A3(1)

RIC - Tsukuba (Japan) Intercomparison of Thermometer Screens / Shields in 2009 – 2010

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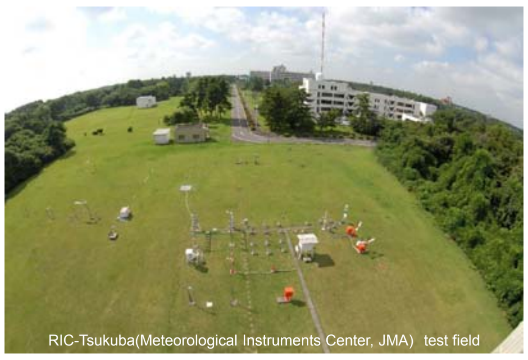
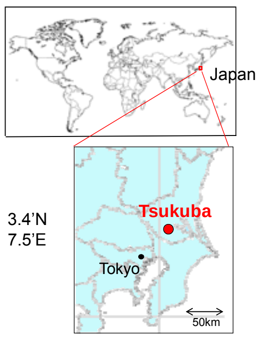
RIC-Tsukuba performed a characteristic investigation involving the intercomparison of six kinds of artificially ventilated thermometer screens/shields and four kinds of naturally ventilated thermometer screens/shields in Tsukuba, Japan.

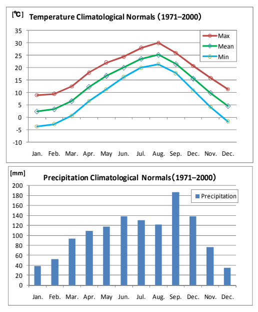
Introduction

- The general function of screens/shields for operational temperature measurements is given in CIMO-Guide(WMO, 2008).
- The experiment was carried out on a test field of RIC-Tsukuba in reference to the examination conditions mostly outlined in ISO 17714. The distance from heat sources and buildings was set to at least 20 m, and the distance between each screen/shield was at least 2 m.
- Test screens/shields were selected from among those that have been used in operational synoptic observation and AWS and are available commercially in Japan.
- Investigation period: 1 August 2009 – 2 Sep. 2009 (summer), 18 Nov. 2009- 30 Apr. 2010 (winter and spring)
- Data : The data sampling interval was every 10 seconds, and data comparison was performed using 10-sec. data (the average of six 10-second momentary data for a minute).
- Tdev: The temperature difference between the test screens/shields and the reference is called the deviation of temperature (referred to below as "Tdev").
- Reference : JMA-95 type screen/shield (as used in operational synoptic stations by JMA (type name JS-258), expressed here as JMA-95(A)) was adopted as the reference standard.
- Thermometer : unified platinum resistance thermometer Pt 100Ω (the size is 3mm in diameter) because we wanted to evaluate only screens/shields effect.





36° 3.4'N
140° 7.5'E



Climatological normals for Tsukuba

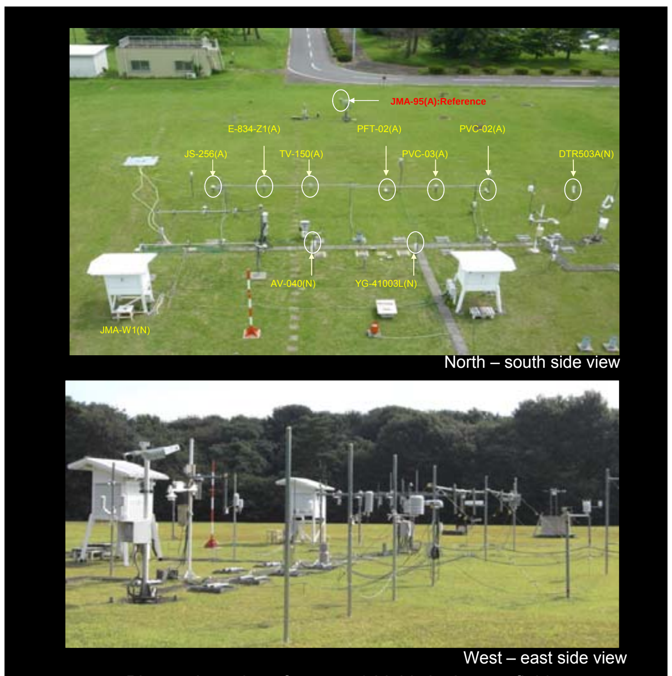


Photo. Location of screens/shields in the test field

Results

"Harerun"
(Mascot of JMA)

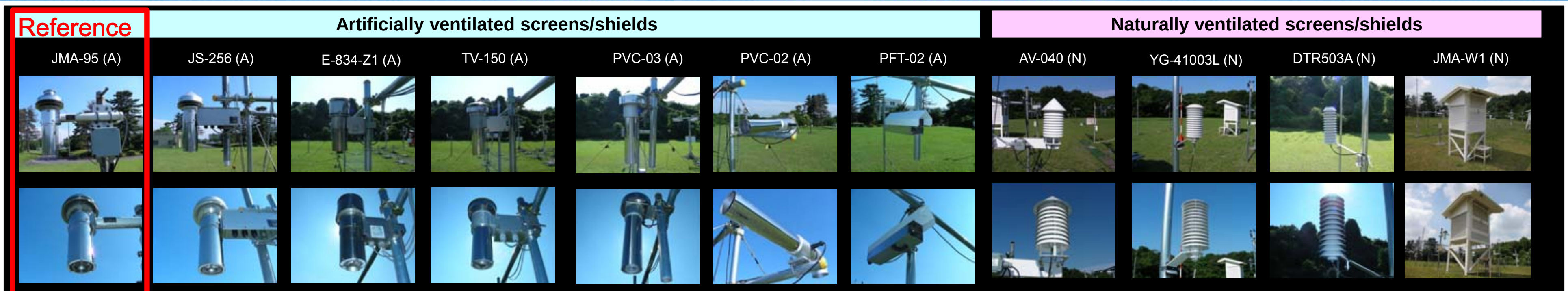
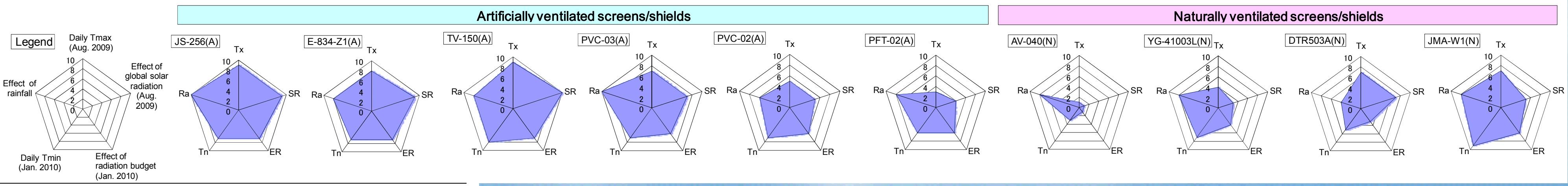


Photo. Pictures of screens/shields (upper: side view; lower: view from underneath)

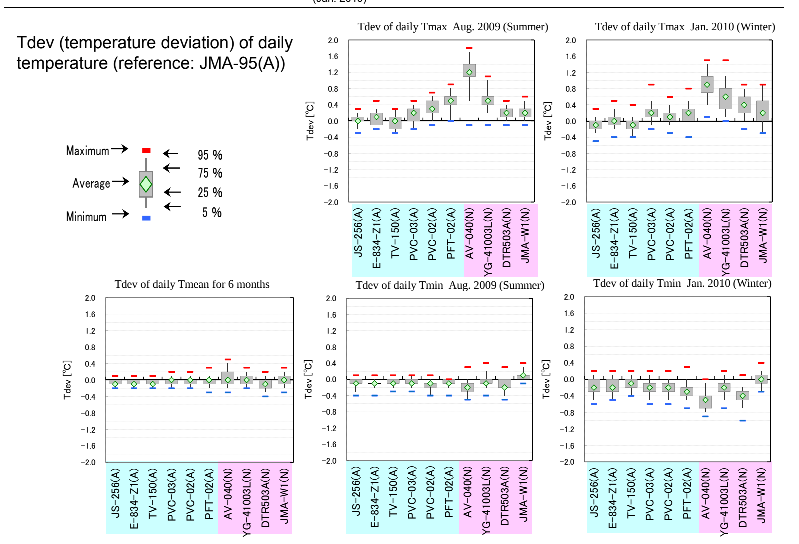
		JMA-95 (A) (JS-258)	JS-256 (A)	E-834-Z1 (A) (used in JMA AWS)	TV-150 (A) (used in JMA AWS)	PVC-03 (A)	PVC-02 (A)	PFT-02 (A)	AV-040 (N)	YG-41003L (N)	DTR503A (N)	JMA-W1 (N)
Manufacturer		Ogasawara	Ogasawara	Yokogawa	Ogasawara	Prede	Prede	Prede	Ogasawara	R. M. Young	Vaisala	Hidakosya
Structure of screens/shields	Form		Vertical type				Horizontal type (pole)	Horizontal type (roof)	10 plates (flat) +snow umbrella	14 plates (dish upside down) Inner: curved downward	12 plates (dish) Rim: flat	Roof, blinds, base: duplication
	Inside structure		Duplication tube						–			
	Insulator/underneath shield plate			○		–			–			
	Material	Stainless steel (SUS304)	Stainless steel (SUS304) Aluminium	Stainless steel (SUS314)	Stainless steel (SUS304)	Stainless steel (SUS304) Portion: aluminium	Stainless steel (SUS304)	Stainless steel (Portion: aluminium, bakelite)	Shade: aluminium Arm: steel plate	UV stabilized white thermoplastic plates Arm: aluminium	Polycarbonate (20% glassfiber) <Reverse: black color>	Wood
	Diameter[mm]	117	117	100	89	88	88	76	200	130～120	105	1125 (W) 930 (L) 1511 (H)
	Length[mm]	475	457	370	358	423	586	630	420	270	238	
Ventilation speed	Measured	5.0 m/s	5.9 m/s	4.7 m/s	4.3 m/s	2.0 m/s	2.5 m/s	3.6 m/s	–			
	Manufacturer	4 - 7 m/s	4 - 7 m/s	4 - 8 m/s	4 - 7 m/s	About 3 m/s	About 3-4 m/s	About 3 m/s				
Temperature deviation [°C] *1) 6 months	Daily Tmean *2)	Reference (used in JMA operational synoptic station)	-0.1 - 0.0	-0.1 - 0.0	-0.1 - 0.0	-0.1 - 0.0	-0.1 - 0.0	-0.1 - 0.0	-0.1 - +0.2	-0.1 - +0.1	-0.2 - 0.0	-0.1 - +0.1
Aug. 2009	Daily Tmax		0.0 - +0.1	-0.1 - +0.2	-0.2 - +0.1	0.0 - +0.3	+0.2 - +0.5	+0.4 - +0.7	+1.1 - +1.4	+0.4 - +0.6	+0.1 - +0.3	+0.1 - +0.3
	Daily Tmin		-0.1 - 0.0	-0.1	-0.1 - 0.0	-0.1 - 0.0	-0.1	-0.1 - 0.0	-0.3 - -0.1	-0.1 - 0.0	-0.2 - 0.0	0.0 - +0.1
	Daily Tmean		0.0	0.0	0.0	0.0 - +0.1	+0.1	+0.1	+0.2 - +0.4	+0.1 - +0.2	0.0 - +0.1	+0.1 - +0.2
Jan. 2010	Daily Tmax		-0.2 - 0.0	-0.1 - +0.1	-0.2 - 0.0	+0.1 - +0.3	0.0 - +0.2	0.0 - +0.3	+0.7 - +1.1	+0.3 - +0.8	+0.2 - +0.6	0.0 - +0.5
	Daily Tmin		-0.3 - 0.0	-0.3 - 0.0	-0.2 - 0.0	-0.3 - -0.1	-0.3 - -0.1	-0.4 - -0.1	-0.7 - -0.4	-0.3 - -0.1	-0.5 - -0.3	-0.1 - +0.1
	Daily Tmean		-0.1	-0.1	-0.2 - -0.1	-0.1	-0.2 - -0.1	-0.2 - -0.1	-0.2 - 0.0	-0.1 - 0.0	-0.3 - -0.2	-0.2 - -0.1
Effect of global solar radiation Aug. 2009 *3)			-0.1 - +0.1	-0.1 - +0.1	-0.2 - 0.0	0.0 - +0.3	+0.1 - +0.5	+0.2 - +0.6	+0.9 - +1.4	+0.3 - +0.7	0.0 - +0.3	+0.2 - +0.5
Effect of radiation budget Jan. 2010 *4)			-0.3 - -0.1	-0.3 - -0.1	-0.3 - -0.1	-0.4 - -0.2	-0.4 - -0.2	-0.4 - -0.2	-0.9 - -0.4	-0.6 - -0.2	-0.7 - -0.4	-0.4 - -0.1
Effect of rainfall *5)			0	-0.1 - 0.0	-0.1 - 0.0	0.0	-0.2 - -0.1	-0.1 - 0.0	-0.1	-0.1 - 0.0	-0.3 - -0.2	-0.1 - +0.1

*1) Tdev is in a range between 25% and 75% assuming that the maximum value is 100% and the minimum is 0% for each meteorological element. Positive Tdev is shown in pink and negative in blue in cases where the value is more than ±0.2 °C. *2) Daily average temperature for 6 months (August, December 2009, January, February, March and April 2010) from the 10-sec. data. *3) Tdev when1 minute averaged global solar radiation was 700 W/m² or more in Aug. 2009. *4) Tdev when 10 minites averaged radiation budget was −50 W/m² or less in Jan. 2010. *5) Tdev when the rainfall intensity was 2 mm or more for 10 minutes from Aug. 2009 to Apr. 2010.

Item	Tx	SR	Tn	ER	Ra
Class \ Tdev [°C]	Daily Tmax (Aug.)	Effect of global solar radiation (Aug.)	Daily Tmin (Jan.)	Effect of radiation budget (Jan.)	Effect of rainfall
10	0 -		0 -		0 -
9	+0.1 -		-0.1 -		
8	+0.2 -		-0.2 -		-0.1 -
7	+0.3 -		-0.3 -		
6	+0.4 -		-0.4 -		-0.2 -
5	+0.5 -		-0.5 -		
4	+0.6 -		-0.6 -		-0.3 -
3	+0.7 -		-0.7 -		
2	+0.8 -		-0.8 -		-0.4 -
1	+0.9 -		-0.9 -		



Tdev (temperature deviation) of daily temperature (reference: JMA-95(A))



Discussion

(1) **Influences of global solar radiation in August 2009 (Summer):**
- Naturally ventilated screens/shields : This influence produces the largest positive Tdev for AV-040(N) and the smallest for DTR503A(N).
- Artificially ventilated screens/shields : Tdev for PFT-02(A), PVC-02(A) and PVC-03(A) shows some influence of global solar radiation.

(2) **Influences of radiation budget in January 2010 (Winter):**
- Naturally ventilated screens/shields : A negative Tdev is seen from the influence of radiative cooling.
- Artificially ventilated screens/shields : Some negative Tdev is seen due to differences in thermal capacity, insulating layers and the rate of ventilation.

(3) **Influences of rainfall:**
- Naturally ventilated screens/shields : Higher rainfall intensity values give a more remarkably negative Tdev for DTR503A(N).
- Artificially ventilated screens/shields : Little difference in the influence of rainfall is seen except for PVC-02(A).

Conclusions

- Naturally ventilated screens/shields are superior in terms of economy and ease of maintenance. However, in cases where they are used in low-latitude regions, care is required because some types might be affected by strong global solar radiation. It is also necessary to carefully consider the influence of the radiation budget. Such screens/shields should also be used with a good understanding of their structure and characteristics, as some are penetrated by rainwater and do not allow accurate temperature measurement.
- For artificially ventilated screens/shields, an essential requirement to minimize the influence of global solar radiation and the radiation budget is an appropriate insulation structure (insulation material/a heat-insulating layer of air). In addition, the horizontal type of artificially ventilated screens/shields requires care on rainy days because its configuration means that it is easily penetrated by wind and rainwater.