52 LEVEL AND DIFFUSIVITY CHANGES IN ILLUMINANCES UNDER CLEAR SKIES

Jana Pulpitlova, Richard Kittler,

Masato Oki

Hiroshi Nakamura

(ÚSTARCH SAV Bratislava, Czechslovakia) (Ashikaga Institute of Tech.)(Kyushu University)

Both the level of the daylight illuminance and the diffusivity of the atmosphere are influenced by solar beam penetration, turbidity and cloud conditions.

Currently there are standardized and used only two extreme illuminance states, model of the CIE Overcast and Clear Sky. Though the standardization of the Clear Sky was proposed in 70-ies there is only an expressions for the relative luminance patterns under clear sky conditions with the alternative for two different turbidities¹⁾.

Daylight measurements made recently²⁾ enable to characterize the natural illuminances under the real sky conditions in their absolute values and under different specific turbidities and cloudiness. A general way for the analysis of the measured data is the normalization to the simultaneous extraterrestrial horizontal illuminance level. The ratio of the global to extraterrestrial illuminance level is known as the atmospheric clearness index³⁾ defined by:

$$k_{vt} = \frac{E_{vh}^g}{E_{vo} \cdot \sin(\gamma_s)}$$

where,

E_{vh}^g =global illuminance,

γ_s =solar height,

E_{vo} =extraterrestrial
horizontal illuminance.

$$k_{et} = \frac{E_{eh}^g}{E_{eo} \cdot \sin(\gamma_s)}$$

where,

E_{eh}^g =global irradiance,

γ_s =solar height,

E_{eo} =extraterrestrial
horizontal irradiance.

Fig.1

晴天天空における照度の拡散度と照度レベルの変動

Jana Pulpitlova, Richard Kittler, 沖 允人、中村 洋

This ratio is expressing the effective penetration or filtering effect of the atmosphere depending on the actual solar height, thus the availability of global illuminance (k_{vt}) or irradiance (k_{et}).

The atmospheric diffusivity and turbidity can be expressed by the ratio of diffuse to global illuminances (k_v) or irradiances (k_e). Daylight measurements in Japan, India, Nepal and Australia are characterized in this system on Fig.1. However clear skies defined only subjectively are classified crude according to prevailing turbidities into two categories. The spread of measured data is quite wide and the values are covering various states from very clear and dry atmospheres (concentration of the deep blue cases in the lower part of Fig.1) through humid atmospheres (k_{vt} and $k_v = 0.7 - 0.8$) to very turbid ones, seemingly "overcast" skies ($k_v = 1.0$).

For verifying of the curves for the typical or characteristic clear skies (e.g. deep blue, blue, white-blue, white) we need more illuminance measurement data. Due to the greater base of measurements data on solar radiation and the validity of the $k_t \sim k$ concept in the solar radiation range we tried to compare the curve by de Brichambaut⁴⁾ in the k_e and k_{et} scheme on Fig.2 with the tendency of measured illuminance data⁵⁾ (in k_v and k_{vt} ratios).

$$k_v = \frac{E_{vh}^d}{E_{vh}^g}$$

where,

E_{vh}^d =diffuse illuminance,

E_{vh}^g =global illuminance.

$$k_e = \frac{E_{eh}^d}{E_{eh}^g}$$

where,

E_{eh}^d =diffuse irradiance,

E_{eh}^g =global irradiance.

Acknowledgments

The authors wish to express their thanks to the useful informations of Mr.Masanobu Nishimura, Daido Institute of Technology, Japan.

References

- (1)CIE:Standardization of luminance distribution on clear skies, Publ. CIE No.22, Paris, 1973.
- (2)Nakamura,H., Oki,M.:Study on the statistic estimation of the horizontal illuminance from unobstructed sky, Journal Light and Visual Environment, Vol.3, No.1, pp.23-31, 1979.
- (3)Kittler, R.:A new concept for standardizing the daylight climate state, Proceedings of 6th LUX Europa Congress, Vol.1, pp.303-312, Budapest, 1989.
- (4)de Brichambaut,P.: La Météorologie, VI série, No.5, pp.129-158, 1976.
- (5)Nishimura, M.:Personal information, Daido Institute of Technology, 1989.

Fig.2