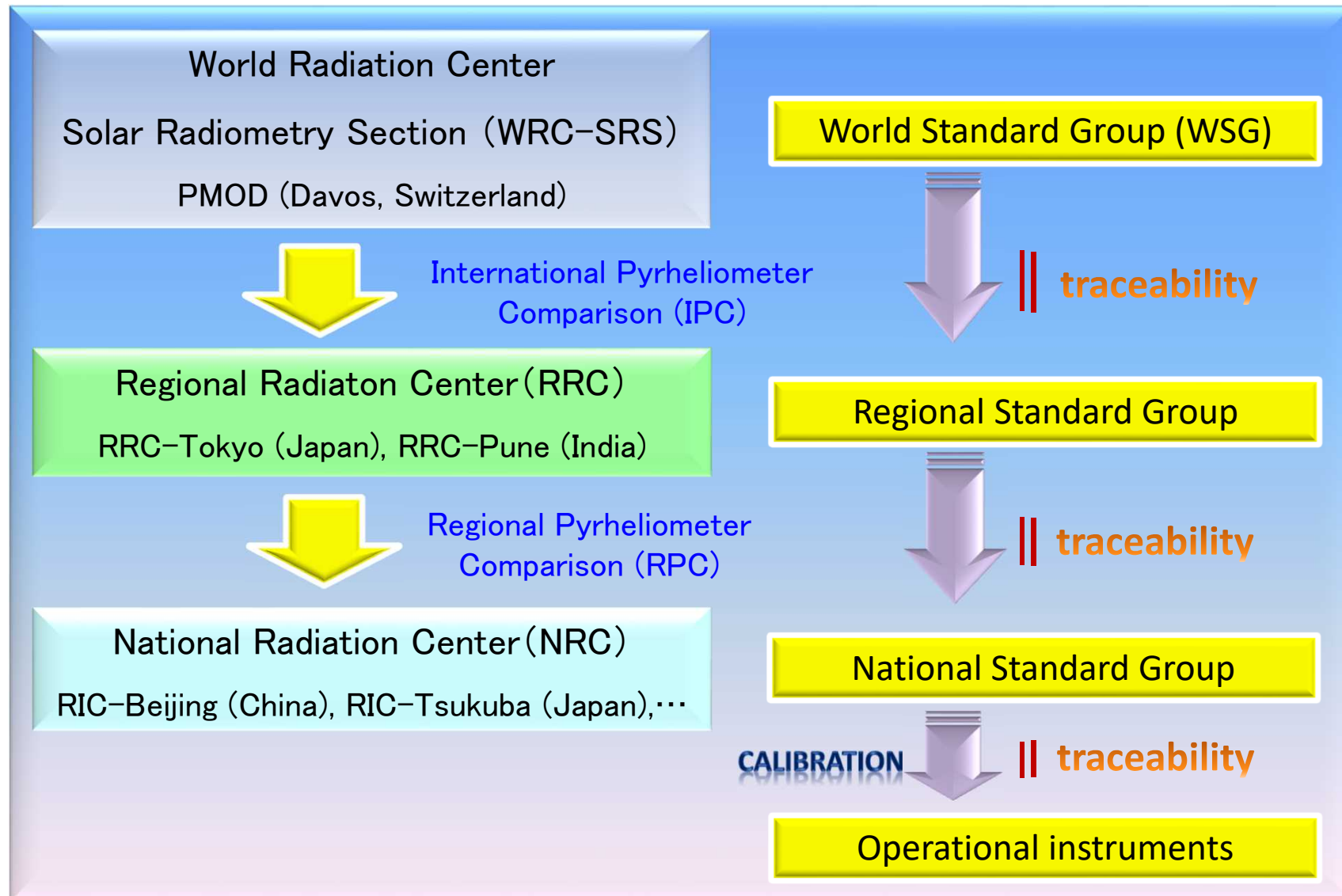


The IPC-XIII Symposium, Oct. 2021, Davos, Switzerland

# Regional Radiation Center(RRC) Tokyo in the WMO RA-II

Japan Meteorological Agency (JMA)

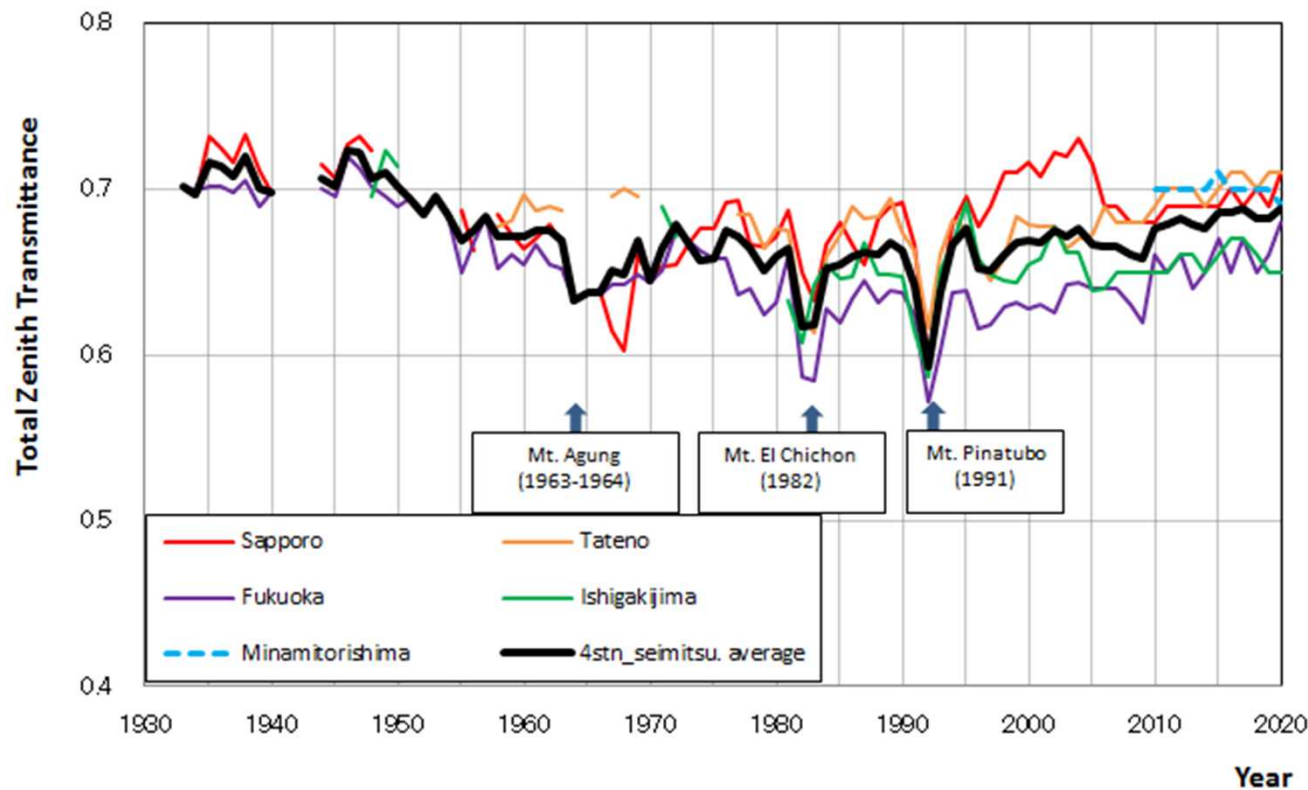
# Background(ex. RA-II)



Conceptual diagram of calibration of solar radiation instruments within the framework of WMO

## Background (cont.)

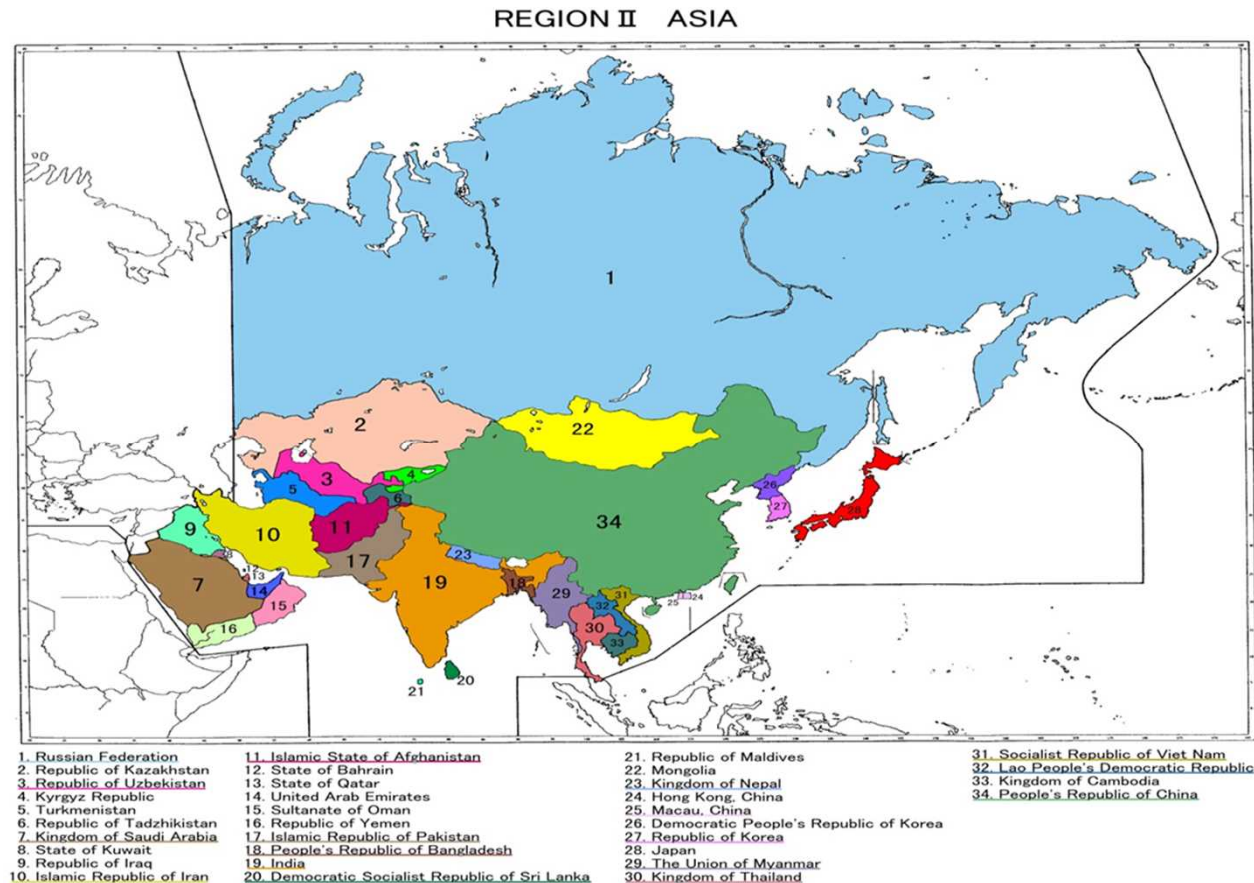
- Japan Meteorological Agency (JMA) has been conducting solar radiation measurements traceable to the international standard scales since the 1930s .
- JMA was designated as the Regional Radiation Center (RRC) in Asia, and has been serving as one of RRCs in RA-II (RRC Tokyo) since 1965.



Long-term variations of annual mean transmittance calculated from direct solar irradiance at 4 (1933-2020) stations in Japan.

# Background (cont.)

- To comply with requirements for RRC, RRC Tokyo holds a Regional Pyrheliometer Comparison (RPC) of RA-II once every 5 years, in the next year of IPC in principle.
- To maintain the regional standard pyrheliometers, RRC Tokyo holds a domestic solar radiometer intercomparison in cooperation with RIC Tsukuba.



# Activities of RRC Tokyo (1/4)

## - History and main activities -

1964	Pyrheliometer Intercomparison : India – Japan (Pune, India)
1965	Regional Radiation Center Establishment (RA II Res.20, CIMO IV Rec.1,3,9)
1968	Pyrheliometer Intercomparison : Thailand - Japan (Tsukuba, Japan)
<b>1970</b>	<b>Join in IPC-III (WRC/Davos, Switzerland)</b>
1975	<b>Join in IPC-IV (WRC/Davos, Switzerland)</b>
	Pyrheliometer Intercomparison : China - Japan (Tsukuba, Japan)
<b>1980</b>	<b>Join in IPC-V (WRC/Davos, Switzerland)</b>
1983	Pyrheliometer Intercomparison : Hong Kong – Japan (Tsukuba, Japan)
<b>1985</b>	<b>Join in IPC-VI (WRC/Davos, Switzerland)</b>

## Activities of RRC Tokyo (cont. 2/4)

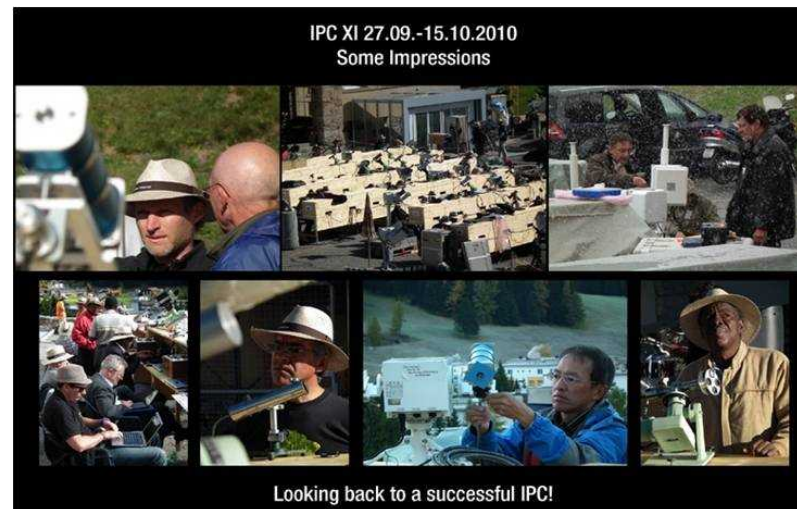
### - History and main activities -

1989	<u>RPC-I : Regional Pyrheliometer Comparison of RA II &amp; RA V (Tsukuba, Japan)</u>
<b>1990</b>	<b>Join in IPC-VII (WRC/Davos, Switzerland)</b>
1994	Reference Pyranometer Calibration : Thailand (Tsukuba, Japan)
<b>1995</b>	Pyrheliometer Intercomparison : China - Japan (Tsukuba, Japan)
	Reference Pyranometer Calibration : Korea (Tsukuba, Japan)
	<b>Join in IPC-VIII (WRC/Davos, Switzerland)</b>
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)

# Activities of RRC Tokyo (cont. 3/4)

## - History and main activities -

<b>2000</b>	<b>Join in IPC-IX (WRC/Davos, Switzerland)</b>
2002	Pyrheliometer Intercomparison : Hong Kong, China & Korea – Japan(Tsukuba, Japan)
<b>2005</b>	<b>Join in IPC-X (WRC/Davos, Switzerland)</b>
2007	<u>RPC-II : Regional Pyrheliometer Comparison of RA II (Tsukuba, Japan)</u>
<b>2010</b>	<b>Join in IPC-XI (WRC/Davos, Switzerland)</b>



# Activities of RRC Tokyo (cont. 4/4)

## - History and main activities -

2012	<u>RPC-III : Regional Pyrheliometer Comparison of RA II (Tsukuba, Japan)</u> reported in <b>WMO IOM report No.113 (2013)</b> ( <a href="http://www.wmo.int/pages/prog/www/IMOP/publications-IOM-series.html">http://www.wmo.int/pages/prog/www/IMOP/publications-IOM-series.html</a> )
2015	Reference Pyranometer Calibration : Indonesia (Tsukuba, Japan)
	<b>Join in IPC-XII (WRC/Davos, Switzerland)</b>
2017	<u>RPC-IV : Regional Pyrheliometer Comparison of RA II &amp; RA V (Tsukuba, Japan)</u> reported in <b>WMO IOM report No.130 (2018)</b> ( <a href="https://library.wmo.int/doc_num.php?explnum_id=5246">https://library.wmo.int/doc_num.php?explnum_id=5246</a> )
2021	<b>Join in IPC-XIII (WRC/Davos, Switzerland, only instruments)</b>
2023	<u>RPC-V : Regional Pyrheliometer Comparison of RA II (Tsukuba, Japan)</u>



## RPC of RA-II at Tsukuba

- The previous RPC (RPC-IV) was held in 2017 (17 Jan. - 5 Feb) at Tsukuba in Japan with participants from 3 NRCs in RA-II and WRC.
- RRC Melbourne and 2 NRCs in RA-V also participated in this RPC.

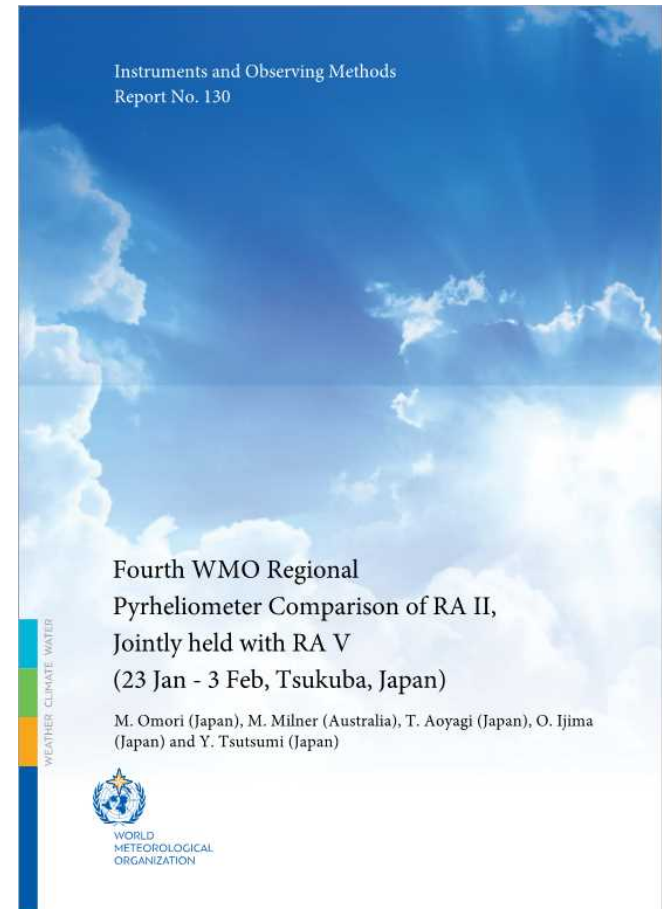
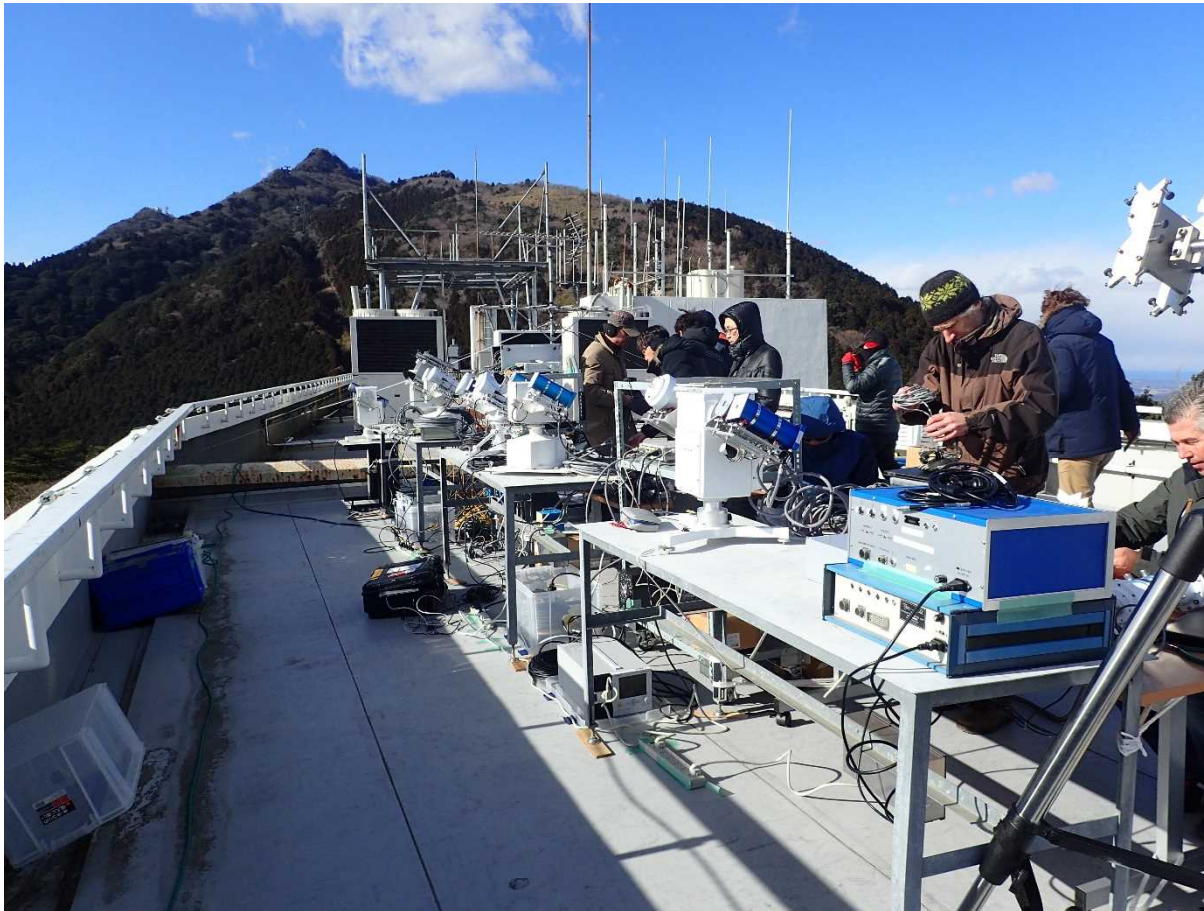


## RPC of RA-II at Tsukuba (cont.)

- The results were reported in WMO IOM report No.130 (2018)

[https://library.wmo.int/doc\\_num.php?explnum\\_id=5246](https://library.wmo.int/doc_num.php?explnum_id=5246)

**Thanks many people for cooperation!!**



# Domestic solar radiometer intercomparison

- A domestic intercomparison of solar radiometers is held once a year between the regional and national standard instruments to maintain their accuracy.

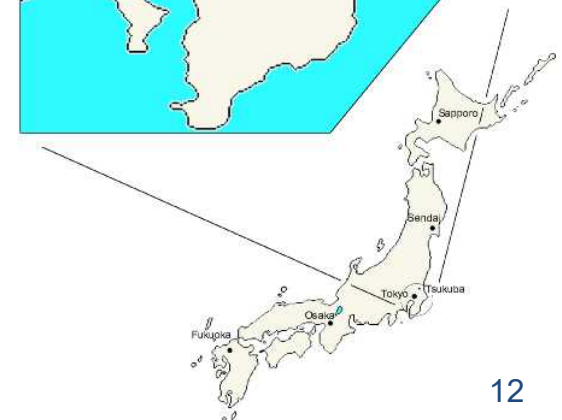


## Annual internal pyrheliometer comparison at Mt. Tsukuba in 2020

Left: Regional standard instruments (pyrheliometers)

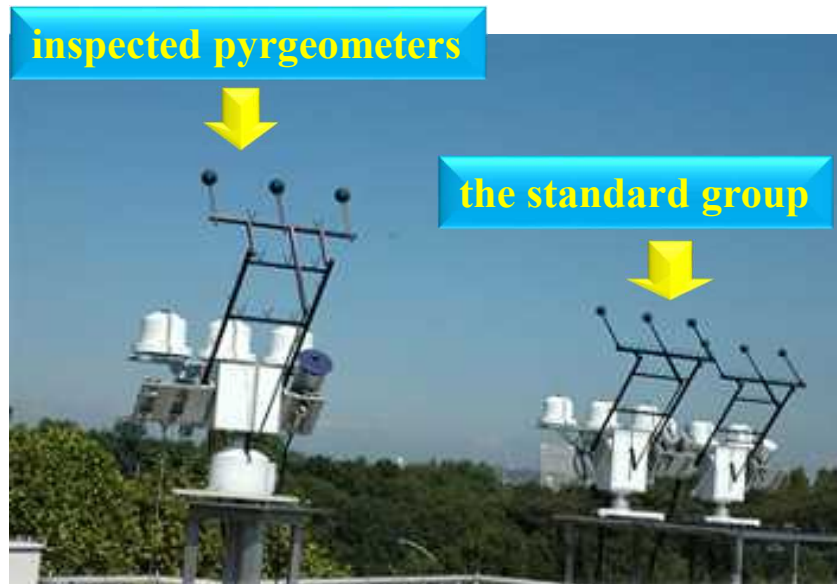
Right: National standard instruments (pyranometers with collimation tubes)

# RPC events and Domestic Intercomparison at Tsukuba



## Pyrgeometer calibration at RRC Tokyo(at Aerological Observatory)

- Aerological Observatory is not only one of BSRN observations but also a calibration institution for pyrgeometers in Japan.
- All our operational pyrgeometers are calibrated to be traceable to the WISG by the same procedure as the WRC-IRS's.
  - Temperature dependency test in the BB cavity →  $k_1, k_2, k_3$
  - outdoors comparison with the standard group → C



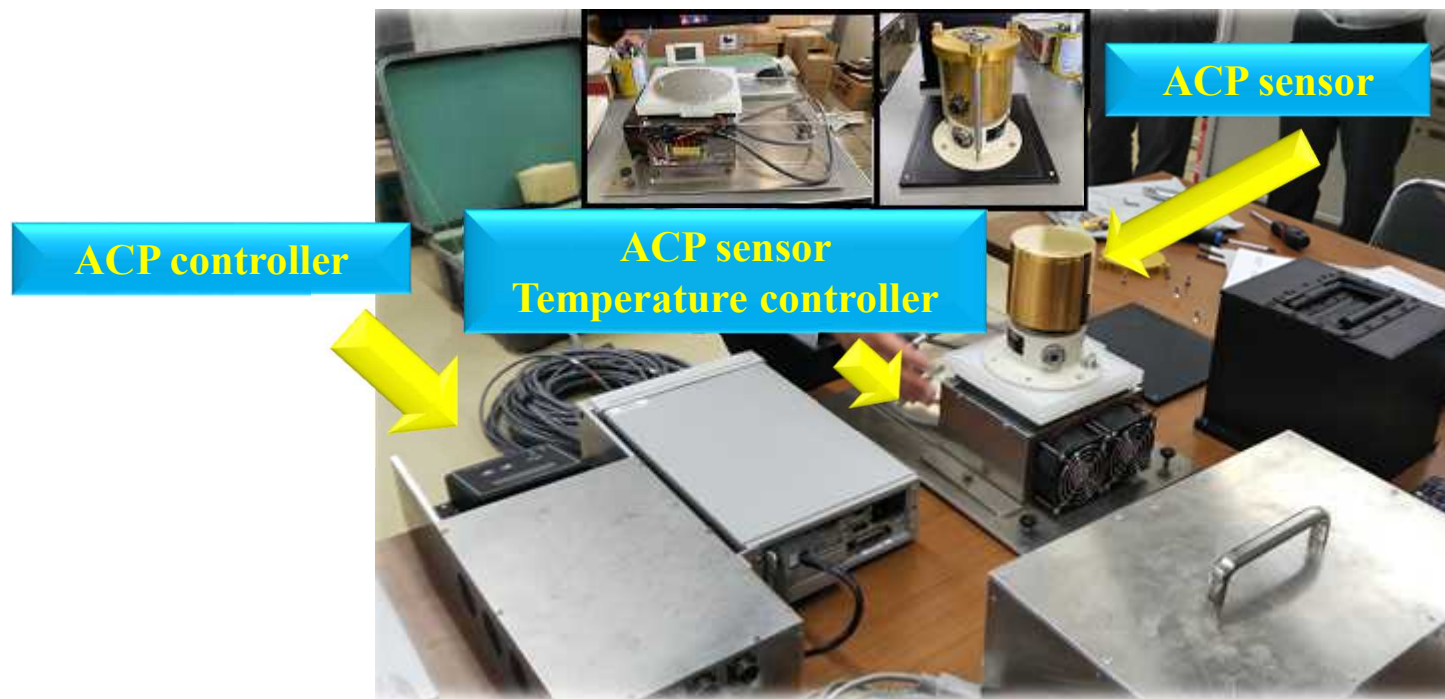
**Outdoor comparisons with the pyrgeometer standard group**



**Temperature dependency test in the BB cavity**

## New Absolute Cavity Pyrgeometer will be conducted by RRC Tokyo

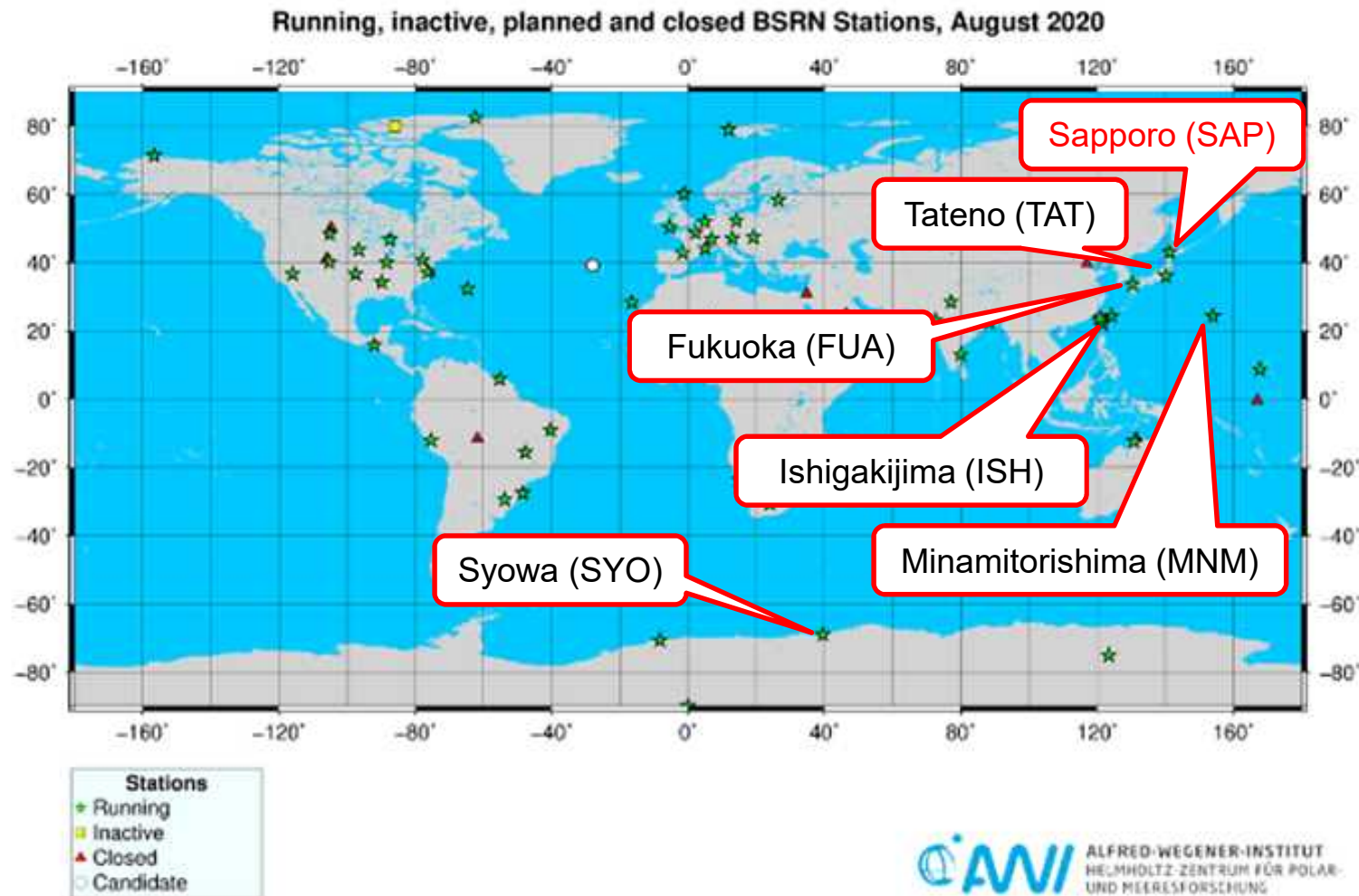
- RRC Tokyo now prepares to operate the Absolute Cavity Pyrgeometer(ACP).
  - That can absolutely measure the amount of infrared radiation.
  - We would be able to maintain the standard pyrgeometers like a regional standard instruments for solar radiation in the near future if a new calibration system for infrared radiation instruments could be established.



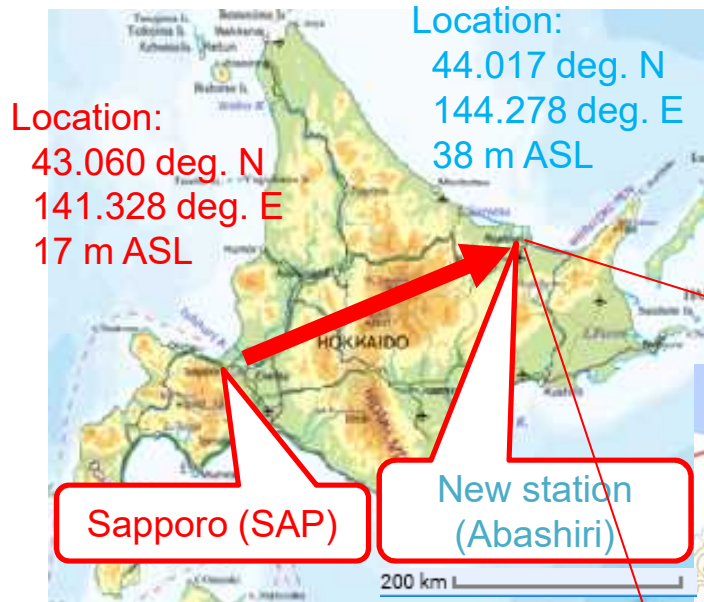
**Absolute Cavity Pyrgeometer(ACP)**

# Current BSRN stations operated by JMA

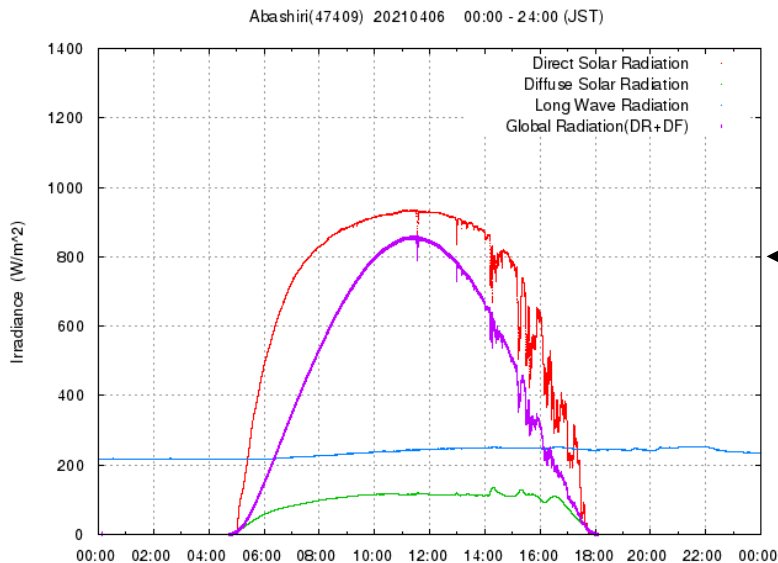
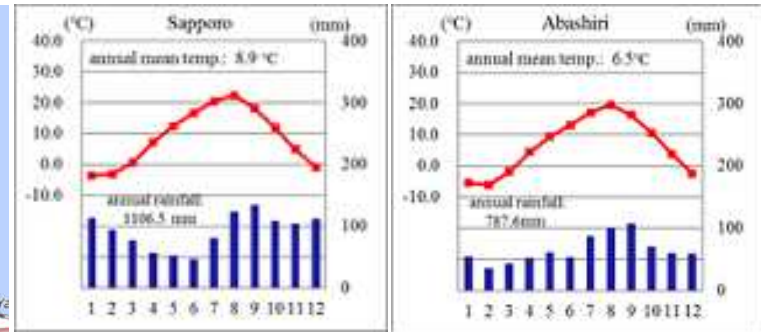
- JMA currently operates six BSRN stations in Japan and Antarctica.



# Establishing a new BSRN type station in Abashiri



- At the termination of SAP, JMA established a new BSRN type station in Abashiri.
- Abashiri is located about 260km east-northeast of Sapporo and in the same climate zone as SAP (Temperate / No dry season climates in Köppen-Geiger climate classification).



Abashiri Local Meteorological Office, JMA

Observation data at Abashiri on Apr.6

red: direct solar radiation  
 green: diffuse radiation  
 purple: global radiation(DH+DF)  
 blue: infrared radiation





# Summary

- JMA was designated as the Regional Radiation Center (RRC) in Asia, and has been serving as one of RRCs in RA-II (RRC Tokyo) since 1965.
- RRC-Tokyo would like to cooperate with NHMSs in calibration of radiation instruments for the improvements of surface radiation measurements.
- To comply with requirements for RRC, RRC Tokyo holds a Regional Pyrheliometer Comparison (RPC) of RA-II once every 5 years, in the next year of IPC in principle.
- The next RPC of RA-II is planned to be held in Jan. 2023. We'd be grateful if many country could participate in the comparison.

**Thank you !!**

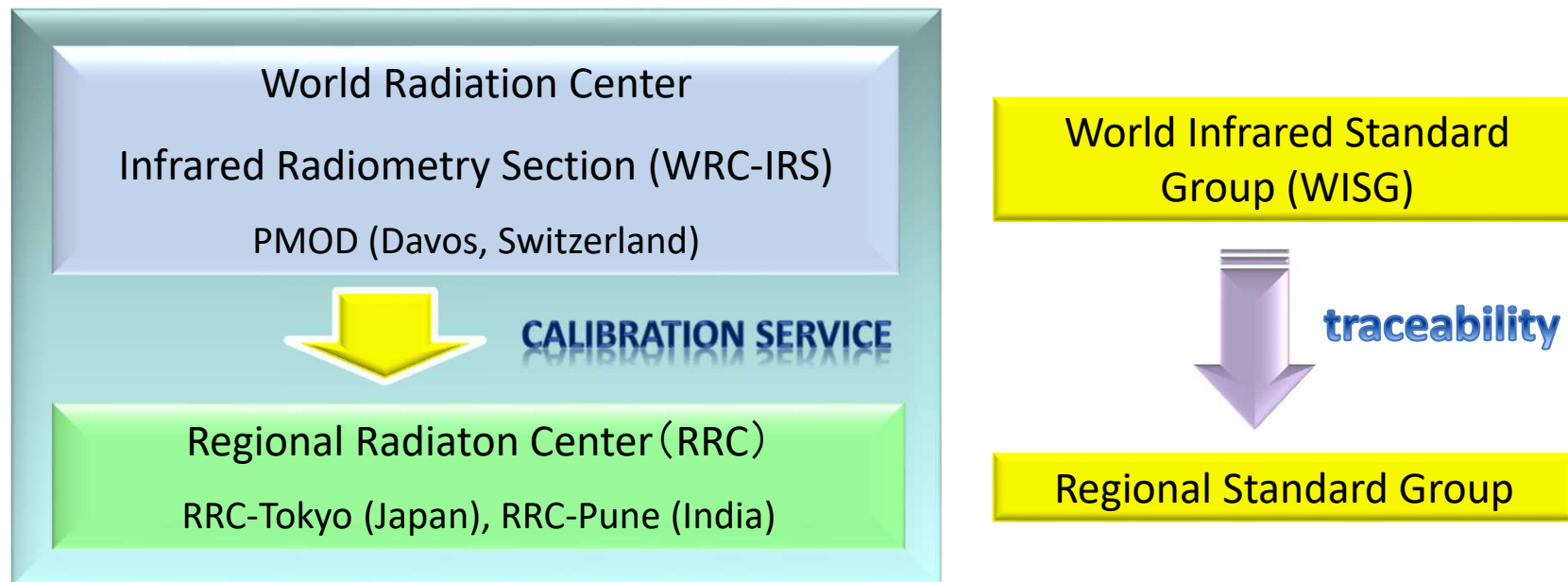


# Acknowledgement

- Although a recent severe situation of COVID-19 prevent us from participating in the IPC-XIII in person, World Meteorological Organization (WMO) kindly arranged, and World Radiation Center (WRC) also kindly accepted that they operate one of our regional standard pyrhelimeters, as a part of control group during the IPC-XIII.
- Then we will be able to keep a traceability of our standard group to the World Standard Group. Next RPC is planned in 2023 at Mt. Tsukuba, and the traceability will be disseminated to NRCs in RA-II.
- RRC-Tokyo appreciates the special cooperation of WMO and WRC.

# Calibration of infrared radiation instruments within the framework of WMO

- The world infrared irradiance standard established at PMOD based on the World Infrared Standard Group (WISG) in 2004.
- RRCs are recommended to have a regional standard group of pyrgeometers and send them every three years to the WRC-IRS for calibration.



**Current state of calibration of infrared radiation instruments within the framework of WMO**

# contribution for improvements of pyrgeometer calibration within the framework of WMO.

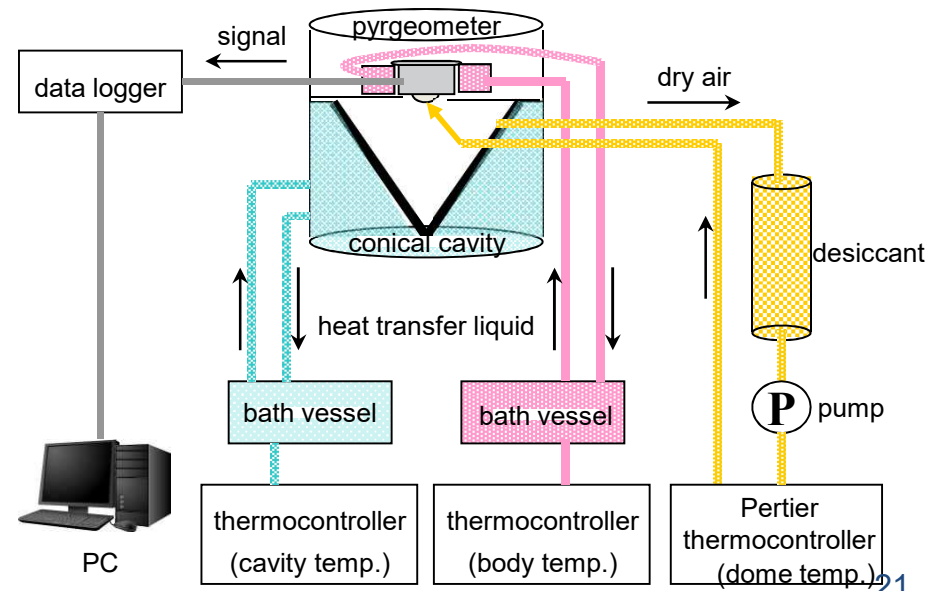
## Performance of JMA's Black body (BB) cavity

Comparisons of mean difference from reference longwave radiation by class of pyrgeometer body temperature (for K&Z CG4 s/n:050798).

Temp. class (deg.C)	difference without BB calibration (W/m <sup>2</sup> )	difference with BB calibration (W/m <sup>2</sup> )
0 - 10	-0.58	0.13
10 - 20	0.02	-0.06
20 - 30	0.40	-0.30

Calibration coefficients for Eppley/PIR (s/n:32205F3) by WMO/World Radiation Center(WRC) and JMA

Coefficient	WRC (Dec. 2006)	JMA (Jun. 2004)	JMA (Jan. 2007)
C	3.91	3.9647	3.9328
k <sub>1</sub>	0.01	0.0146	0.0143
k <sub>2</sub>	1.0024	1.0025	1.0028
k <sub>3</sub>	3.2	2.8752	2.9012



Picture and schematic figure of JMA's BB cavity

## The regional standard group at RRC-Tokyo

- List of pyrgeometers making up the regional standard group (calibration date)
  - Eppley PIR/32205F3 (Dec, 2006)
  - Kipp&Zonen CG4/010567 (Oct, 2010)
  - Kipp&Zonen CGR4/070037 (Dec, 2013)
  - Kipp&Zonen CGR4/070038 (Dec, 2014)
  - Kipp&Zonen CGR4/070039 (Dec, 2015)
- Each reference pyrgeometer is sent to WRC-IRS every 3 years for calibration.



**the regional standard group in a desiccator**