UV SHADE CHART

The method proposed in this research makes possible the design of shades for protecting people against ultraviolet radiation.

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Japan

We don’t know how to evaluate shade against ultraviolet radiation.

I try to find standards or criteria for UV shade design, but I can’t find.

So, we should make evaluation method for UV shade design.

Today, I propose Architectural SPF and UV shade chart for UV shade design.

Is this shade high or low performance against UV ?

Outline

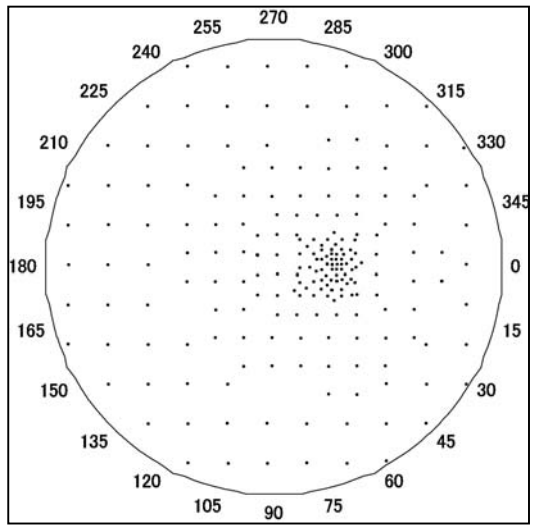
1．Measurement of sky spectrum radiation distribution

①Measurement method、②Sky distribution of UVINDEX

2．How to use UV shade chart for shade

①Architectural SPF、 ②Application

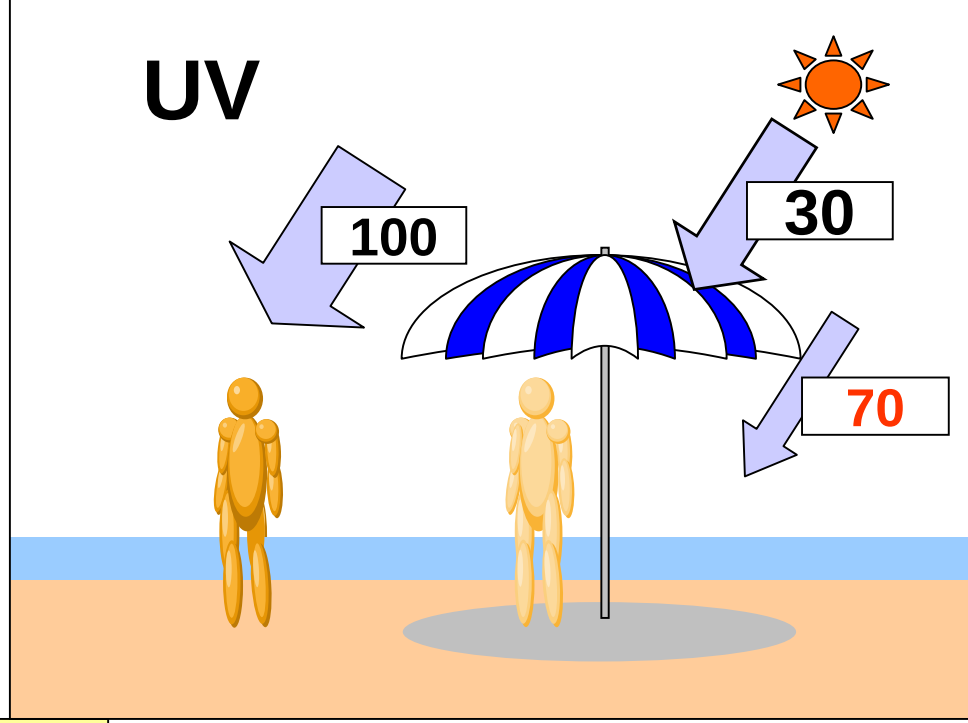
3. Q & A

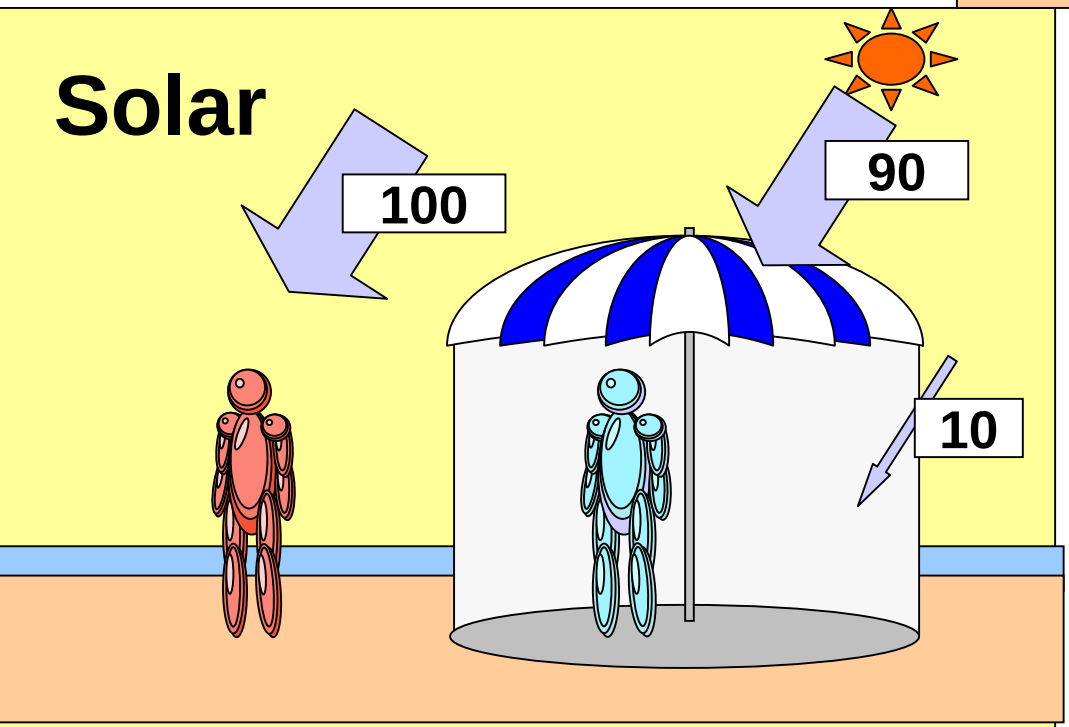


UV shade chart

1. Why we need UV shade chart?

Difference between solar and ultraviolet radiation





Sky UV enters in the shade

We must measure not only global UVINDEX but also UVINDEX of each sky elements.

Sun elevation 70˚

How to made UV shade chart -Measurement-

(1) Spectral Measurements of sky ultraviolet radiation distribution were carried out in at north latitude 35.6° and east longitude 140° in Japan.

(2) Sky ultraviolet radiation spectrums were measured using a combination of an spectrumradiometer and direction/angle scanner at a solar elevation of 50, 60, 70 degrees.

(3) Measurement data were taken 140 case 20,300 data on May 2005 through September 2006. Data in fine weather with cloudiness of 0 and 1 were selected for data analysis.

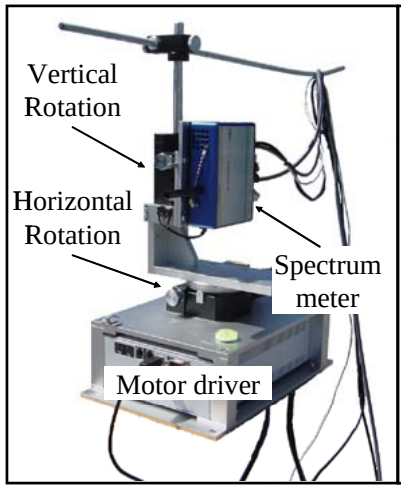


Fig.1 Sensor & Scanner

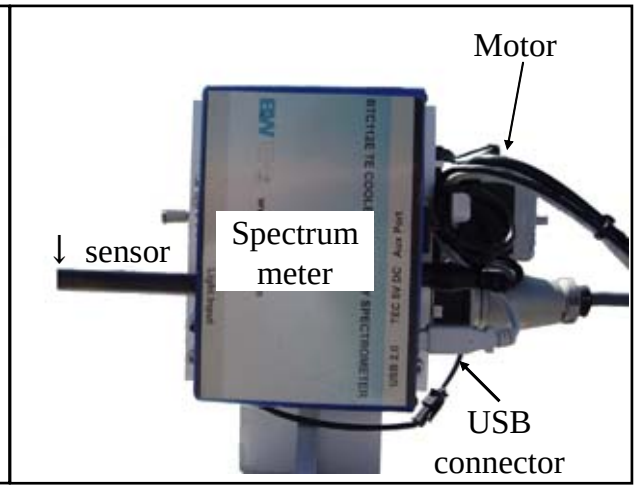


Fig.2 Spectrometer

Measurement Points

(1)Measurements were made for 145 sky elements.

(2)Angle of elevation of

6, 18, 30, 42, 54, 66,78,90°

(3)Azimuth of

12, 12, 15, 15, 20, 30,60 °

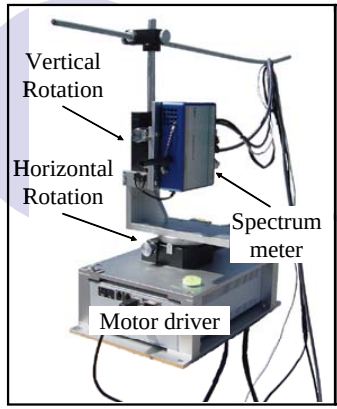


Fig.1 Sensor & Scanner

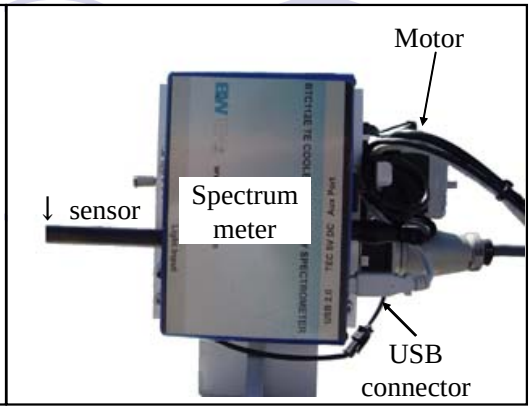
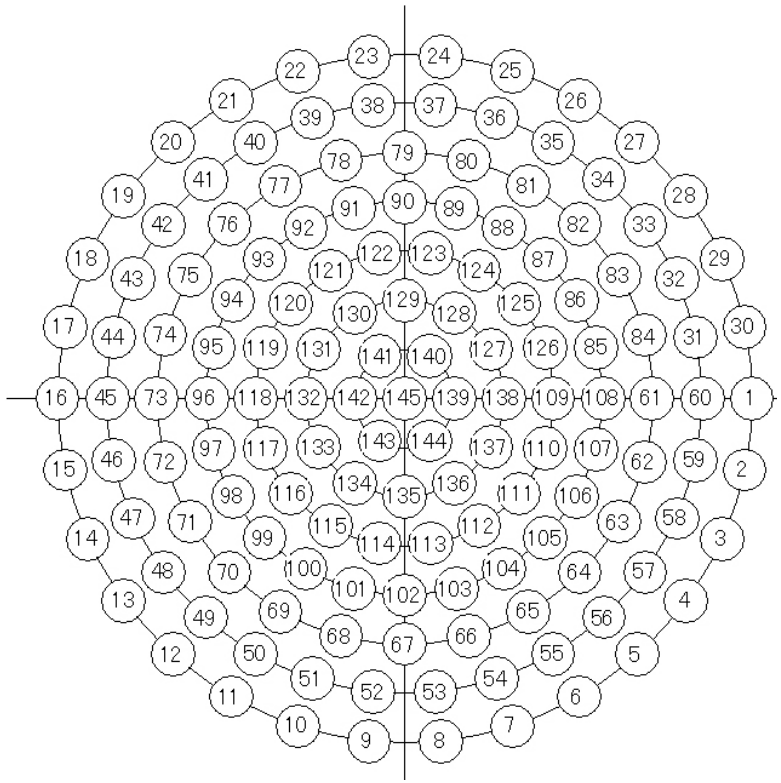


Fig.2 Spectrometer



145 Sky Elements

The distribution of radiance at 310nm.

(i) Radiance is high near the sun.

(ii) Radiance gradually decreases from the sun toward the horizon.

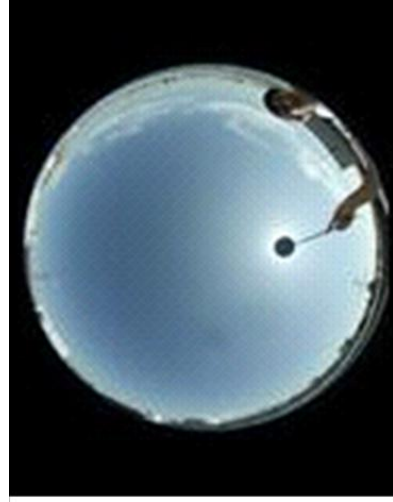
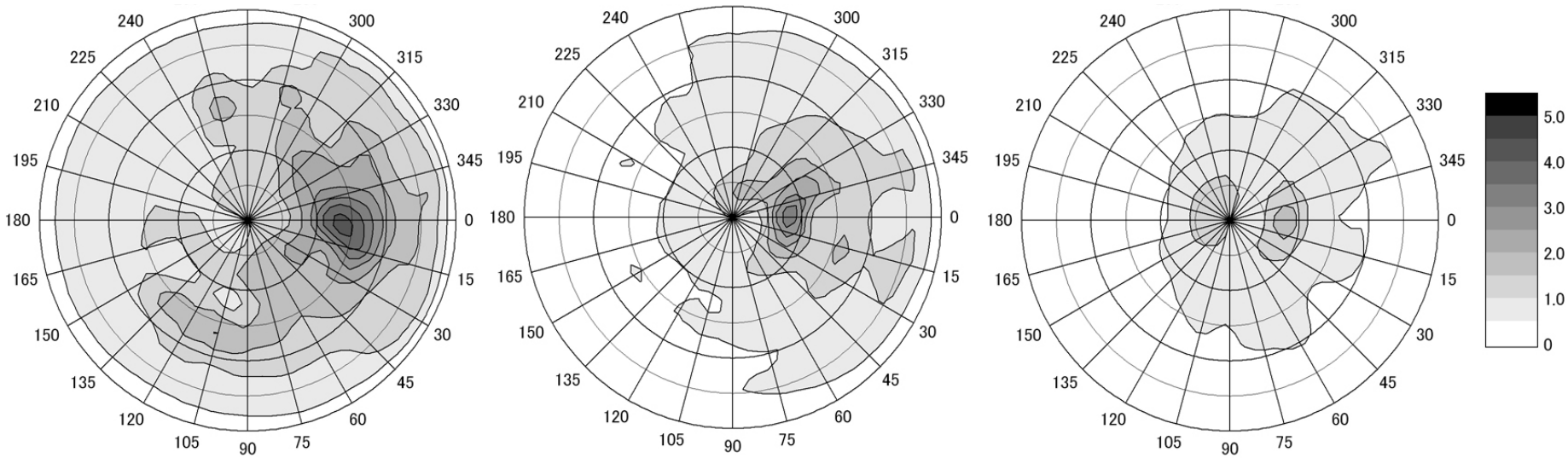


Fig 2 Fisheye

Each Radiance is normalized by zenith radiance.

zenith radiances: sun elevation 50,60,70 are 3.08×10^{-4},4.06×10^{-4},5.32×10^{-4} (W/m^{2}sr)



$h_s=50^\circ$ $h_s=60^\circ$ $h_s=70^\circ$

UV Radiance Distribution

Calculating process to erythema action radiation.

(1)Radiance weighted by erythema action spectrum CIER (Horizontal component)

$$CIER = \int L(\lambda) \times Ery(\lambda) \times \sin h \, d\lambda$$

$$(\lambda = 250 \sim 400\text{nm}) \quad (\text{W/m}^2\text{sr}) \qquad (1)$$

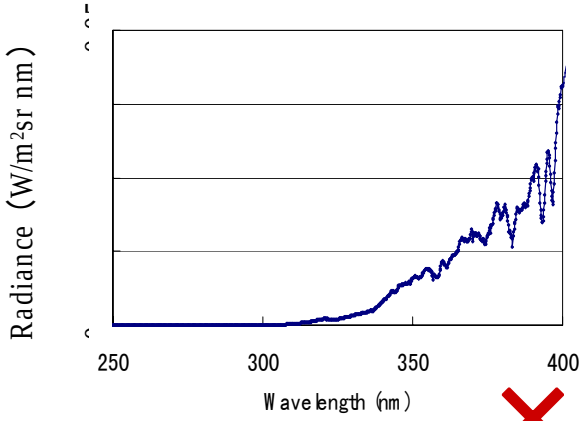
$L(\lambda)$ is solar radiance spectrum, $Ery(\lambda)$ is CIE erythema action spectrum, h is sky elevation.

(2)UVI is obtained by summing up CIER of elevation and direction.

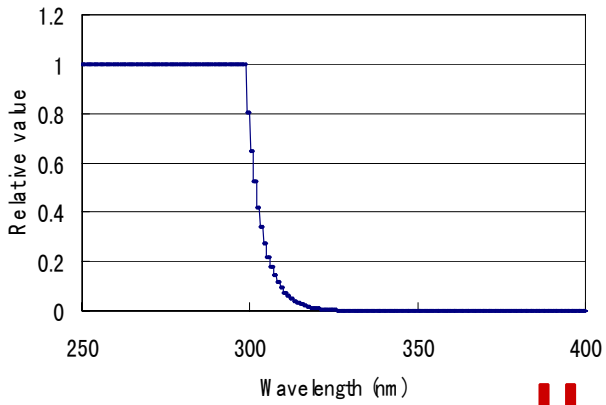
$$UVI = 40 \int \int CIER \, d\theta \, d\phi$$

$$(\theta = 0 \sim \pi/2, \phi = 0 \sim 2\pi) \quad (\text{UVI}) \qquad (2)$$

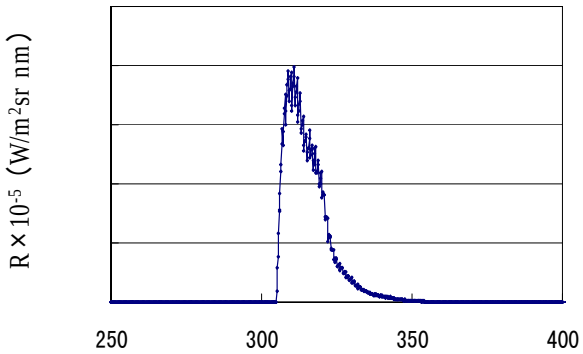
θ is Altitude of sky element. ϕ is direction of the element.



Solar Radiation



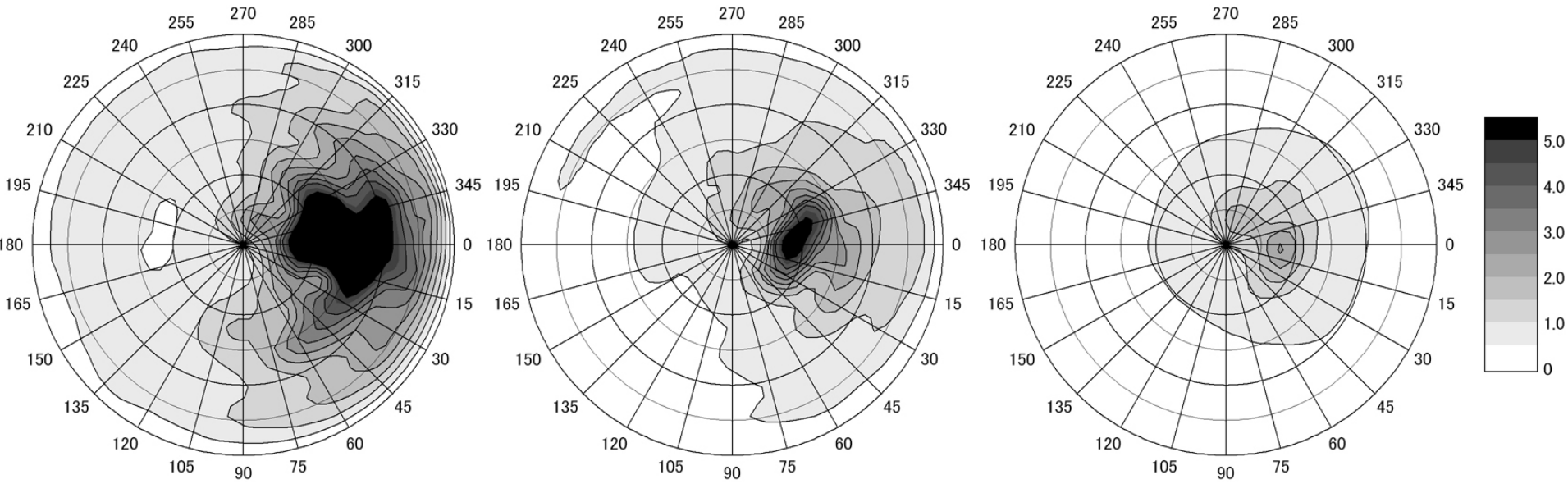
CIE Erythema Action



Erythema Weighted Radiance

Sky Distribution of Erythema Action UV

Figure shows sky distribution of erythema action UV radiance CIER horizontal component at solar elevations. Each CIER is normalized by zenith radiance.



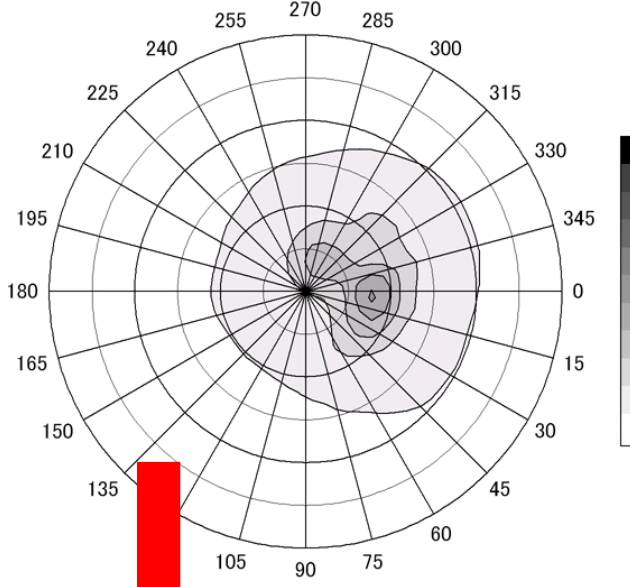
$h_s=50^\circ$ $h_s=60^\circ$

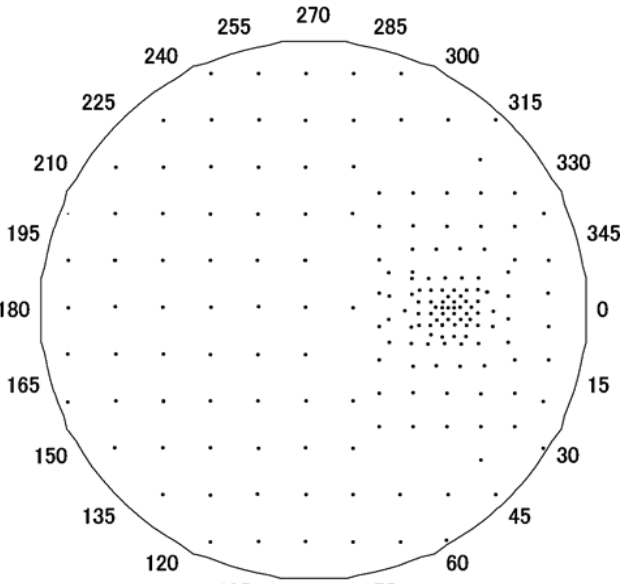
$h_s=70^\circ$

CIER Distribution at Solar Elevations

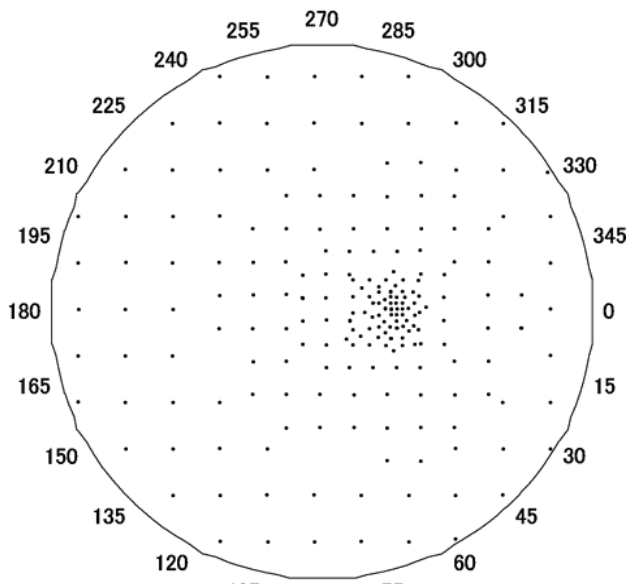
UV Shade Chart

The levels of CIER were represented by points based on space density. UVI equals to summing up the points.

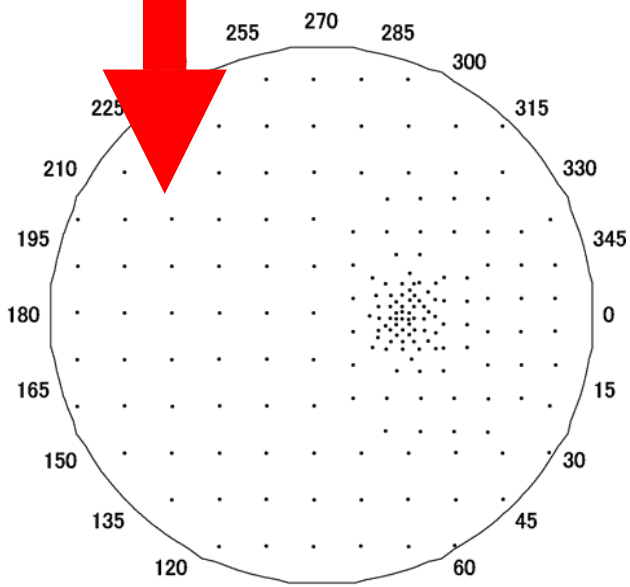




h_s=50



h_s=60,



h_s=70

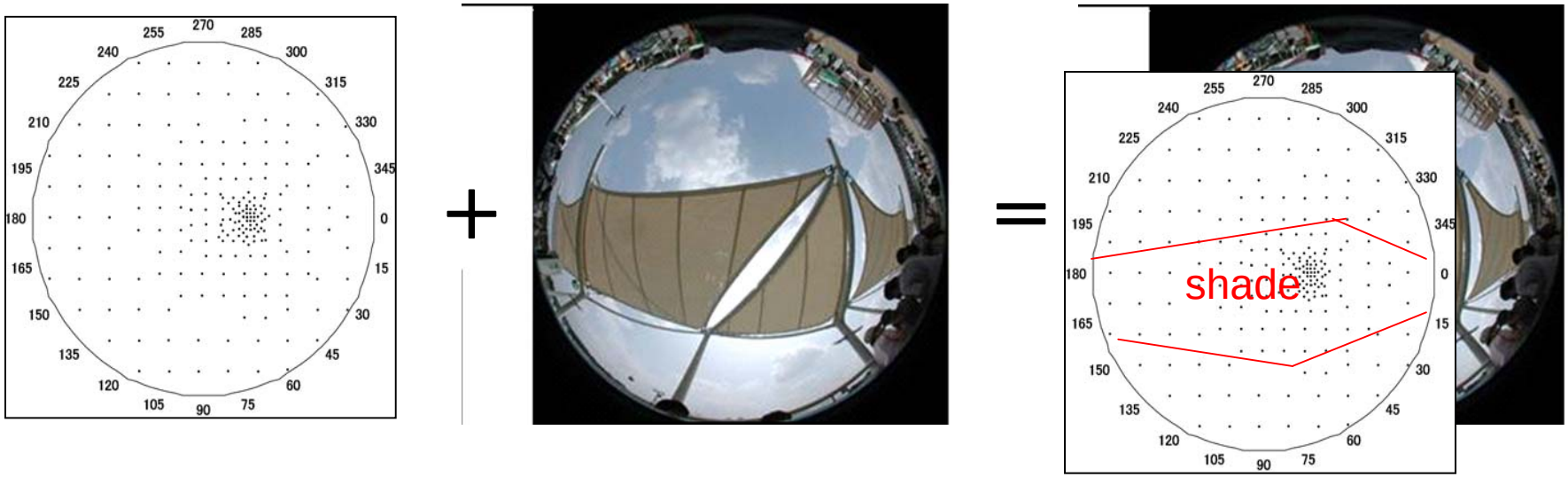
P_t=215

CIER Sky Distributions

2.

How to use UV shade chart and to know ASPF ?

UV Shade Chart + Fisheye Photo



ASPF= UVI out of shade ÷ UVI under shade

=Total points ÷ Points of sky under shade

= 215 / 43 = 5

UV shade chart can be used to estimate ultraviolet exposure under shade

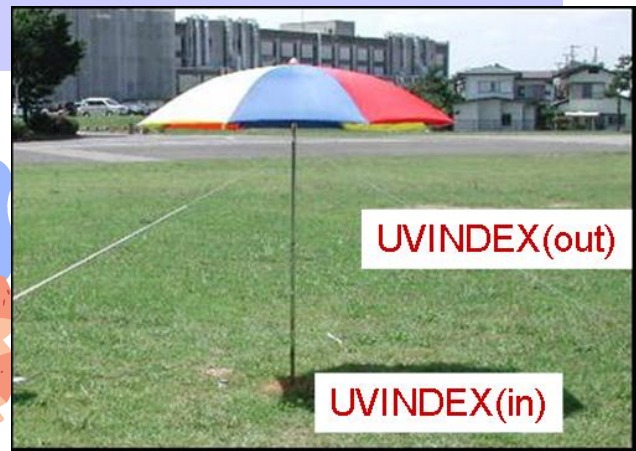
SPF & ASPF

SPF： Sun Protection Factor 太陽防御指数

Use a Sunscreen - SPF 15 or higher on any exposed skin.
Use it an hour before going outside

ASPF: Architectural Sun Protection Factor建築的太陽防御指数
=UVIndex out of shade ÷ UVIndex under shade

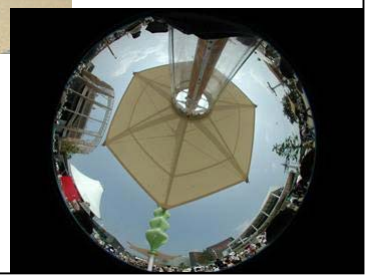
If ASPF equal 5, You can stay 5 time more hour compare with outside of shade.



Application of UV shade chart
ASPF of shade in Japan

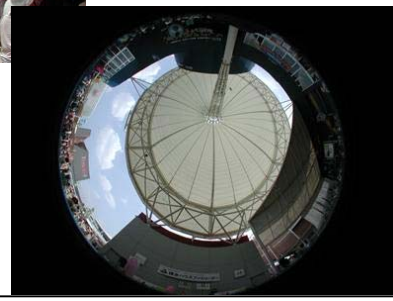
ASPF=7.4

Sunburn Time
148minutes



ASPF=20

Sunburn Time 400min



(1) Analysis Point is on the chair.
(2) Sheet UV transmittance is nearly zero.
(3) Japanese sunburn time is 20 minutes at midsummer, noon, clear sky.
(4) Ground reflection is zero.

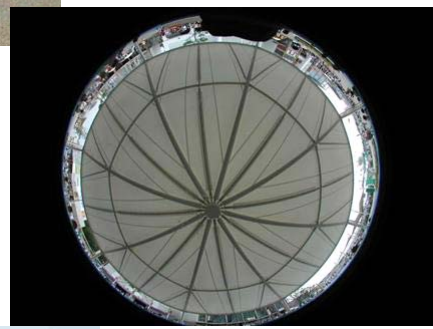
ASPF=11

Sunburn Time

220minutes

ASPF=67

Sunburn Time ∞



ASPF=5

Sunburn Time

100minutes

ASPF=5

Sunburn Time

100minutes

ASPF of Beach Sunshade

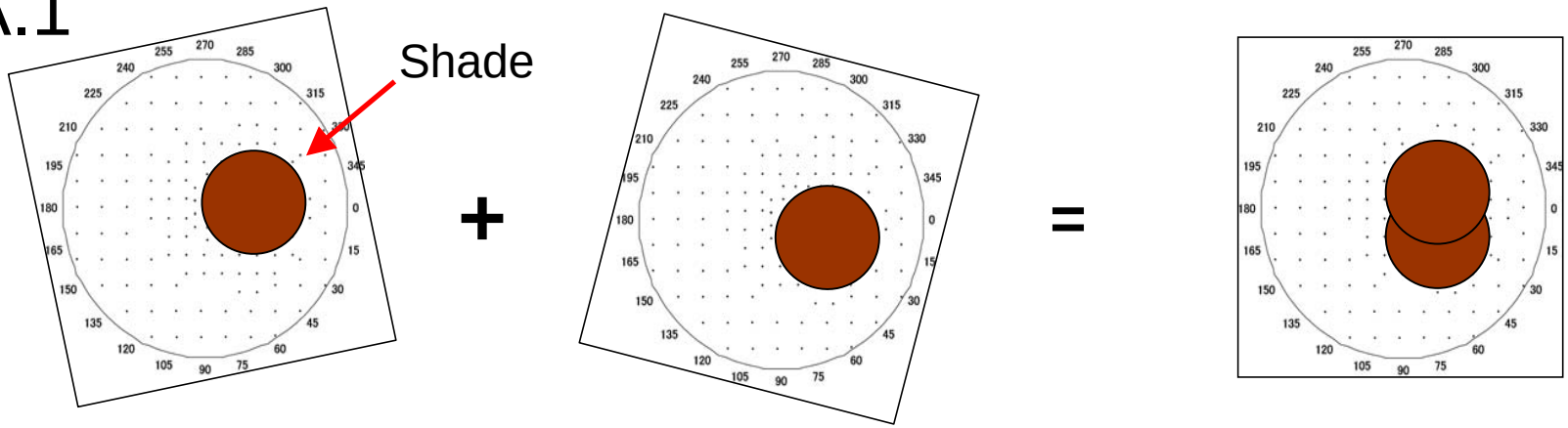
Shade Name	ASPF
a	7
b	6
c	6
d	3
e	3
f	2

40～60minute

3.Questions received to past presentation

Q.1 Sun is moving. How to use the chart for moving.

A.1



AM 11 **PM 1** **AM 11- PM1**

Q.2 Do you have the chart at another sun elevation?

A.2 I have the chart at 50,60,70 degree. I will try to measure at 80,90 degree in this winter. The measurement location will be Singapore.

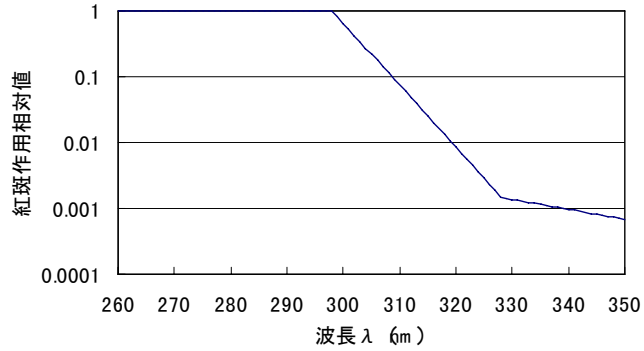
Q.3 What is CIE Erythema Action Spectrum ?

A.3

$S(\lambda)=10^{0}$ （250＜λ＜298nm）

$S(\lambda)=10^{0.094(298-\lambda)}$ （298＜λ＜328nm）

$S(\lambda)=10^{0.015(328-\lambda)}$ (328＜λ＜400nm)



Q.4 What kind of spectrumradiometer using ?

A.4 B&W Tech. BTC

Q.5 How high UVINDEX in Japan ?

A.5 UVI is from 7 to 10 in summer.

Q.6 Is Skin cancer big problem in Japan ?

A.6 No. This research is for high UV radiation area.

Q.7 Can this chart use for design new parasol ?

A.7 Yes!

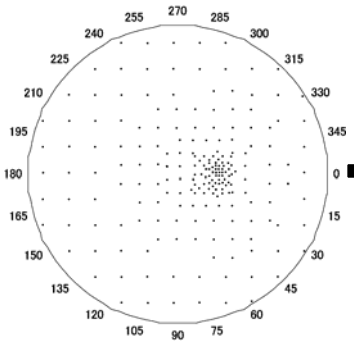
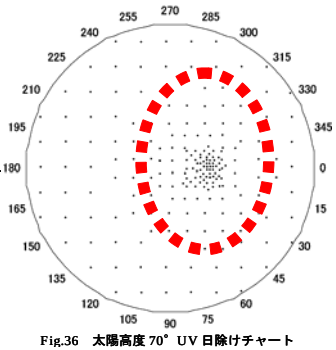


Fig.36 太陽高度 70° UV 日除けチャート



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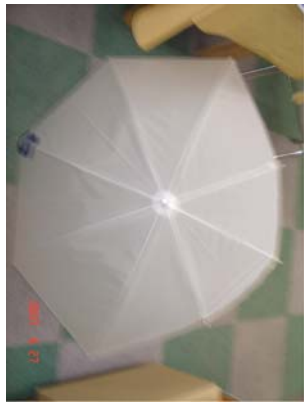


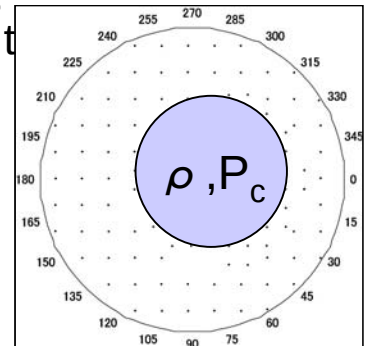
Q.8 How to evaluate the shade at design stage ? There is not fisheye photograph.

A.8 Fisheye type figure can make by computer CAD from a draft for shade.

Q.9 If UV go through shade cloth, how to do.

A.9 UV transmittance of shade ρ、 Points of cloth area P_c, Points of sky area P_s, Points of total P_t

$$ASPF=P_t \div (\rho \times P_c + P_s)$$



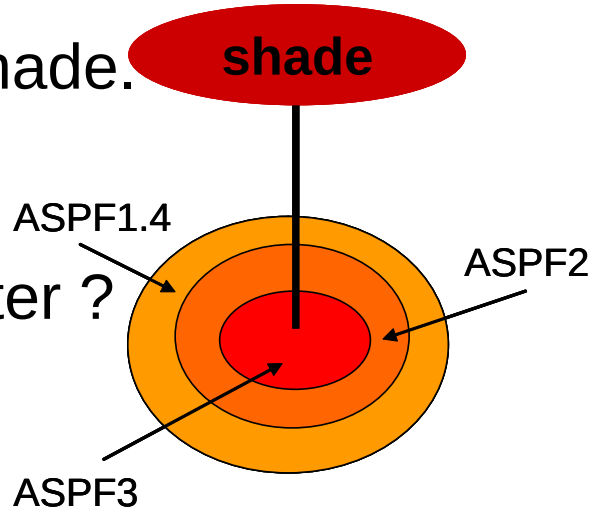
Q.10　Sunburn time is not linear for passage time.

A.10 Right !

ASPF × 20min is approximation value like SPF for sunscreen.

Q.11　ASPF is depend on location under shade.

A.11　Yes!



Q.12 How to calibrate the spectrumradiometer ?

A.12　The meter is calibrated using integral sphere with standard lump in Japan National Polar Institute.

Q13. Can it use on cloudy day?

A13. The chart can’t use on cloudy day. Because using data is for clear day. The shade should be designed for worst condition during a year.

After presentation, I give you transparency UV shade chart.

CONCLUSION

1. Radiance spectrum of sky ultraviolet radiation was measured in solar culmination, summer, clear day.
2. UV shade chart was made by measurement results.
3. ASPF is calculated using the chart.
4. The method proposed in this study makes possible the design of shades for protecting people against ultraviolet radiation.

Thank you

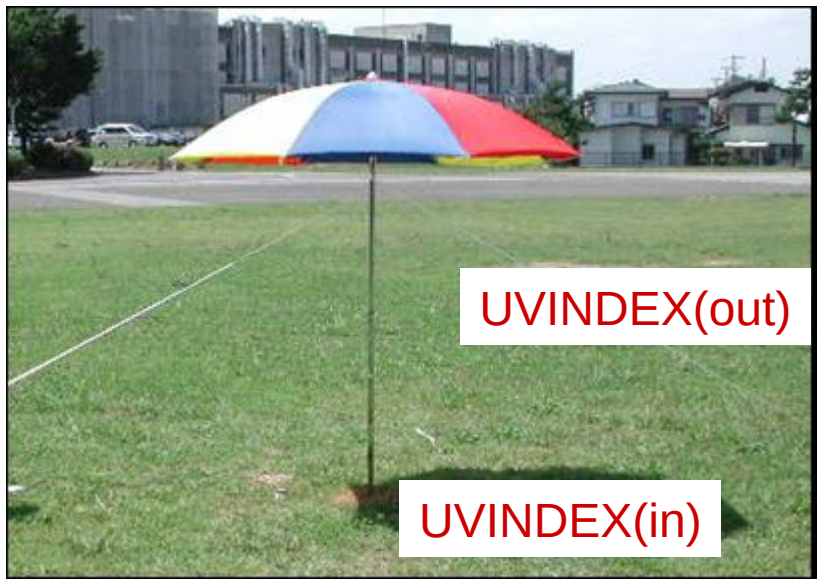
Another Factors of Sunshade

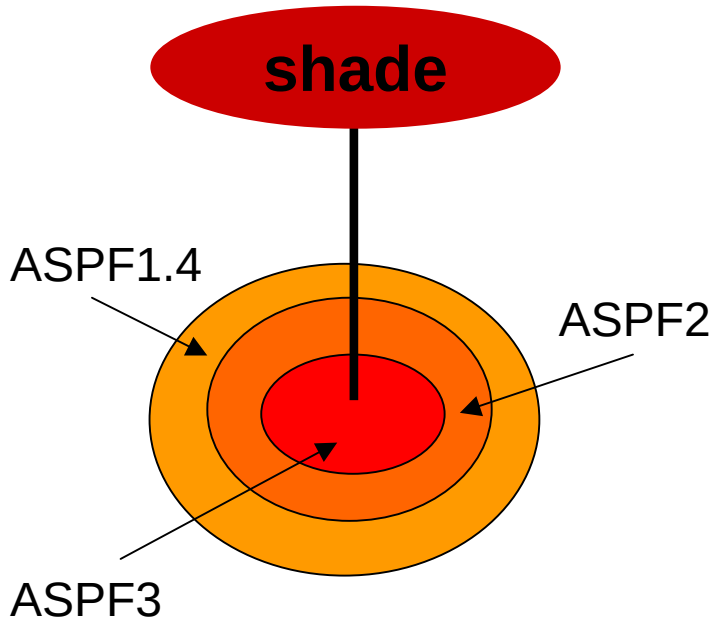
（Condition：Mid Summer、Noon、Clear Sky）

(１) Ultraviolet Sunshade Space (UVSS)

紫外放射日除け面積　（紫外天空率の関数）

UVSS= sunshade space of some UVSF





What shall we do for UV shade design?

1.What is UV shade ?

Difference between solar shade and UV shade.

2.How to evaluate UV shade performance ?

Method, UVINDEX measurement, material, type

Material (Erythema action spectrum transmittance and reflectance)

Type (Awing, Parasol, Tent, others)

3.Can we make standard or criterion of UV shade design ?

Shade design Conditions: Mid summer, Noon(11am-13pm), Fine day, Sun elevation 60,70,80,90(+Tropical and highland area)

4.We must take the data of sky UV and erythema radiance distribution in the world.

5.My proposal is ASPF (Architectural Sun Protection Factor) & UV shade chart

ASPF=5

Sunburn Time

100minutes

How to evaluate the UV shade?
日除けの性能評価は？

There are no standards of shade evaluation,
because ①Shade has existed very long ago.
②It was hard to measure UVB.
③Skin cancer was not big problem.

But now, We need a lot of shade.
Design & evaluation method
are needed.