:30	921.246	926.816	923.506	923.856	921.640	0.997601)	923.324	0.999424	923.208	0.999299)
11:51:30	914.617	915.839	916.836	915.764	915.402	0.999605	915.896	1.000144	916.298	1.000583
12:06:30	924.858	925.267	925.404	925.176	925.268	1.000099	927.342	1.002341	926.780	1.001734
12:09:30	919.537	919.285	919.058	919.293	919.439	1.000159	920.340	1.001139	920.568	1.001387
12:12:30	921.766	921.537	921.588	921.630	923.144	1.001643	921.728	1.000106	922.044	1.000449
12:15:30	929.217	929.370	929.670	929.419	929.079	0.999634	929.030	0.999581	930.119	1.000753
12:18:30	928.081	928.436	928.172	928.230	927.657	0.999383	928.397	1.000180	929.731	1.001617
12:21:30	926.578	925.341	924.971	925.630	925.594	0.999961	926.403	1.000835	926.314	1.000739

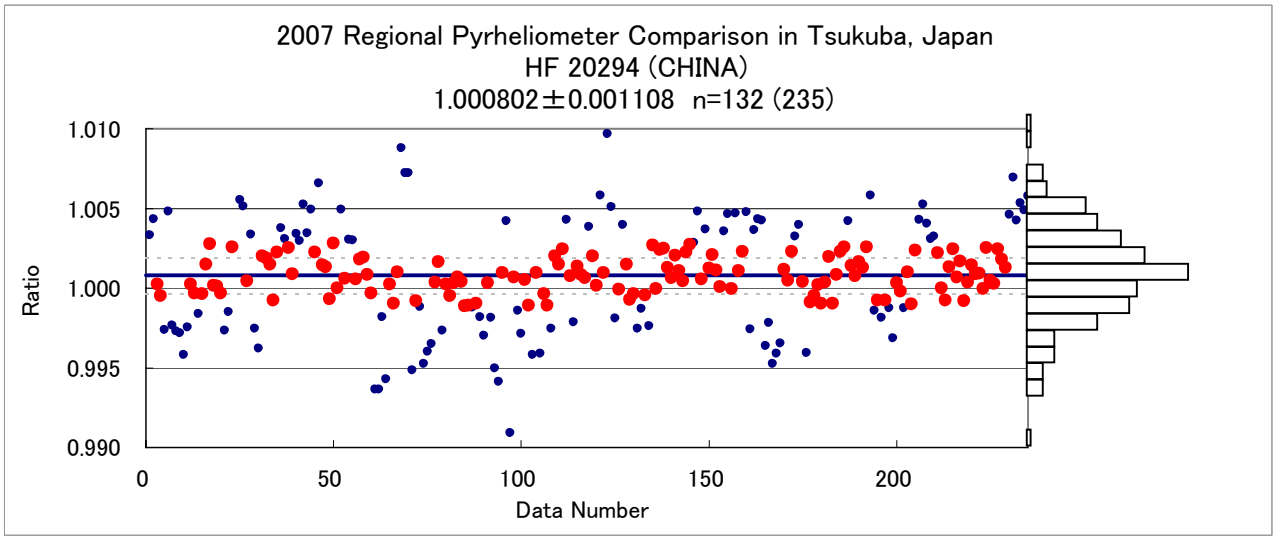
	WSG & Regional Standard Pyrheliometers				National Standard Pyrheliometers				Support Pyrheliometers	
	PMO5	PMO6	AHF		AHF 32455		PMO6 960801		CH1 970139	
Time	WSG	811107	32446	Average	WRC		Japan		Japan	
(hh:mm:ss)	(W m^{-2})	(W m^{-2})	(W m^{-2})	(W m^{-2})	(W m^{-2})	Ratio	(W m^{-2})	Ratio	(W m^{-2})	Ratio
13:01:30	913.811	912.596	912.482	912.963	912.439	0.999426	914.836	1.002052	913.813	1.000931
13:04:30	917.500	917.205	917.566	917.424	918.087	1.000723	918.774	1.001471	918.938	1.001650
13:07:30	916.916	917.179	917.481	917.192	918.169	1.001065	917.846	1.000713	918.860	1.001819
13:10:30	913.816	910.124	913.607	912.516	914.511	1.002186	914.234	1.001883	914.512	1.002187
13:13:30	914.661	914.686	915.557	914.968	916.564	1.001744	915.697	1.000797	916.608	1.001792
13:16:30	907.148	907.755	907.480	907.461	907.630	1.000186	908.165	1.000776	908.689	1.001353
13:31:30	904.305	905.570	904.877	904.917	904.689	0.999748	906.470	1.001716	905.272	1.000392
13:34:30	906.612	906.936	907.444	906.997	907.435	1.000483	907.545	1.000604	907.757	1.000838
13:37:30	905.884	906.410	906.355	906.216	906.778	1.000620	906.225	1.000010	907.369	1.001272
13:40:30	905.456	905.749	906.077	905.761	906.533	1.000852	907.534	1.001957	907.369	1.001775
13:43:30	894.014	894.595	894.060	894.223	894.673	1.000503	894.740	1.000578	895.256	1.001155
13:46:30	895.410	895.842	894.431	895.228	895.350	1.000136	895.817	1.000658	896.188	1.001072
14:01:30	887.834	889.474	889.309	888.872	889.557	1.000771	891.034	1.002432	891.374	1.002815
14:04:30	892.409	892.101	891.233	891.914	891.489	0.999524	892.792	1.000984	893.315	1.001571
14:07:30	878.794	880.531	879.933	879.753	881.525	1.002014	880.814	1.001206	882.367	1.002971
14:10:30	875.647	876.103	875.058	875.603	875.062	0.999382	876.189	1.000669	877.087	1.001695
14:13:30	873.184	874.076	872.820	873.360	874.064	1.000806	874.100	1.000847	874.990	1.001866
14:16:30	877.065	879.143	878.398	878.202	879.573	1.001561	879.828	1.001851	880.891	1.003062
14:31:30	843.187	842.114	843.263	842.855	842.829	0.999969	844.034	1.001399	843.932	1.001278
14:34:30	836.127	835.892	836.080	836.033	836.294	1.000312	836.299	1.000318	836.711	1.000811
14:37:30	817.739	818.671	818.440	818.283	818.161	0.999851	819.034	1.000918	819.706	1.001739
14:40:30	809.322	809.178	808.733	809.078	809.014	0.999921	810.273	1.001477	810.311	1.001524
14:43:30	802.251	803.302	802.040	802.531	802.596	1.000081	803.096	1.000704	803.556	1.001277
14:46:30	796.563	796.508	796.596	796.556	795.430	0.998586	796.815	1.000325	797.577	1.001282
15:01:30	765.247	***	766.072	765.660	766.137	1.000623	***	***	767.917	1.002948
15:04:30	753.894	754.774	753.332	754.000	753.941	0.999922	755.748	1.002318	755.493	1.001980
15:07:30	734.628	735.371	734.749	734.916	734.597	0.999566	736.872	1.002662	736.315	1.001904
15:10:30	727.878	728.215	728.481	728.191	728.758	1.000779	729.089	1.001233	730.414	1.003053
15:13:30	722.150	722.937	722.751	722.613	722.432	0.999750	723.875	1.001746	724.590	1.002736
15:16:30	714.662	716.426	715.106	715.398	714.856	0.999242	717.227	1.002557	717.602	1.003081
26 Jan 2007										
09:01:30	733.422	741.201	737.195	737.273	737.199	0.999900	739.558	1.003099	741.517	1.005756)
09:04:30	741.721	737.743	742.644	740.703	743.226	1.003406)	743.997	1.004447)	746.564	1.007913)
09:07:30	735.239	734.326	736.137	735.234	735.690	1.000620	738.514	1.004461)	740.430	1.007067)
09:10:30	739.749	746.333	740.217	742.100	740.423	0.997740)	741.999	0.999864	744.235	1.002877
09:13:30	736.894	739.051	740.316	738.754	740.669	1.002592)	742.270	1.004759)	744.545	1.007839)
09:16:30	752.497	755.906	754.788	754.397	754.646	1.000330	755.659	1.001673	760.230	1.007732)
10:31:30	837.272	835.869	838.476	837.206	838.058	1.001018	839.603	1.002863	841.836	1.005530)
10:34:30	834.551	836.094	837.988	836.211	837.630	1.001697	838.703	1.002980	840.205	1.004776)
10:37:30	828.328	829.700	828.926	828.985	827.983	0.998791	830.574	1.001917	831.431	1.002951

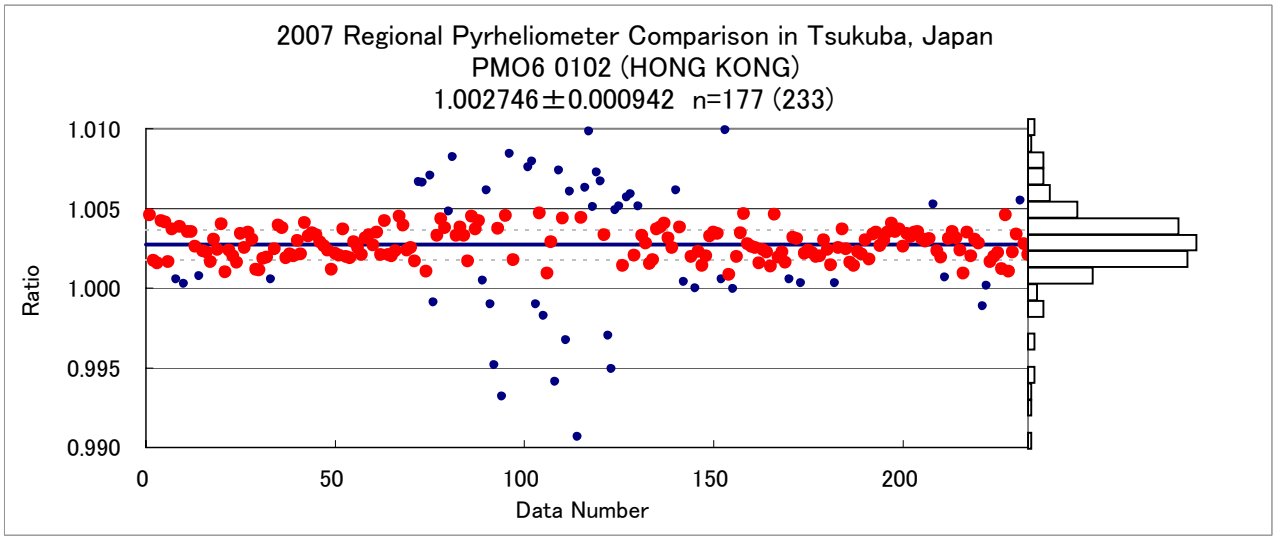
	WSG & Regional Standard Pyrheliometers				National Standard Pyrheliometers				Support Pyrheliometers	
	PMO5	PMO6	AHF		AHF 32455		PMO6 960801		CH1 970139	
Time	WSG	811107	32446	Average	WRC		Japan		Japan	
(hh:mm:ss)	(W m^{-2})	(W m^{-2})	(W m^{-2})	(W m^{-2})	(W m^{-2})	Ratio	(W m^{-2})	Ratio	(W m^{-2})	Ratio
10:40:30	823.037	824.036	823.500	823.524	825.099	1.001913	826.801	1.003979)	827.083	1.004322)
10:43:30	796.526	797.094	794.831	796.150	796.152	1.000002	799.912	1.004725)	800.528	1.005499)
10:46:30	828.826	828.887	827.827	828.513	829.069	1.000671	830.368	1.002239	831.120	1.003147
11:01:30	835.173	836.172	835.754	835.700	835.613	0.999896	837.811	1.002526	839.040	1.003997)
11:04:30	826.876	828.415	827.737	827.676	827.609	0.999919	828.829	1.001393	831.120	1.004161)
11:07:30	831.106	832.638	832.548	832.097	832.622	1.000631	832.110	1.000016	836.090	1.004799)
11:10:30	814.224	815.026	813.621	814.290	813.355	0.998852	814.351	1.000075	816.601	1.002838
11:13:30	818.530	823.476	819.953	820.653	820.315	0.999588	822.231	1.001923	822.346	1.002063
11:16:30	813.743	815.087	814.545	814.458	815.240	1.000960	815.866	1.001729	817.610	1.003870)
27 Jan 2007										
09:31:30	779.762	788.201	784.596	784.186	785.672	1.001895	786.332	1.002737	787.561	1.004304)
09:34:30	784.587	784.522	783.206	784.105	783.902	0.999741	785.866	1.002246	785.775	1.002130
09:37:30	793.003	797.039	795.354	795.132	796.059	1.001166	794.941	0.999760	797.500	1.002978
09:40:30	806.351	810.088	808.079	808.173	808.766	1.000734	806.513	0.997946)	811.554	1.004184)
09:43:30	800.688	796.210	795.349	797.416	795.315	0.997365)	797.968	1.000692	797.577	1.000202
09:46:30	822.657	825.208	823.738	823.868	822.615	0.998479	820.251	0.995610)	825.297	1.001735
10:01:30	851.799	848.989	850.008	850.265	851.305	1.001223	850.837	1.000673	852.861	1.003053
10:04:30	862.203	861.002	862.258	861.821	863.120	1.001507	864.746	1.003394)	864.663	1.003298
10:07:30	846.735	855.157	857.512	853.135	855.833	1.003162)	854.839	1.001997	860.005	1.008053)
10:10:30	846.432	843.794	848.056	846.094	848.092	1.002361)	***	***	850.299	1.004970)
10:13:30	873.111	862.320	870.507	868.646	872.197	1.004088)	***	***	877.941	1.010701)
10:16:30	880.980	883.669	881.821	882.157	881.534	0.999294	879.894	0.997435)	882.444	1.000325
10:31:31	900.392	900.367	897.337	899.365	896.700	0.997037)	899.697	1.000369	899.138	0.999748
10:34:31	891.803	887.005	883.457	887.422	883.260	0.995310)	887.143	0.999686	883.997	0.996141)
10:37:31	899.342	909.061	906.738	905.047	904.826	0.999756	906.663	1.001786	913.813	1.009686)
10:40:31	910.365	905.797	907.621	907.928	908.621	1.000763	909.479	1.001708	908.223	1.000325
10:43:31	897.833	908.113	901.380	902.442	900.939	0.998335	900.891	0.998281)	903.098	1.000727
10:46:31	934.327	929.505	931.010	931.614	932.085	1.000506	931.207	0.999563	931.749	1.000145
11:01:30	924.675	927.765	925.323	925.921	924.286	0.998234)	926.181	1.000281	925.460	0.999502)
11:04:30	910.985	917.553	915.581	914.706	913.902	0.999121	912.888	0.998012)	916.143	1.001571
11:07:30	920.432	915.182	924.630	920.081	921.309	1.001335	925.269	1.005639)	925.149	1.005508)
11:10:30	913.588	910.963	911.741	912.097	911.103	0.998910	913.716	1.001775	912.726	1.000690
11:13:30	914.339	918.065	917.975	916.793	914.968	0.998009)	915.268	0.998337)	917.385	1.000646
11:16:30	891.479	887.000	893.705	890.728	892.344	1.001814	893.957	1.003625)	893.315	1.002904
11:31:30	890.426	888.815	887.677	888.973	887.652	0.998514	891.352	1.002676	889.665	1.000778
11:34:30	887.499	890.716	888.031	888.749	886.551	0.997527)	886.156	0.997082)	888.889	1.000157
11:37:30	877.401	877.084	873.261	875.915	873.898	0.997697)	876.424	1.000581	875.611	0.999653)
11:40:30	894.743	893.903	894.773	894.473	894.299	0.999805	898.520	1.004524)	896.188	1.001917
11:43:30	884.224	883.556	882.167	883.316	883.908	1.000670	887.149	1.004339)	884.774	1.001651
11:46:30	895.552	895.285	890.713	893.850	892.827	0.998856	895.636	1.001998	893.315	0.999401)

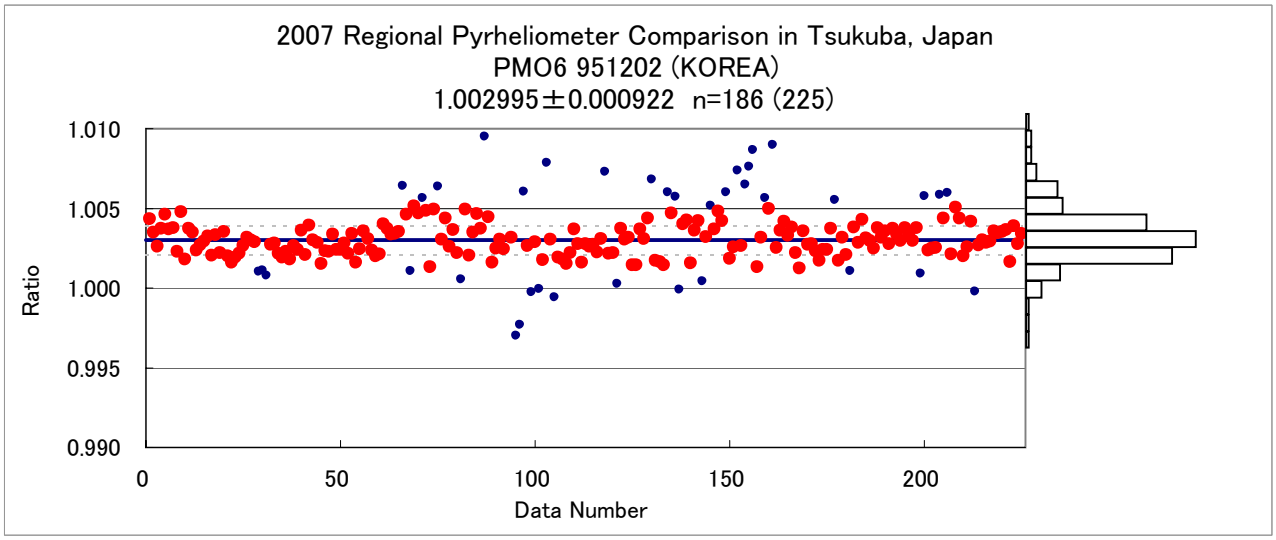
	WSG & Regional Standard Pyrheliometers				National Standard Pyrheliometers				Support Pyrheliometers	
	PMO5	PMO6	AHF		AHF 32455		PMO6 960801		CH1 970139	
Time	WSG	811107	32446	Average	WRC		Japan		Japan	
(hh:mm:ss)	(W m^{-2})	(W m^{-2})	(W m^{-2})	(W m^{-2})	(W m^{-2})	Ratio	(W m^{-2})	Ratio	(W m^{-2})	Ratio
12:01:30	868.402	867.323	869.095	868.273	868.731	1.000527	868.815	1.000624	870.487	1.002550
12:04:30	853.039	853.064	852.537	852.880	852.686	0.999772	854.712	1.002148	853.560	1.000797
12:07:30	853.021	853.469	852.241	852.910	852.742	0.999803	852.991	1.000095	853.249	1.000398
12:10:30	877.486	879.806	879.254	878.849	878.967	1.000134	879.419	1.000649	881.357	1.002854
12:13:30	876.204	882.637	880.296	879.712	881.323	1.001831	880.244	1.000605	883.531	1.004341)
12:16:30	899.918	894.842	901.133	898.631	902.474	1.004277)	898.990	1.000400	903.331	1.005230)
12:31:30	874.592	875.620	876.958	875.723	875.636	0.999901	878.018	1.002621	877.630	1.002178
12:34:30	880.774	884.208	883.625	882.869	882.647	0.999748	882.916	1.000053	883.997	1.001278
12:37:30	856.683	***	858.171	857.427	857.615	1.000219	860.507	1.003592)	859.151	1.002011
12:40:30	864.933	862.727	864.329	863.996	864.412	1.000482	866.508	1.002907	865.673	1.001941
12:43:30	873.407	877.219	875.144	875.257	875.539	1.000322	876.189	1.001065	876.621	1.001558
12:46:30	868.372	868.842	861.941	866.385	866.271	0.999868	866.889	1.000582	867.226	1.000971
13:01:30	879.631	***	879.677	879.654	879.773	1.000135	883.085	1.003900)	881.668	1.002290
13:04:30	872.910	***	873.200	873.055	873.509	1.000520	875.198	1.002455	875.146	1.002395
13:07:30	876.704	***	876.251	876.478	876.473	0.999994	878.786	1.002633	877.786	1.001492
13:10:30	864.148	***	863.945	864.047	863.660	0.999552	865.122	1.001244	865.207	1.001342
13:13:30	851.626	***	850.757	851.192	850.954	0.999720	854.093	1.003408)	852.706	1.001779
13:16:30	840.449	***	840.426	840.438	841.099	1.000787	847.138	1.007972)	842.224	1.002125
13:31:30	843.724	***	843.293	843.509	844.882	1.001628	846.051	1.003014	845.330	1.002159
13:34:30	834.311	***	831.986	833.149	834.297	1.001378	834.781	1.001959	833.683	1.000641
13:37:30	813.281	***	813.040	813.161	814.916	1.002158	812.003	0.998576)	815.358	1.002702
13:40:30	815.260	***	814.464	814.862	816.553	1.002075	820.256	1.006620)	816.601	1.002134
13:43:30	819.785	***	819.270	819.527	821.527	1.002440)	823.050	1.004299)	821.803	1.002777
13:46:30	799.192	***	800.692	799.942	803.035	1.003866)	800.991	1.001311	803.090	1.003935)
14:01:30	792.709	***	792.227	792.468	792.081	0.999512	794.793	1.002934	793.773	1.001647
14:04:30	794.339	***	795.367	794.853	795.238	1.000484	797.526	1.003363	797.577	1.003427
14:07:30	799.879	***	798.970	799.425	799.841	1.000520	800.593	1.001461	801.382	1.002448
14:10:30	801.071	***	800.304	800.688	800.208	0.999401	801.196	1.000634	801.537	1.001060
14:13:30	802.646	***	802.430	802.538	802.923	1.000480	802.542	1.000005	805.109	1.003204
14:16:30	800.010	***	801.071	800.541	801.894	1.001690	801.043	1.000627	803.711	1.003960)
14:34:30	773.686	***	773.781	773.734	774.360	1.000809	780.074	1.008194)	775.914	1.002817
14:37:30	765.920	***	765.247	765.584	765.561	0.999970	773.740	1.010653)	767.606	1.002641
14:40:30	727.037	726.264	729.159	727.487	730.114	1.003611)	731.675	1.005757)	731.967	1.006158)
14:43:30	734.371	734.900	733.626	734.299	734.694	1.000538	734.479	1.000245	736.548	1.003063
14:46:30	735.019	732.657	732.281	733.319	733.310	0.999988	734.882	1.002131	735.306	1.002710
15:01:30	721.490	722.486	724.497	722.824	722.558	0.999632	723.654	1.001148	725.056	1.003088
15:04:30	712.323	709.472	715.263	712.353	714.820	1.003463)	714.490	1.003000	716.593	1.005952)
15:07:30	705.036	707.692	706.201	706.310	705.154	0.998363	703.688	0.996288)	707.120	1.001147
15:10:30	690.555	693.410	690.572	691.512	691.575	1.000091	692.184	1.000972	693.377	1.002697
15:13:30	674.264	668.569	677.066	673.300	675.826	1.003752)	674.518	1.001809	677.615	1.006409)
15:16:30	679.915	682.812	681.685	681.471	680.611	0.998738	681.751	1.000411	683.050	1.002317

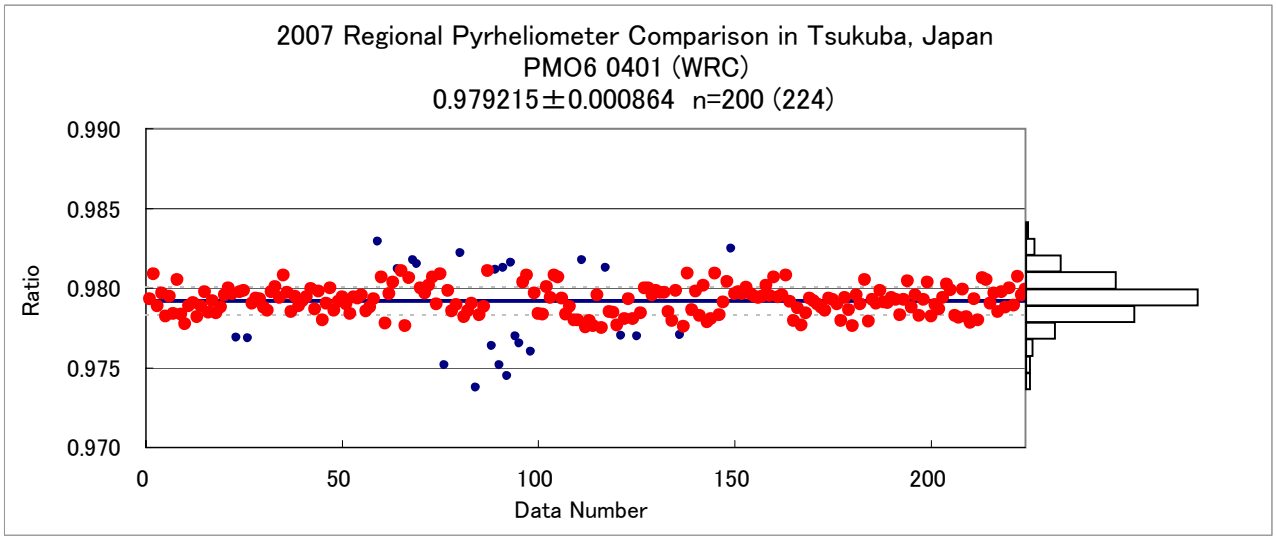
	WSG & Regional Standard Pyrheliometers				National Standard Pyrheliometers				Support Pyrheliometers	
	PMO5	PMO6	AHF		AHF 32455		PMO6 960801		CH1 970139	
Time	WSG	811107	32446	Average	WRC		Japan		Japan	
(hh:mm:ss)	(W m^{-2})	(W m^{-2})	(W m^{-2})	(W m^{-2})	(W m^{-2})	Ratio	(W m^{-2})	Ratio	(W m^{-2})	Ratio
30 Jan 2007										
08:31:31	797.862	800.199	798.449	798.837	798.606	0.999711	799.293	1.000571	798.820	0.999979
08:34:31	803.741	801.914	803.802	803.152	803.752	1.000747	805.840	1.003347	804.177	1.001276
08:37:31	810.680	803.184	809.976	807.947	810.724	1.003437)	808.570	1.000771	810.622	1.003311
08:40:31	816.316	817.515	816.207	816.679	816.686	1.000009	818.892	1.002710	816.368	0.999619)
08:43:31	826.435	827.732	826.218	826.795	826.817	1.000027	828.365	1.001899	826.772	0.999972
08:46:31	826.795	829.561	828.206	828.187	828.326	1.000168	830.058	1.002259	828.636	1.000542
09:01:30	857.864	859.633	858.005	858.501	858.400	0.999882	859.625	1.001309	858.296	0.999761
09:04:30	860.214	862.841	861.781	861.612	862.571	1.001113	864.094	1.002881	862.179	1.000658
09:07:30	870.363	870.515	869.594	870.157	869.334	0.999054	872.513	1.002708	869.400	0.999130)
09:10:30	874.266	874.637	873.738	874.214	874.603	1.000445	873.336	0.998996)	874.059	0.999823
09:13:30	871.449	872.765	872.691	872.302	872.481	1.000205	873.006	1.000807	872.117	0.999788
09:16:30	876.192	876.295	876.501	876.329	876.861	1.000607	878.985	1.003031	876.233	0.999890
09:31:30	899.407	899.468	899.596	899.490	900.330	1.000934	900.094	1.000671	899.526	1.000040
09:34:30	903.215	904.063	903.339	903.539	904.551	1.001120	905.029	1.001649	903.020	0.999426)
09:37:30	909.288	910.875	909.465	909.876	910.529	1.000718	910.644	1.000844	908.689	0.998695)
09:40:30	909.376	908.526	909.699	909.200	909.533	1.000366	910.388	1.001307	908.223	0.998925)
09:43:30	915.392	913.936	916.214	915.181	916.107	1.001012	917.188	1.002193	916.065	1.000966
09:46:30	917.682	917.791	917.158	917.544	918.185	1.000699	917.461	0.999910	916.919	0.999319)
10:01:30	929.197	932.344	929.718	930.420	928.484	0.997919)	930.402	0.999981	928.100	0.997506)
10:04:30	930.900	932.625	931.273	931.599	931.004	0.999361	932.191	1.000635	930.274	0.998578)
10:07:30	917.530	919.249	918.409	918.396	917.307	0.998814	920.074	1.001827	917.074	0.998561)
10:10:30	934.186	935.188	934.030	934.468	933.563	0.999032	935.791	1.001416	932.681	0.998088)
10:13:30	944.845	945.781	945.164	945.263	945.378	1.000122	946.511	1.001320	944.328	0.999011)
10:16:30	945.731	945.413	945.740	945.628	945.750	1.000129	947.163	1.001623	944.871	0.999199)
10:31:30	953.765	953.376	953.742	953.628	952.819	0.999152	953.519	0.999886	951.394	0.997657)
10:34:30	951.063	954.313	953.073	952.816	952.427	0.999592	953.472	1.000688	950.462	0.997529)
10:37:30	958.161	960.699	959.816	959.559	959.166	0.999590	959.451	0.999887	957.838	0.998206)
10:40:30	959.678	959.272	959.138	959.363	958.998	0.999620	960.516	1.001202	957.295	0.997844)
10:43:30	957.391	957.623	957.961	957.658	957.637	0.999978	959.291	1.001705	956.674	0.998972)
10:46:30	955.629	954.158	957.838	955.875	956.316	1.000461	956.822	1.000991	956.208	1.000348
11:01:30	953.264	956.019	954.042	954.442	953.311	0.998815	955.414	1.001018	952.714	0.998189)
11:04:30	963.088	961.480	964.317	962.962	963.196	1.000243	963.746	1.000814	962.264	0.999275)
11:07:30	962.240	962.163	962.252	962.218	961.070	0.998807	963.249	1.001071	959.469	0.997143)
11:10:30	961.855	963.473	961.783	962.370	960.142	0.997685)	962.437	1.000070	959.314	0.996825)
11:13:30	960.649	958.829	961.269	960.249	960.280	1.000032	961.586	1.001392	959.158	0.998864)
11:16:30	964.080	963.248	963.745	963.691	962.375	0.998634	965.516	1.001894	962.497	0.998761)
15:01:30	847.614	849.959	849.434	849.002	850.591	1.001872	850.321	1.001554	849.833	1.000979
15:04:30	843.699	845.351	843.930	844.327	844.095	0.999725	845.970	1.001946	843.621	0.999164)
15:07:30	826.516	826.405	825.750	826.224	826.309	1.000103	826.705	1.000582	826.306	1.000099

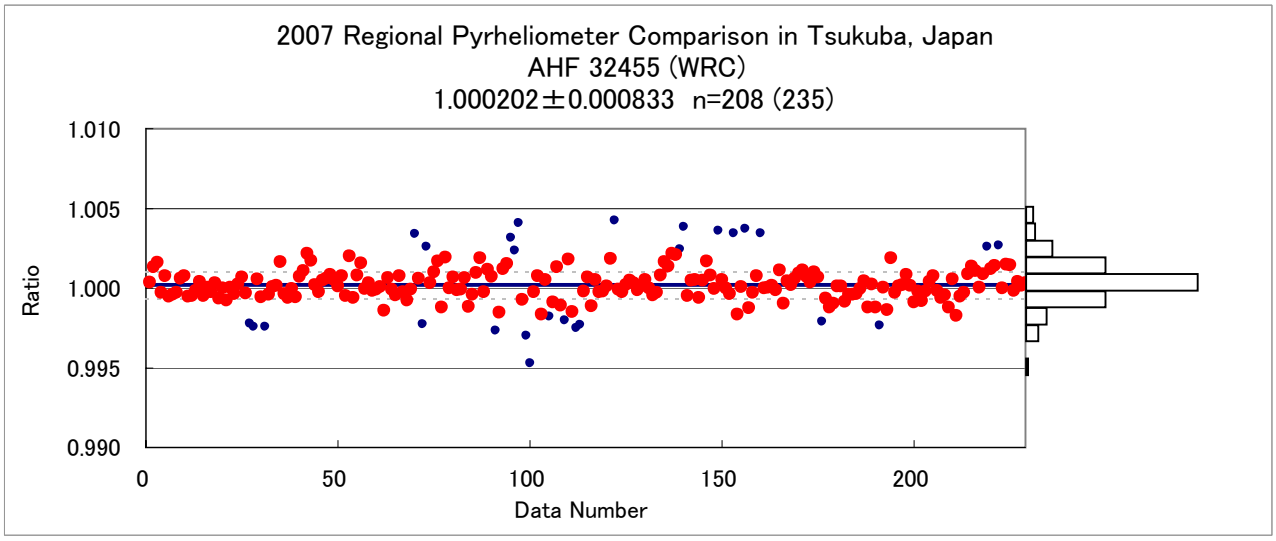
	WSG & Regional Standard Pyrheliometers				National Standard Pyrheliometers				Support Pyrheliometers	
	PMO5	PMO6	AHF		AHF 32455		PMO6 960801		CH1 970139	
Time	WSG	811107	32446	Average	WRC		Japan		Japan	
(hh:mm:ss)	(W m^{-2})	(W m^{-2})	(W m^{-2})	(W m^{-2})	(W m^{-2})	Ratio	(W m^{-2})	Ratio	(W m^{-2})	Ratio
15:10:30	816.973	816.239	816.653	816.622	816.776	1.000189	817.722	1.001347	816.834	1.000260
15:13:30	810.703	810.145	809.182	810.010	810.688	1.000837	810.984	1.001202	810.234	1.000277
15:16:30	799.549	799.763	798.888	799.400	799.520	1.000150	800.763	1.001705	799.752	1.000440
15:31:30	741.306	741.450	741.085	741.280	740.611	0.999097	743.187	1.002573	742.604	1.001786
15:34:30	729.136	727.473	727.370	727.993	727.851	0.999805	729.308	1.001806	729.172	1.001620
15:37:30	718.978	719.402	718.452	718.944	718.355	0.999181	720.243	1.001807	720.242	1.001805
15:40:30	703.520	703.049	702.201	702.923	702.776	0.999791	704.177	1.001784	704.791	1.002658
15:43:30	691.520	691.574	690.209	691.101	691.381	1.000405	692.098	1.001443	692.600	1.002169
15:46:30	675.150	676.030	675.880	675.687	676.195	1.000752	676.842	1.001709	677.615	1.002853
31 Jan 2007										
08:31:31	746.209	746.753	746.303	746.422	746.290	0.999823	748.164	1.002334	748.350	1.002583
08:34:31	753.369	752.964	752.488	752.940	752.473	0.999380	754.625	1.002238	754.406	1.001947
08:37:31	762.971	763.682	763.646	763.433	763.105	0.999570	759.314	0.994605)	765.743	1.003026
08:40:31	765.941	766.462	763.923	765.442	764.530	0.998809	763.829	0.997893)	765.976	1.000698
08:43:31	784.255	782.921	783.948	783.708	784.144	1.000556	784.119	1.000524	786.241	1.003232
08:46:31	801.584	803.237	800.707	801.843	800.446	0.998258	802.254	1.000513	802.702	1.001071
09:01:28	837.793	839.903	838.003	838.566	838.134	0.999485	840.211	1.001962	840.438	1.002232
09:04:28	844.148	846.206	843.896	844.750	844.524	0.999732	844.361	0.999540	845.563	1.000962
09:07:28	843.045	845.751	845.096	844.631	845.370	1.000875	846.039	1.001667	846.960	1.002757
09:10:28	852.950	849.818	852.178	851.649	852.825	1.001381	854.278	1.003087	853.948	1.002699
09:13:28	856.227	855.887	856.532	856.215	857.132	1.001071	858.779	1.002995	857.986	1.002068
09:16:28	863.638	864.116	863.310	863.688	863.715	1.000031	862.992	0.999194)	865.285	1.001849
09:31:30	881.770	883.835	882.747	882.784	883.548	1.000865	884.047	1.001431	883.609	1.000935
09:34:30	888.151	884.546	887.526	886.741	889.061	1.002616)	889.205	1.002779	888.734	1.002248
09:37:30	885.487	888.817	886.598	886.967	888.045	1.001215	887.402	1.000490	888.112	1.001291
09:40:30	894.149	895.680	894.996	894.942	896.205	1.001411	896.044	1.001231	896.110	1.001305
09:43:30	896.552	895.907	896.674	896.378	898.778	1.002677)	897.729	1.001507	897.663	1.001434
09:46:30	904.184	907.888	903.773	905.282	905.280	0.999998	903.926	0.998502)	904.573	0.999217)
10:01:30	911.941	915.099	916.299	914.446	915.794	1.001474	916.213	1.001932	916.608	1.002364
10:04:30	930.039	928.075	929.628	929.247	930.575	1.001429	928.811	0.999531	930.740	1.001607
10:07:30	922.951	922.800	922.619	922.790	922.650	0.999848	922.356	0.999530	923.131	1.000370
10:10:30	916.948	916.681	916.827	916.819	917.191	1.000406	917.792	1.001061	917.540	1.000786
10:13:30	914.698	914.228	915.509	914.812	914.968	1.000171	914.615	0.999785	915.599	1.000860
10:16:30	925.977	925.202	924.650	925.276	925.590	1.000339	926.447	1.001266	925.926	1.000703
11:01:30	934.868	936.888	937.116	936.291	937.011	1.000769	938.008	1.001834	937.883	1.001700
11:04:30	940.298	939.580	940.464	940.114	940.873	1.000807	940.842	1.000774	941.377	1.001343
11:07:30	941.702	942.043	942.270	942.005	941.770	0.999751	942.117	1.000119	942.387	1.000406
11:10:30	945.974	941.931	944.826	944.244	945.256	1.001072	946.378	1.002260	945.415	1.001240
11:13:30	945.276	942.999	943.512	943.929	944.140	1.000224	946.061	1.002259	943.163	0.999189)
11:16:30	949.314	947.787	951.560	949.554	951.121	1.001650	951.920	1.002492	950.928	1.001447

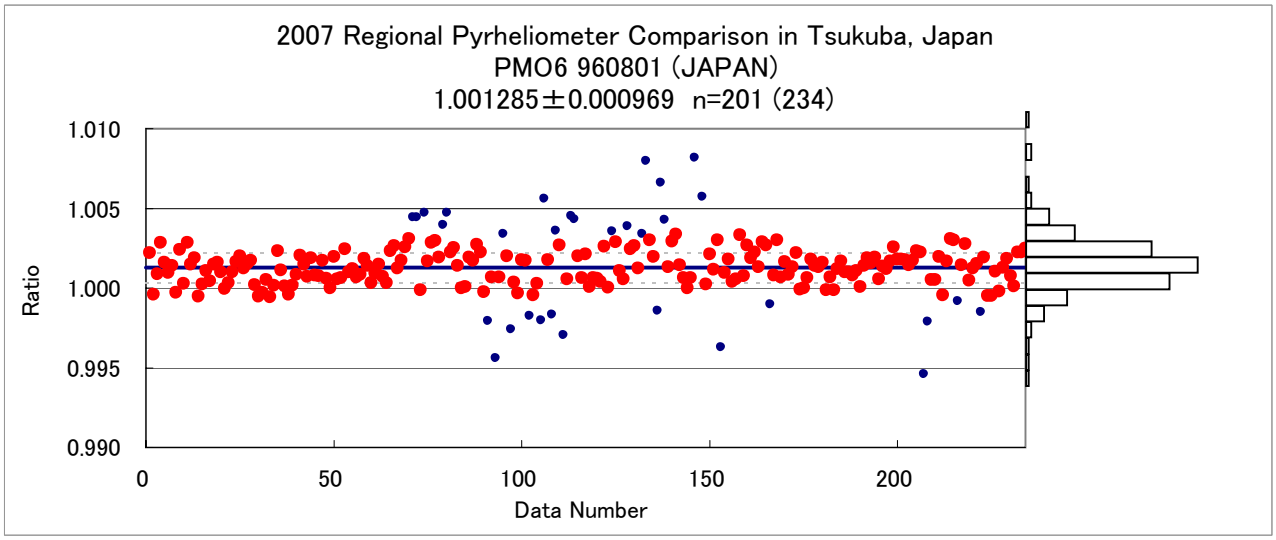

2007 Regional Pyrheliometer Comparison in Tsukuba, Japan
HF 20294 (CHINA)
1.000802±0.001108 n=132 (235)
Ratio
1.010
1.005
1.000
0.995
0.990
0
50
100
150
200
Data Number

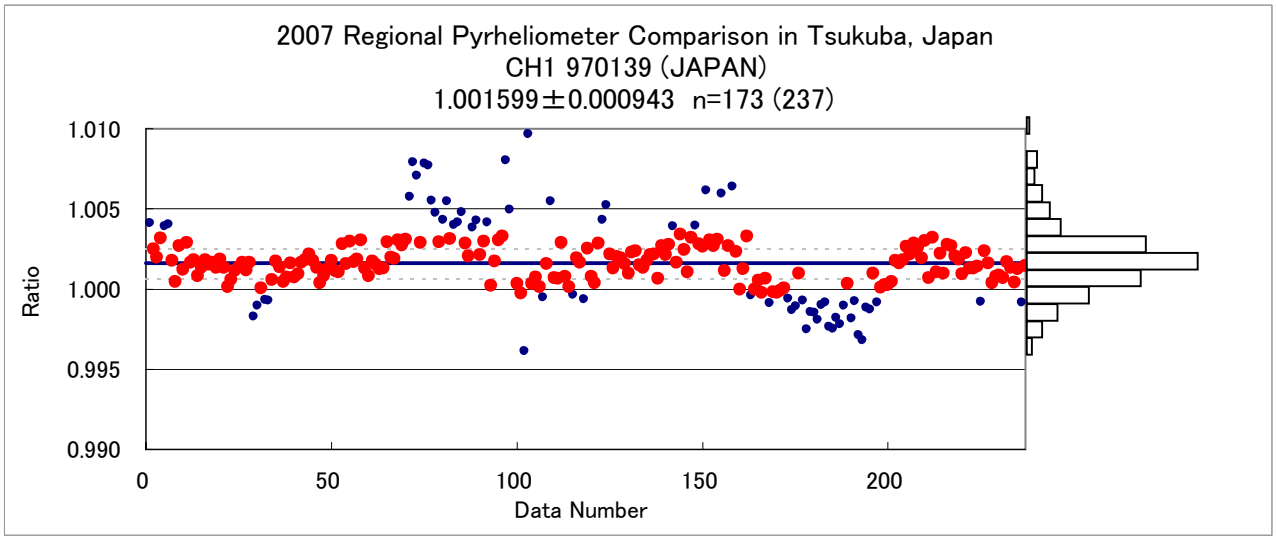

2007 Regional Pyrheliometer Comparison in Tsukuba, Japan
PMO6 0102 (HONG KONG)
1.002746±0.000942 n=177 (233)
Ratio
1.010
1.005
1.000
0.995
0.990
0
50
100
150
200
Data Number


2007 Regional Pyrheliometer Comparison in Tsukuba, Japan
PMO6 951202 (KOREA)
1.002995±0.000922 n=186 (225)
Ratio
1.010
1.005
1.000
0.995
0.990
0
50
100
150
200
Data Number


2007 Regional Pyrheliometer Comparison in Tsukuba, Japan
PMO6 0401 (WRC)
0.979215±0.000864 n=200 (224)
Ratio
0.990
0.985
0.980
0.975
0.970
0
50
100
150
200
Data Number


2007 Regional Pyrheliometer Comparison in Tsukuba, Japan
AHF 32455 (WRC)
1.000202±0.000833 n=208 (235)
Ratio
1.010
1.005
1.000
0.995
0.990
0
50
100
150
200
Data Number


2007 Regional Pyrheliometer Comparison in Tsukuba, Japan
PMO6 960801 (JAPAN)
1.001285±0.000969 n=201 (234)
Ratio
1.010
1.005
1.000
0.995
0.990
0
50
100
150
200
Data Number


2007 Regional Pyrheliometer Comparison in Tsukuba, Japan
CH1 970139 (JAPAN)
1.001599±0.000943 n=173 (237)
Ratio
1.010
1.005
1.000
0.995
0.990
0
50
100
150
200
Data Number

Meteorological Data

The table in this appendix shows meteorological data during irradiance measurement.

1. Temperature, Relative Humidity, Station Pressure, Wind Direction and Wind Speed

Temperature, relative humidity, station pressure, wind direction/speed (instantaneous value) were measured at the start and end of a series. The mean values of the start and end times are shown.

2. Irradiance and Standard deviation

Mean irradiances calculated from 13 CH1 (No.970139) measurements of one series and its standard deviation, using the current calibration factor.

3. Zenith Angle

The solar zenith angle at the middle time of each measurement series.

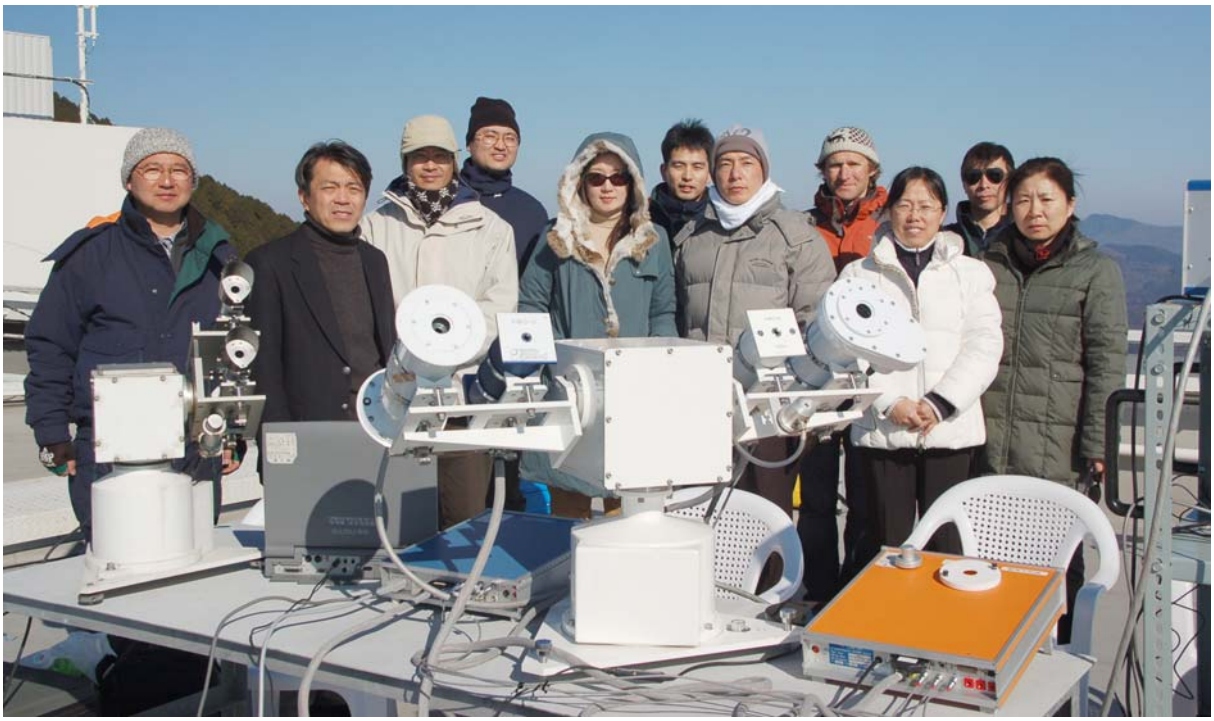
4. Optical Air Mass (m), Feussner-Dubois's Turbidity Coefficient (τ_0)

Values calculated from CH1 (No.970139) measurement at the middle time of each measurement series.

Date	Run No.	Time	Temp. (°C)	Humidity (%)	Pressure (hPa)	W. Speed (m sec^{-1})	W. Dir. (degree)	Direct Irrad. ± σ (W m^{-2})	Zenith (degree)	m	τ_0
25 Jan 2007	1	8:39:00	4.4	54	941	0.7	190	757.1 ± 10.8	71.6	3.14	2.73
	2	9:09:00	5.4	57	941	1.5	70	775.2 ± 10.2	67.5	2.60	3.00
	3	9:39:00	6.9	50	942	calm	-	835.3 ± 8.9	63.6	2.24	2.93
	4	10:09:00	7.3	52	942	0.6	200	876.9 ± 3.6	60.5	2.02	2.87
	5	10:39:00	6.3	56	942	1.3	50	888.1 ± 5.0	58.0	1.88	2.95
	6	11:14:00	6.9	50	942	1.9	50	898.5 ± 7.5	56.0	1.78	2.99
	7	11:44:00	7.2	50	941	1.7	50	920.9 ± 7.5	55.3	1.75	2.87
	8	12:14:00	8.2	42	941	1.9	90	924.9 ± 3.9	55.5	1.76	2.83
	9	13:09:00	8.9	40	942	2.3	70	913.8 ± 3.7	58.2	1.89	2.76
	10	13:39:00	8.3	35	941	1.2	170	902.2 ± 5.9	60.7	2.04	2.69
	11	14:09:00	8.7	34	942	1.3	170	881.3 ± 7.4	64.0	2.27	2.61
	12	14:39:00	8.8	35	942	1.1	40	817.6 ± 18.6	67.8	2.63	2.71
	13	15:09:00	8.9	38	942	1.7	130	736.8 ± 19.3	72.1	3.23	2.79
26 Jan 2007	14	8:39:00	5.0	53	945	0.4	250	663.2 ± 21.8	71.5	3.12	3.31
	15	9:09:00	7.4	49	945	1.1	40	740.7 ± 7.1	67.3	2.58	3.24
	16	9:39:00	7.7	49	946	1.6	50	412.3 ± 312.8	63.4	2.22	6.84
	17	10:09:00	7.5	54	945	2.4	330	559.8 ± 297.5	60.3	2.01	5.55
	18	10:39:00	7.7	52	945	0.4	240	825.1 ± 15.1	57.8	1.87	3.42
	19	11:09:00	7.1	53	945	2.7	240	824.1 ± 9.1	56.0	1.78	3.55
	20	11:39:00	7.7	51	945	2.2	240	457.7 ± 374.9	55.2	1.75	7.50
27 Jan 2007	21	8:39:00	4.8	83	937	3.2	260	523.9 ± 152.3	71.3	3.09	4.36
	22	9:09:00	5.8	77	937	3.0	240	752.1 ± 12.5	67.2	2.56	3.19
	23	9:39:00	5.4	82	936	3.3	280	798.8 ± 15.2	63.2	2.21	3.21
	24	10:09:00	6.6	71	936	3.2	250	860.4 ± 13.4	60.1	2.00	3.01
	25	10:39:00	7.6	68	935	3.6	270	905.6 ± 14.6	57.5	1.86	2.86
	26	11:09:00	8.4	56	936	8.0	260	913.4 ± 12.1	55.8	1.77	2.90
	27	11:39:00	9.1	65	937	3.5	260	887.5 ± 7.0	54.9	1.73	3.14
	28	12:09:00	9.7	61	937	4.1	250	871.9 ± 17.7	54.9	1.74	3.26
	29	12:39:00	11.3	50	936	4.6	260	870.3 ± 9.3	55.9	1.78	3.21
	30	13:09:00	11.3	47	937	5.2	270	864.1 ± 15.5	57.6	1.86	3.14
	31	13:39:00	11.8	44	938	4.0	260	820.7 ± 15.5	60.2	2.01	3.28
	32	14:09:00	12.0	43	941	4.0	270	798.4 ± 3.9	63.5	2.23	3.19
	33	14:39:00	11.9	37	936	4.1	270	746.9 ± 21.1	67.3	2.58	3.20
	34	15:09:00	11.4	42	939	4.2	260	698.0 ± 19.1	71.7	3.15	3.07
	35	15:39:00	11.2	40	937	3.9	260	575.8 ± 33.1	76.4	4.19	3.23

Date	Run No.	Time	Temp. (°C)	Humidity (%)	Pressure (hPa)	W. Speed (m sec^{-1})	W. Dir. (degree)	Direct Irrad. ± σ (W m^{-2})	Zenith (degree)	m	τ_0
30 Jan 2007	36	8:39:00	5.0	67	948	4.5	20	813.6 ± 12.3	70.8	3.01	2.48
	37	9:09:00	5.6	68	946	4.5	40	868.9 ± 7.2	66.6	2.50	2.50
	38	9:39:00	6.4	63	949	2.9	50	909.1 ± 6.8	62.6	2.16	2.52
	39	10:09:00	6.7	64	949	3.2	20	934.3 ± 10.2	59.4	1.96	2.54
	40	10:39:00	7.6	59	949	3.3	60	956.5 ± 2.9	56.8	1.82	2.53
	41	11:09:00	9.0	54	949	2.0	50	961.0 ± 3.4	55.0	1.74	2.59
	42	11:39:00	10.3	51	947	1.2	100	928.7 ± 27.1	54.1	1.70	2.86
	43	12:09:00	11.5	52	948	1.6	170	894.9 ± 12.9	54.1	1.70	3.11
	44	12:39:00	11.1	55	947	0.9	130	890.5 ± 12.7	55.1	1.74	3.10
	45	13:09:00	11.5	47	947	1.8	170	867.8 ± 12.7	56.9	1.82	3.15
	46	13:39:00	11.8	53	948	1.0	280	823.3 ± 14.1	59.4	1.96	3.31
	47	14:09:00	10.8	51	948	1.5	250	837.0 ± 6.7	62.7	2.17	2.97
	48	14:39:00	11.2	48	947	1.6	220	863.3 ± 11.7	66.6	2.51	2.53
	49	15:09:00	11.3	35	948	0.7	110	824.3 ± 19.5	71.0	3.04	2.41
	50	15:39:00	11.2	36	948	0.6	310	709.7 ± 24.4	75.8	4.00	2.55
31 Jan 2007	51	8:39:00	7.1	76	942	4.0	250	769.0 ± 20.5	70.6	2.99	2.75
	52	9:09:00	7.9	66	941	4.3	250	849.9 ± 9.1	66.4	2.48	2.63
	53	9:39:00	8.2	68	941	4.2	250	892.2 ± 8.3	62.4	2.15	2.64
	54	10:09:00	9.1	69	941	4.2	250	920.6 ± 6.1	59.2	1.95	2.65
	55	10:39:00	9.2	69	942	3.2	260	933.6 ± 7.0	56.6	1.81	2.70
	56	11:09:00	10.0	67	942	3.2	250	942.7 ± 4.5	54.8	1.73	2.73
	57	11:39:00	10.4	65	939	3.6	240	931.2 ± 14.1	53.8	1.69	2.87

Photographs of Participants



Participants in the Regional Pyrheliometer Comparison of RA II (Tsukuba, Japan)
(from left to right): K.HONDA*, H.SASAKI*, K.W.CHAN, T.FUJITA*,
N.Y.YIM, H.TATSUMI*, S.C.RYU, W.FINSTERLE, Y.YANG,
M.NAKAMURA*, D.WANG (*: 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)

Part II

CALIBRATION OF REFERENCE PYRANOMETER FROM KOREA

1. BACKGROUND

At the request of the Korea Meteorological Administration, calibration of Korea's reference pyranometer (CM21, No. 990609) was jointly carried out during the period of the Regional Pyrheliometer Comparison of RA II (22 January - 2 February 2007).

2. METHOD OF CALIBRATION AND DATA ACQUISITION

Calibration was performed using the collimation tube method. By this technique, the pyranometer to be calibrated 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 of the pyranometer and the collimation tube are adjusted to the same as the absolute cavity radiometer (a half opening angle of 2.5 degrees), both instruments can be compared directly using the common radiation source. The output voltage from the pyranometer was acquired in the same manner as the thermoelectric pyrheliometer described in Part I, Section 5-3.

3. DEFINITION OF THE PYRANOMETER CALIBRATION FACTOR

In this report, the pyranometer calibration factor is defined as the irradiance sensitivity as stated in the following formula:

$$S = K\, V_{th}$$

with

S	irradiance [W m^{-2}]
V_{th}	output of pyranometer [mV]
K	calibration factor [(W m^{-2}) mV^{-1}]

4. DATA EVALUATION PROCEDURES

The final pyranometer calibration factor was obtained by applying the same procedures for evaluating pyrheliometers as described in Section 7, Part I.

5. CALIBRATION RESULTS

A total of 237 comparison measurements were made for pyranometer calibration. By applying the data selection criteria in Step 2 of Part I, Section 7, 182 measurements were selected for final evaluation.

The new calibration factor K was 85.762 [(W m^{-2}) mV^{-1}] with a standard deviation of 0.001026.

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

Photo 1 View of the collimation tube with pyranometer. The pyranometer without sunscreen is attached to the bottom of the tube.

	WSG & Regional Standard Pyrheliometers				Pyranometer	
	PMO5	PMO6	AHF		CM21 990609	
Time	WSG	811107	32446	Average	Rep. of Korea	
(hh:mm:ss)	(W m^{-2})	(W m^{-2})	(W m^{-2})	(W m^{-2})	(W m^{-2})	Ratio
25 Jan 2007						
08:31:31	***	743.910	745.071	744.491	744.619	1.000172
08:34:31	***	756.661	756.126	756.394	755.081	0.998264
08:37:31	770.131	770.422	769.827	770.127	769.660	0.999394
08:40:31	767.848	765.734	767.739	767.107	766.658	0.999415
08:43:31	759.683	758.268	760.263	759.405	759.455	1.000066
08:46:31	743.719	744.274	746.384	744.792	744.362	0.999423
09:34:30	***	823.499	825.895	824.697	824.029	0.999190
09:37:30	***	828.324	827.750	828.037	826.001	0.997541)
09:40:30	835.334	834.871	837.157	835.787	834.405	0.998347
09:43:30	843.893	845.982	845.361	845.079	842.724	0.997213)
09:46:30	842.369	841.447	844.609	842.808	842.209	0.999289
10:01:30	874.781	871.199	873.484	873.155	872.910	0.999719
10:04:30	871.295	873.185	873.458	872.646	871.280	0.998435
10:07:30	876.884	879.685	877.711	878.093	876.597	0.998296
10:10:30	880.856	880.677	879.927	880.487	879.599	0.998991
10:13:30	880.466	881.258	881.054	880.926	879.942	0.998883
10:16:30	875.328	876.731	876.298	876.119	875.225	0.998980
10:31:30	883.670	883.696	***	883.683	883.200	0.999453
10:34:30	882.513	883.679	883.856	883.349	882.857	0.999443
10:37:30	888.044	886.737	886.499	887.093	886.802	0.999672
10:40:30	893.764	894.881	894.243	894.296	893.062	0.998620
10:43:30	892.301	892.028	892.174	892.168	891.176	0.998888
11:06:30	886.349	886.384	886.066	886.266	885.773	0.999444
11:09:30	892.835	895.587	894.993	894.472	893.491	0.998903
11:12:30	897.242	898.150	898.657	898.016	897.693	0.999640
11:15:30	901.219	901.694	902.134	901.682	900.866	0.999095
11:18:30	900.616	904.278	904.057	902.984	902.924	0.999934
11:21:30	905.102	908.901	908.727	907.577	906.698	0.999031
11:36:30	925.977	922.044	921.195	923.072	920.247	0.996940)
11:39:30	915.096	910.896	912.166	912.719	910.557	0.997631)
11:42:30	916.590	917.036	916.540	916.722	916.731	1.000010
11:45:30	933.570	932.440	934.075	933.362	932.510	0.999087
11:48:30	921.246	926.816	923.506	923.856	920.418	0.996279)
11:51:30	914.617	915.839	916.836	915.764	913.472	0.997497)
12:06:30	924.858	925.267	925.404	925.176	925.221	1.000049
12:09:30	919.537	919.285	919.058	919.293	919.132	0.999825
12:12:30	921.766	921.537	921.588	921.630	921.619	0.999988
12:15:30	929.217	929.370	929.670	929.419	927.622	0.998067
12:18:30	928.081	928.436	928.172	928.230	926.936	0.998606
12:21:30	926.578	925.341	924.971	925.630	925.135	0.999465
13:01:30	913.811	912.596	912.482	912.963	912.700	0.999712
13:04:30	917.500	917.205	917.566	917.424	917.331	0.999899
13:07:30	916.916	917.179	917.481	917.192	917.246	1.000059
13:10:30	913.816	910.124	913.607	912.516	913.129	1.000672
13:13:30	914.661	914.686	915.557	914.968	915.016	1.000052
13:16:30	907.148	907.755	907.480	907.461	907.298	0.999820
13:31:30	904.305	905.570	904.877	904.917	905.325	1.000451
13:34:30	906.612	906.936	907.444	906.997	907.041	1.000049
13:37:30	905.884	906.410	906.355	906.216	905.926	0.999680
13:40:30	905.456	905.749	906.077	905.761	906.011	1.000276
13:43:30	894.014	894.595	894.060	894.223	892.977	0.998607
13:46:30	895.410	895.842	894.431	895.228	894.520	0.999209
14:01:30	887.834	889.474	889.309	888.872	889.889	1.001144
14:04:30	892.409	892.101	891.233	891.914	891.776	0.999845
14:07:30	878.794	880.531	879.933	879.753	881.142	1.001579
14:10:30	875.647	876.103	875.058	875.603	875.482	0.999862
14:13:30	873.184	874.076	872.820	873.360	874.110	1.000859
14:16:30	877.065	879.143	878.398	878.202	879.599	1.001591
14:31:30	843.187	842.114	843.263	842.855	844.010	1.001370
14:34:30	836.127	835.892	836.080	836.033	836.721	1.000823

	WSG & Regional Standard Pyrheliometers				Pyranometer	
	PMO5	PMO6	AHF		CM21 990609	
Time	WSG	811107	32446	Average	Rep. of Korea	
(hh:mm:ss)	(W m^{-2})	(W m^{-2})	(W m^{-2})	(W m^{-2})	(W m^{-2})	Ratio
14:37:30	817.739	818.671	818.440	818.283	819.655	1.001677
14:40:30	809.322	809.178	808.733	809.078	810.222	1.001414
14:43:30	802.251	803.302	802.040	802.531	803.876	1.001676
14:46:30	796.563	796.508	796.596	796.556	796.930	1.000469
15:01:30	765.247	***	766.072	765.660	767.430	1.002312)
15:04:30	753.894	754.774	753.332	754.000	755.424	1.001889
15:07:30	734.628	735.371	734.749	734.916	736.215	1.001768
15:10:30	727.878	728.215	728.481	728.191	730.126	1.002657)
15:13:30	722.150	722.937	722.751	722.613	724.037	1.001971)
15:16:30	714.662	716.426	715.106	715.398	717.005	1.002246)
26 Jan 2007						
09:01:30	733.422	741.201	737.195	737.273	736.987	0.999612
09:04:30	741.721	737.743	742.644	740.703	743.761	1.004128)
09:07:30	735.239	734.326	736.137	735.234	736.901	1.002267)
09:10:30	739.749	746.333	740.217	742.100	741.617	0.999349
09:13:30	736.894	739.051	740.316	738.754	741.446	1.003644)
09:16:30	752.497	755.906	754.788	754.397	756.110	1.002271)
10:31:30	837.272	835.869	838.476	837.206	838.007	1.000957
10:34:30	834.551	836.094	837.988	836.211	837.321	1.001327
10:37:30	828.328	829.700	828.926	828.985	826.945	0.997539)
10:40:30	823.037	824.036	823.500	823.524	824.200	1.000821
10:43:30	796.526	797.094	794.831	796.150	795.129	0.998718
10:46:30	828.826	828.887	827.827	828.513	828.831	1.000384
11:01:30	835.173	836.172	835.754	835.700	835.263	0.999477
11:04:30	826.876	828.415	827.737	827.676	827.373	0.999634
11:07:30	831.106	832.638	832.548	832.097	832.090	0.999992
11:10:30	814.224	815.026	813.621	814.290	812.795	0.998164
11:13:30	818.530	823.476	819.953	820.653	819.398	0.998471
11:16:30	813.743	815.087	814.545	814.458	815.024	1.000695
27 Jan 2007						
09:31:30	779.762	788.201	784.596	784.186	785.610	1.001816
09:34:30	784.587	784.522	783.206	784.105	783.809	0.999623
09:37:30	793.003	797.039	795.354	795.132	795.386	1.000319
09:40:30	806.351	810.088	808.079	808.173	808.850	1.000838
09:43:30	800.688	796.210	795.349	797.416	794.529	0.996380)
09:46:30	822.657	825.208	823.738	823.868	822.571	0.998426
10:01:30	851.799	848.989	850.008	850.265	850.013	0.999704
10:04:30	862.203	861.002	862.258	861.821	862.019	1.000230
10:07:30	846.735	855.157	857.512	853.135	856.788	1.004282)
10:10:30	846.432	843.794	848.056	846.094	847.783	1.001996)
10:13:30	873.111	862.320	870.507	868.646	874.625	1.006883)
10:16:30	880.980	883.669	881.821	882.157	880.542	0.998169
10:31:31	900.392	900.367	897.337	899.365	896.750	0.997092)
10:34:31	891.803	887.005	883.457	887.422	879.770	0.991377)
10:37:31	899.342	909.061	906.738	905.047	911.243	1.006846)
10:40:31	910.365	905.797	907.621	907.928	906.355	0.998267
10:43:31	897.833	908.113	901.380	902.442	900.952	0.998349
10:46:31	934.327	929.505	931.010	931.614	930.109	0.998385
11:01:30	924.675	927.765	925.323	925.921	923.849	0.997762)
11:04:30	910.985	917.553	915.581	914.706	914.158	0.999401
11:07:30	920.432	915.182	924.630	920.081	922.905	1.003069)
11:10:30	913.588	910.963	911.741	912.097	911.929	0.999816
11:13:30	914.339	918.065	917.975	916.793	914.844	0.997874)
11:16:30	891.479	887.000	893.705	890.728	890.661	0.999925
11:31:30	890.426	888.815	887.677	888.973	887.231	0.998040
11:34:30	887.499	890.716	888.031	888.749	885.687	0.996555)
11:37:30	877.401	877.084	873.261	875.915	872.052	0.995590)
11:40:30	894.743	893.903	894.773	894.473	893.234	0.998615
11:43:30	884.224	883.556	882.167	883.316	882.857	0.999480
11:46:30	895.552	895.285	890.713	893.850	891.433	0.997296)

	WSG & Regional Standard Pyrheliometers				Pyranometer	
	PMO5	PMO6	AHF		CM21 990609	
Time	WSG	811107	32446	Average	Rep. of Korea	
(hh:mm:ss)	(W m^{-2})	(W m^{-2})	(W m^{-2})	(W m^{-2})	(W m^{-2})	Ratio
12:01:30	868.402	867.323	869.095	868.273	868.793	1.000599
12:04:30	853.039	853.064	852.537	852.880	851.471	0.998348
12:07:30	853.021	853.469	852.241	852.910	850.785	0.997509)
12:10:30	877.486	879.806	879.254	878.849	878.141	0.999194
12:13:30	876.204	882.637	880.296	879.712	881.400	1.001919
12:16:30	899.918	894.842	901.133	898.631	901.466	1.003155)
12:31:30	874.592	875.620	876.958	875.723	875.139	0.999333
12:34:30	880.774	884.208	883.625	882.869	882.686	0.999793
12:37:30	856.683	***	858.171	857.427	857.559	1.000154
12:40:30	864.933	862.727	864.329	863.996	863.648	0.999597
12:43:30	873.407	877.219	875.144	875.257	875.911	1.000747
12:46:30	868.372	868.842	861.941	866.385	865.878	0.999415
13:01:30	879.631	***	879.677	879.654	880.542	1.001009
13:04:30	872.910	***	873.200	873.055	873.510	1.000521
13:07:30	876.704	***	876.251	876.478	876.254	0.999744
13:10:30	864.148	***	863.945	864.047	863.905	0.999836
13:13:30	851.626	***	850.757	851.192	851.556	1.000428
13:16:30	840.449	***	840.426	840.438	840.065	0.999556
13:31:30	843.724	***	843.293	843.509	844.696	1.001407
13:34:30	834.311	***	831.986	833.149	832.519	0.999244
13:37:30	813.281	***	813.040	813.161	813.824	1.000815
13:40:30	815.260	***	814.464	814.862	815.539	1.000831
13:43:30	819.785	***	819.270	819.527	821.027	1.001830
13:46:30	799.192	***	800.692	799.942	802.933	1.003739)
14:01:30	792.709	***	792.227	792.468	792.642	1.000220
14:04:30	794.339	***	795.367	794.853	795.987	1.001427
14:07:30	799.879	***	798.970	799.425	800.274	1.001062
14:10:30	801.071	***	800.304	800.688	800.789	1.000126
14:13:30	802.646	***	802.430	802.538	804.048	1.001881
14:16:30	800.010	***	801.071	800.541	802.761	1.002773)
14:34:30	773.686	***	773.781	773.734	775.405	1.002160)
14:37:30	765.920	***	765.247	765.584	766.830	1.001628
14:40:30	727.037	726.264	729.159	727.487	731.241	1.005160)
14:43:30	734.371	734.900	733.626	734.299	735.786	1.002025)
14:46:30	735.019	732.657	732.281	733.319	733.985	1.000908
15:01:30	721.490	722.486	724.497	722.824	724.380	1.002153)
15:04:30	712.323	709.472	715.263	712.353	716.491	1.005809)
15:07:30	705.036	707.692	706.201	706.310	706.886	1.000815
15:10:30	690.555	693.410	690.572	691.512	692.994	1.002143)
15:13:30	674.264	668.569	677.066	673.300	677.043	1.005559)
15:16:30	679.915	682.812	681.685	681.471	682.446	1.001431
30 Jan 2007						
08:31:31	797.862	800.199	798.449	798.837	798.302	0.999330
08:34:31	803.741	801.914	803.802	803.152	803.790	1.000794
08:37:31	810.680	803.184	809.976	807.947	810.051	1.002604)
08:40:31	816.316	817.515	816.207	816.679	815.453	0.998499
08:43:31	826.435	827.732	826.218	826.795	825.487	0.998418
08:46:31	826.795	829.561	828.206	828.187	826.859	0.998396
09:01:30	857.864	859.633	858.005	858.501	858.331	0.999802
09:04:30	860.214	862.841	861.781	861.612	861.933	1.000373
09:07:30	870.363	870.515	869.594	870.157	869.222	0.998925
09:10:30	874.266	874.637	873.738	874.214	874.025	0.999784
09:13:30	871.449	872.765	872.691	872.302	871.623	0.999222
09:16:30	876.192	876.295	876.501	876.329	876.168	0.999816
09:31:30	899.407	899.468	899.596	899.490	899.323	0.999814
09:34:30	903.215	904.063	903.339	903.539	903.353	0.999794
09:37:30	909.288	910.875	909.465	909.876	909.013	0.999052
09:40:30	909.376	908.526	909.699	909.200	908.155	0.998851
09:43:30	915.392	913.936	916.214	915.181	916.388	1.001319
09:46:30	917.682	917.791	917.158	917.544	916.817	0.999208
10:01:30	929.197	932.344	929.718	930.420	927.708	0.997085)

	WSG & Regional Standard Pyrheliometers				Pyranometer	
	PMO5	PMO6	AHF		CM21 990609	
Time	WSG	811107	32446	Average	Rep. of Korea	
(hh:mm:ss)	(W m^{-2})	(W m^{-2})	(W m^{-2})	(W m^{-2})	(W m^{-2})	Ratio
10:04:30	930.900	932.625	931.273	931.599	930.109	0.998401
10:07:30	917.530	919.249	918.409	918.396	917.160	0.998654
10:10:30	934.186	935.188	934.030	934.468	932.167	0.997538)
10:13:30	944.845	945.781	945.164	945.263	944.173	0.998847
10:16:30	945.731	945.413	945.740	945.628	943.573	0.997827)
10:31:30	953.765	953.376	953.742	953.628	952.062	0.998358
10:34:30	951.063	954.313	953.073	952.816	949.747	0.996779)
10:37:30	958.161	960.699	959.816	959.559	957.808	0.998175
10:40:30	959.678	959.272	959.138	959.363	957.379	0.997932)
10:43:30	957.391	957.623	957.961	957.658	955.664	0.997918)
10:46:30	955.629	954.158	957.838	955.875	955.235	0.999330
11:01:30	953.264	956.019	954.042	954.442	951.205	0.996608)
11:04:30	963.088	961.480	964.317	962.962	960.638	0.997587)
11:07:30	962.240	962.163	962.252	962.218	958.065	0.995684)
11:10:30	961.855	963.473	961.783	962.370	958.494	0.995972)
11:13:30	960.649	958.829	961.269	960.249	958.494	0.998172
11:16:30	964.080	963.248	963.745	963.691	960.895	0.997099)
15:01:30	847.614	849.959	849.434	849.002	850.270	1.001494
15:04:30	843.699	845.351	843.930	844.327	843.667	0.999218
15:07:30	826.516	826.405	825.750	826.224	825.658	0.999315
15:10:30	816.973	816.239	816.653	816.622	816.568	0.999934
15:13:30	810.703	810.145	809.182	810.010	810.565	1.000685
15:16:30	799.549	799.763	798.888	799.400	799.245	0.999806
15:31:30	741.306	741.450	741.085	741.280	741.532	1.000340
15:34:30	729.136	727.473	727.370	727.993	728.582	1.000809
15:37:30	718.978	719.402	718.452	718.944	719.835	1.001239
15:40:30	703.520	703.049	702.201	702.923	703.456	1.000758
15:43:30	691.520	691.574	690.209	691.101	691.965	1.001250
15:46:30	675.150	676.030	675.880	675.687	676.872	1.001754
31 Jan 2007						
08:31:31	746.209	746.753	746.303	746.422	747.535	1.001491
08:34:31	753.369	752.964	752.488	752.940	753.452	1.000680
08:37:31	762.971	763.682	763.646	763.433	764.771	1.001753
08:40:31	765.941	766.462	763.923	765.442	765.200	0.999684
08:43:31	784.255	782.921	783.948	783.708	785.610	1.002427)
08:46:31	801.584	803.237	800.707	801.843	801.904	1.000076
09:01:28	837.793	839.903	838.003	838.566	839.636	1.001276
09:04:28	844.148	846.206	843.896	844.750	844.696	0.999936
09:07:28	843.045	845.751	845.096	844.631	845.982	1.001600
09:10:28	852.950	849.818	852.178	851.649	853.100	1.001704
09:13:28	856.227	855.887	856.532	856.215	857.045	1.000969
09:16:28	863.638	864.116	863.310	863.688	863.905	1.000251
09:31:30	881.770	883.835	882.747	882.784	882.943	1.000180
09:34:30	888.151	884.546	887.526	886.741	887.831	1.001229
09:37:30	885.487	888.817	886.598	886.967	887.402	1.000490
09:40:30	894.149	895.680	894.996	894.942	895.292	1.000391
09:43:30	896.552	895.907	896.674	896.378	896.836	1.000511
09:46:30	904.184	907.888	903.773	905.282	903.353	0.997869)
10:01:30	911.941	915.099	916.299	914.446	916.302	1.002030)
10:04:30	930.039	928.075	929.628	929.247	930.109	1.000928
10:07:30	922.951	922.800	922.619	922.790	922.134	0.999289
10:10:30	916.948	916.681	916.827	916.819	916.474	0.999624
10:13:30	914.698	914.228	915.509	914.812	915.187	1.000410
10:16:30	925.977	925.202	924.650	925.276	925.478	1.000218
11:01:30	934.868	936.888	937.116	936.291	936.541	1.000267
11:04:30	940.298	939.580	940.464	940.114	939.971	0.999848
11:07:30	941.702	942.043	942.270	942.005	940.485	0.998386
11:10:30	945.974	941.931	944.826	944.244	944.173	0.999925
11:13:30	945.276	942.999	943.512	943.929	942.629	0.998623
11:16:30	949.314	947.787	951.560	949.554	950.519	1.001016

Plot Figure of Measurement Values

In this figure, the ratios of all individual calibration factors K(i) to the final calibration factor K are plotted. The corresponding histogram is shown on the right side. The dashed horizontal lines represent the standard deviation σ.

The final calibration factor and the standard deviation are printed on top of the plot with the number of points used to determine these values (the number in parentheses is the number of total data).