

**DEFINING OF SKY TYPES FOR THE WESTERN PART OF  
UKRAINE BASING ON DSTU ISO 15469:2008 (CIE S 011/E:2003)  
«SPATIAL DISTRIBUTION OF DAYLIGHT – CIE STANDARD  
GENERAL SKY»**

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***Summary.*** Basing on DSTU-N B V.1.1-27:2010 «Building climatology» and satellite data was done an analysis light-climatology conditions of the western part territory of Ukraine for the subsequent defining of inherent standard sky types by DSTU ISO 15469:2008 (CIE S 011/E:2003).

***Keywords:*** a build climatology, light climatic districting of territory, sun light radiation, standardized MKO type of firmament.

*Formulation of the problem.* One of basic questions in build light physics there is a study of the states of firmaments after light descriptions. The results of labours are become by the mathematical models of firmaments, which give possibility to expect both the brightness of arbitrary areas of sky and luminosity, in points on the planes arbitrarily located in space. Now wide application is acquired by a model standardized the International commission on luminosity (MKO) [1], accepted on territory of Ukraine as DSTU ISO 15469:2008 [2]. As the indicated norm gives mathematical description of model only, actual is determination of gradation of the standardized types of firmaments for territory of Ukraine on the basis of existent climatology information after DSTU-N B.V.1.1-27:2010 [3].

*Analysis of recent research.* From the moment of introduction of standard of ISO 15469 in Europe (in 2004) the already conducted researches of gradation of types of firmaments for Hong Kong [4], Chile [5] and Singapore [6]. Detailed description of algorithm of selection of types and determination of group of the standardized types of sky for m. Kyiv, Ukraine done in [7].

*Formulation of article purposes.* Determination of accordance of the light physics states of firmaments of territory of western part of Ukraine (16 regional centers) is to the standardized types of sky after MKO [1].

*Main part.* A standard [1] is inculcated by 15 types of firmaments which are divided after cloudiness on 3 groups for 5 types – cloudy sky, with a variable cloudiness, cloudless. To each characteristic coefficients [tabl.1, 2] which are put in the formula of calculation of relative brightness

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of element of sky answer of types of firmaments:

$$\frac{L_{\gamma}}{L_z} = \frac{f(\chi) \cdot \varphi(Z)}{f(Z_s) \cdot \varphi(0)} = \frac{(1+c \cdot [\exp(d\chi) - \exp(d\pi/2)] + e \cdot \cos^2 \chi) \times (1+a \cdot \exp(b/\cos Z))}{(1+c \cdot [\exp(dZ_s) - \exp(d\pi/2)] + e \cdot \cos^2 Z_s) \times (1+a \cdot \exp b)}, \quad (1)$$

where a,b,c,d,e are coefficients which determine the group of gradations and indicatrixs of the standardized type of sky [8, s.20-21].

Determination of types of firmaments is based on the detailed description of mathematical model after [8] and by the offered method in [7]. In accordance with the method of adoption of the light-climatic districting of territory of the USSR [9, s.28] for calculations average annual information is select. Basic initial information is climatic information after a table. №№ 2, 8, 24 [3] and satellite information in relation to a brightness in a zenith in cities [10], that in the moment of writing of the article present only for western part of Ukraine in the period of 1996 to 2000 years (tabl.1).

In accordance with [8] by a main parameter which characterizes the type of firmament for concrete locality is  $L_z/D_v$  correlation of brightness in a zenith to horizontal diffuse luminosity under the opened firmament. As there is satellite information by instantaneous light sizes, and a value of diffuse luminosity is total for a month power sizes, for correct correlation of information it is needed to conduct the row of transformations:

1. To find the average annual value of power diffuse sun radiation. On the basis of information after a table. 8 [3] for 12 months hatches mean arithmetic value.

2. To expect the instantaneous value of the dissipated radiation. Determination takes place by a programmatic complex "Atmospheric of radiation", being based on the calculation of length of light day for civil twilights, which is resulted in [11].

3. To define a light equivalent on the basis of spectral composition of sun radiation and expect the average annual instantaneous value of horizontal diffuse luminosity. The light stream of source settles accounts with a continuous spectrum:

$$\Phi = 683 \int_{380}^{780} \Phi_{e\lambda}(\lambda) V(\lambda) d\lambda, \quad (2)$$

where  $\Phi$  – is a light stream, Lm;

$\Phi_{e\lambda}(\lambda)$  – it is a spectral fluence radiation;

$V(\lambda)$  – it is relative spectral light efficiency.

A spectral fluence is expected by a programmatic complex «SMARTS», developed the National laboratory of renew energy, USA [12]. By the result of calculation of spectral closeness given in relation to power of stream of light for an elementary wave-length (fig.1, 2).

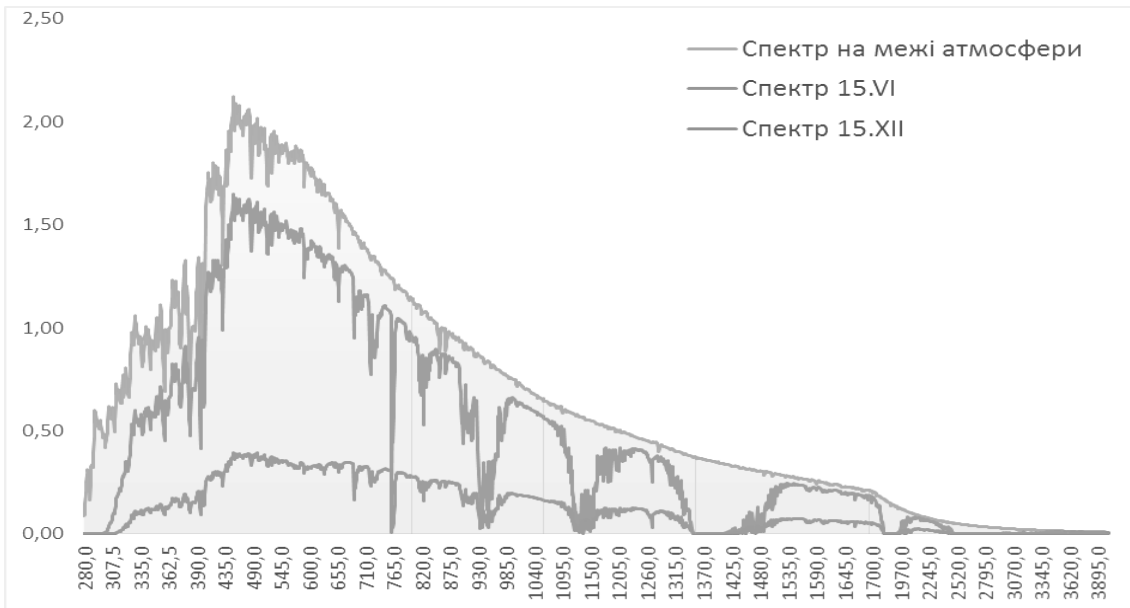


Fig. 1. Graphic arts of spectral composition of sun radiation for Kyiv city 1200 hour 15.VI but 15.XII on verge of atmosphere and on a horizontal terrene.

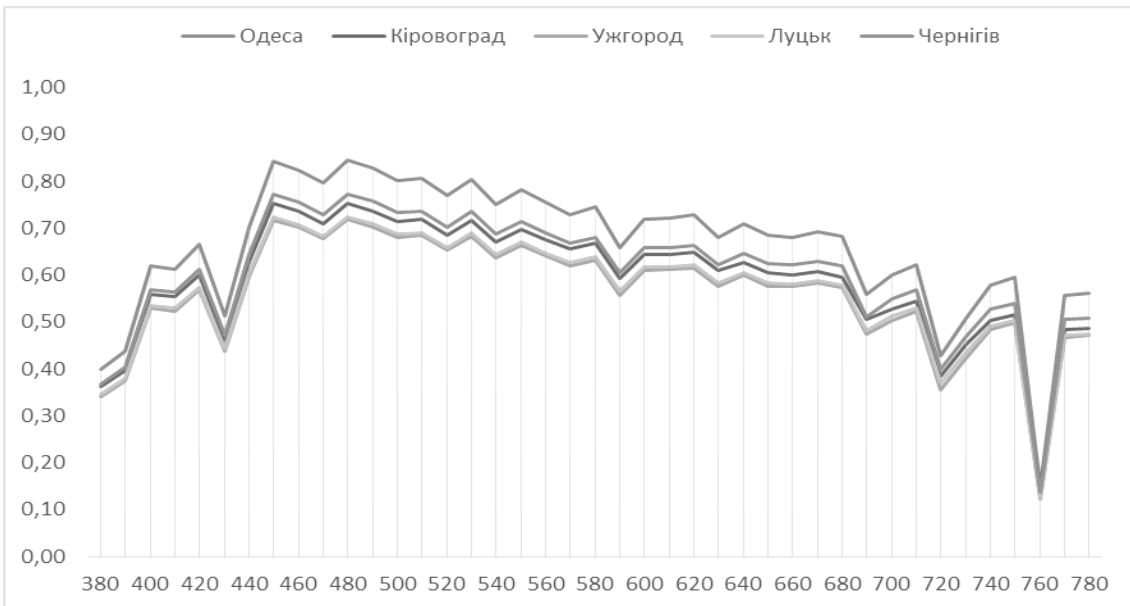


Fig. 2. Graphic arts of average annual spectral composition of sun radiation are in a visible range on a horizontal terrene cities of Ukraine.

On the basis of findings and charts of distributing of spectrum the got coefficients of relative spectral closeness of radiation are with a step through 10 nm (tabl.1), and value of light equivalent for a sun radiation.

Таблиця 1.

Summary of initial data, intermediate calculations and determine the type of standardized sky.									
№ п/ п	city Name	$D_v$ річ сеп, MJ/m <sup>2</sup>	$D_v$ річ сеп , W/m <sup>2</sup>	$D_v$ річ сеп , Lm	$L_z$ річ сеп , Kd/m <sup>2</sup>	$L_{zсеп}$ / $D_{vсеп}$	$D_v$ розр Lk	$D_v$ річ сеп/ $D_v$ розр , %	Type heaven
1	Vinnytsia	164,66	114,33	18221	4450	0,24	18251	0,16	III. 4
2	Zhytomyr	164,25	115,44	18252	4483	0,24	18386	0,72	
3	Ivano-Frankivsk	161,83	112,42	18223	4460	0,24	18615	1,55	
4	Kyiv	167,41	117,67	18166	4315	0,23	18242	2,10	
5	Kirovohrad	169,91	118,03	18695	4434	0,23	18576	0,41	
6	Lutsk	162,33	114,09	18035	4097	0,23	17635	0,64	
7	Lviv	161,33	112,02	18206	4472	0,24	18842	2,26	
8	Odessa	166,25	120,03	19026	4517	0,23	18734	3,37	
9	Rivne	162,41	114,15	18035	4175	0,23	17657	2,14	
10	Sumy	161,08	113,21	18025	4090	0,23	17297	4,20	
11	Ternopil	161,16	111,90	18254	4461	0,24	18780	2,80	
12	Uzhhorod	163,16	115,43	18226	4416	0,24	18504	1,50	
13	Khmelnitsky	161,00	111,78	18217	4445	0,24	18704	2,60	
14	Cherkasy	166,75	117,17	18246	4432	0,24	18652	2,17	
15	Chernivtsi	163,58	113,63	18771	4514	0,24	18901	0,68	
16	Chernihiv	168,75	117,16	17734	4085	0,23	17347	2,23	

As for calculations the usednened indexes of the physical and chemical state of atmosphere were elected, accept, that light climatic descriptions of area answer descriptions of regional centers. On the basis of findings conduct light climatic zonuvannya of the considered part of territory of Ukraine.

*Conclusions.* As a result of research certainly following:

1. For 16 regional cities of Ukraine is the average annual value of brightness expected in a zenith which is within the limits  $4085 \div 4517$  Kd/m<sup>2</sup>.

2. Graphic arts and tabular information of average annual spectral composition of sun radiation are got. On the basis of the resulted information are light equivalents for diffuse luminosity, which are evened  $0.006054 \div 0.006607$ .

3. As correlation of horizontal diffuse luminosity to the brightness, changing in every town, remains in one numerical limit (0,227-0,243), for territory of western part of Ukraine the type of firmament is № III.4 in accordance with [2].

4. Results of translation of horizontal diffuse luminosity from a power size to light comparison  $D_{v \text{ річ сеп}}$  with the calculation values of horizontal luminosity after a mathematical model [2] with the certain type of firmament. Is a relative error  $0,16 \div 4,20 \%$ , that testifies to authenticity of electing as a firmament for the considered territory.

5. On the basis of information the combined map is offered light climatic districting of western part of territory of Ukraine after an index «horizontal diffuse luminosity / a brightness is in a zenith».

6. Subsequent researches will be directed on extrapolation of the got results on all territory of Ukraine and clarification of the normative light climatic districting of territory of Ukraine and method of calculation of natural illumination of apartments.

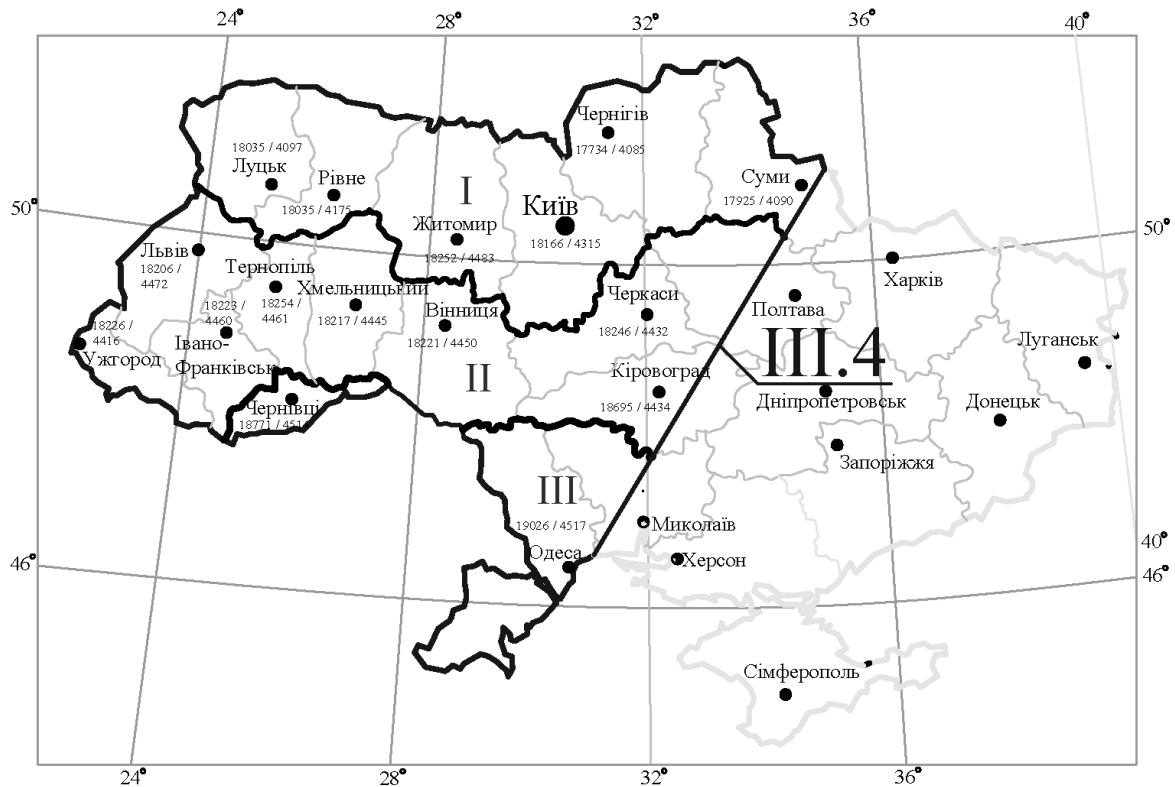


Fig. 3. Light climatic of districting of territory of western part of Ukraine after horizontal diffuse luminosity / by a brightness in a zenith and type of firmament.

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