

# GEOMETRICAL MODELING OF THE TERRITORY OF UKRAINE CLIMATIC ZONES OVER THE COOLING PERIOD

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**Summary.** Modeling of climatic zones of Ukrainian territory during the cooling periods is being developed in order to improve the regulatory framework for the energy certification of buildings.

**Keywords:** climatic map, the period of cooling, climate data, microclimate, temperature zone.

*Formulation of the problem.* In modern construction attention is increasingly focused on improving people's comfortable stay in buildings. Achievement of optimal microclimatic conditions is important not only in the cold season that most experts usually emphasize, but also in hot period.

Currently new edition of the construction standards of thermal insulation of buildings is being developed; work is being finalized concerning standard of calculating method the energy consumption at heating, cooling, ventilation, lighting and hot water. These documents include assessment of Energy Performance of Buildings by year operation period. To evaluate the cost of buildings cooling need to know duration of use the cooling systems, which primarily depends on the climatic conditions of the construction area. For the certification purposes is expected establishing the fixed values of the cooling period duration of Ukrainian zones temperature according to [1]. However, these zones are set according to climatic conditions of winter period and using them for summer period may be incorrect. This in turn may lead to errors in the certification of buildings. Therefore climatic zoning of Ukraine according to period of cooling and determining representative indicators for each area is the actual problem.

*Analysis of recent research.* Data on the climatic characteristics of the construction area, technical requirements for equipment and microclimate facilities conditions, that depends on the destination premises, are necessary for the engineering systems calculation.

The main document in Ukraine, which establishes climatic characteristics, which are used in designing of building objects and engineering systems, is called ISO-H B V.1.1-27: 2010 "Building Climatology" [2] and was passed in 2011. On its basis is currently being developed ISO project-H B-XXX A.2.2: 201H "Method of calculating the energy consumption at heating, cooling, ventilation, lighting and hot water

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supply" [3], which defines the method for calculating the energy consumption and establishes national decision relating to the calculation method assessment of the annual energy consumption of buildings at heating and cooling according to ISO B EN ISO 13790 [4]. But these documents do not define the length of the cooling period, so it is necessary additionally determine.

Microclimate parameters corresponding to the appointment of premises are defined in [5]. Limit temperature readings internal air for the heating period and the period of overheating are defined in Annex A [6]. But these two documents do not determine what the temperature is a basic, i.e. starting from which the outside air temperature is necessary to use air cooling system (cooling period).

For EU countries is a basic temperature value  $18^{\circ}\text{C}$  [7], for USA -  $65^{\circ}\text{F}$  ( $18,33^{\circ}\text{C}$ ) [8]. In many papers is noted the need to establish a base temperature depending on the climatic conditions of the country [9,10,11], and a higher value (to  $23^{\circ}\text{C}$ ) is proposed to use for countries with warm and hot climates. In the Soviet Union the overheating period was considered the period with temperatures above  $21^{\circ}\text{C}$ . During this period it was necessary to protect people from sun rays, to count heat resistance of external enclosures and more.

For Ukraine, the basic temperature of the cooling period beginning not entered, which negatively affects the quality of engineering systems designing of buildings.

*The formulation of article purposes.* Proposals development for modeling of climatic zones of Ukrainian territory during the cooling periods for certification energy efficiency purposes of buildings, improvement of the Ukrainian regulatory framework in the field of construction, and the formulation of future researches in this scientific area.

*Main part.* Duration of cooling period depends on the value of the basic temperature. On the basis of climate data in Ukraine and the method that is given in [12]; was calculated the length of the cooling period for the basic outdoor air temperature as  $18-21^{\circ}\text{C}$ , with a gradation of  $1^{\circ}\text{C}$  (Table. 1).

Surface distribution of the length of the cooling period for each indicator baseline temperature over the territory of Ukraine was built based on data from the table and with using MatLab software system. For this surfaces division into districts in two or three areas was carried out. The resulting map schema for basic temperature  $21^{\circ}\text{C}$  is shown in Figure 1.

In the analysis of climatic maps for different basic temperatures at 2 and 3 temperature zones is defined, that the most optimum is distribution in Ukrainian territory into two temperature zones with the basic temperature of  $21^{\circ}\text{C}$ . The basic temperature of  $21^{\circ}\text{C}$  more reliably describes the geographical location of the Ukrainian territory as a country with a

temperate climate. It will allow to create rational microclimate conditions of premises without excessive energy consumption for air cooling.

Table 1

Annual duration of cooling period.

	Settlement	Duration of cooling period (year) depending on the basic temperature (° C)			
		18°C	19°C	20°C	21°C
1	2	3	4	5	6
1	Vinnitsa	1297	1070	848	614
2	Dnipropetrovsk	1847	1589	1361	1156
3	Donetsk	1680	1443	1218	1008
4	Zhitomir	1204	980	762	552
5	Zaporozhye	2016	1737	1490	1277
6	Ivano-Frankivsk	1228	968	764	484
7	Kyiv	1472	1228	860	740
8	Kirovograd	1540	1398	1182	992
9	Lugansk	1859	1648	1441	1254
10	Lutsk	1191	966	742	526
11	Lvov	1056	829	581	368
12	Nikolaev	2112	1822	1582	1342
13	Odessa	2094	1435	1278	1075
14	Poltava	1611	1372	1144	909
15	Rovno	1169	927	695	474
16	Simferopol	1938	1668	1413	1205
17	Sumy	1514	1170	957	744
18	Ternopil	1097	870	631	423
19	Uzhgorod	1733	1478	1232	877
20	Kharkov	1620	1409	1155	924
21	Kherson	2020	1763	1542	1304
22	Khmelnitsky	1213	970	759	518
23	Cherkasy	1573	1344	1112	888
24	Chernivtsi	1384	1139	885	650
25	Chernihiv	1333	1113	892	698
26	Yalta	2436	2090	1802	1550

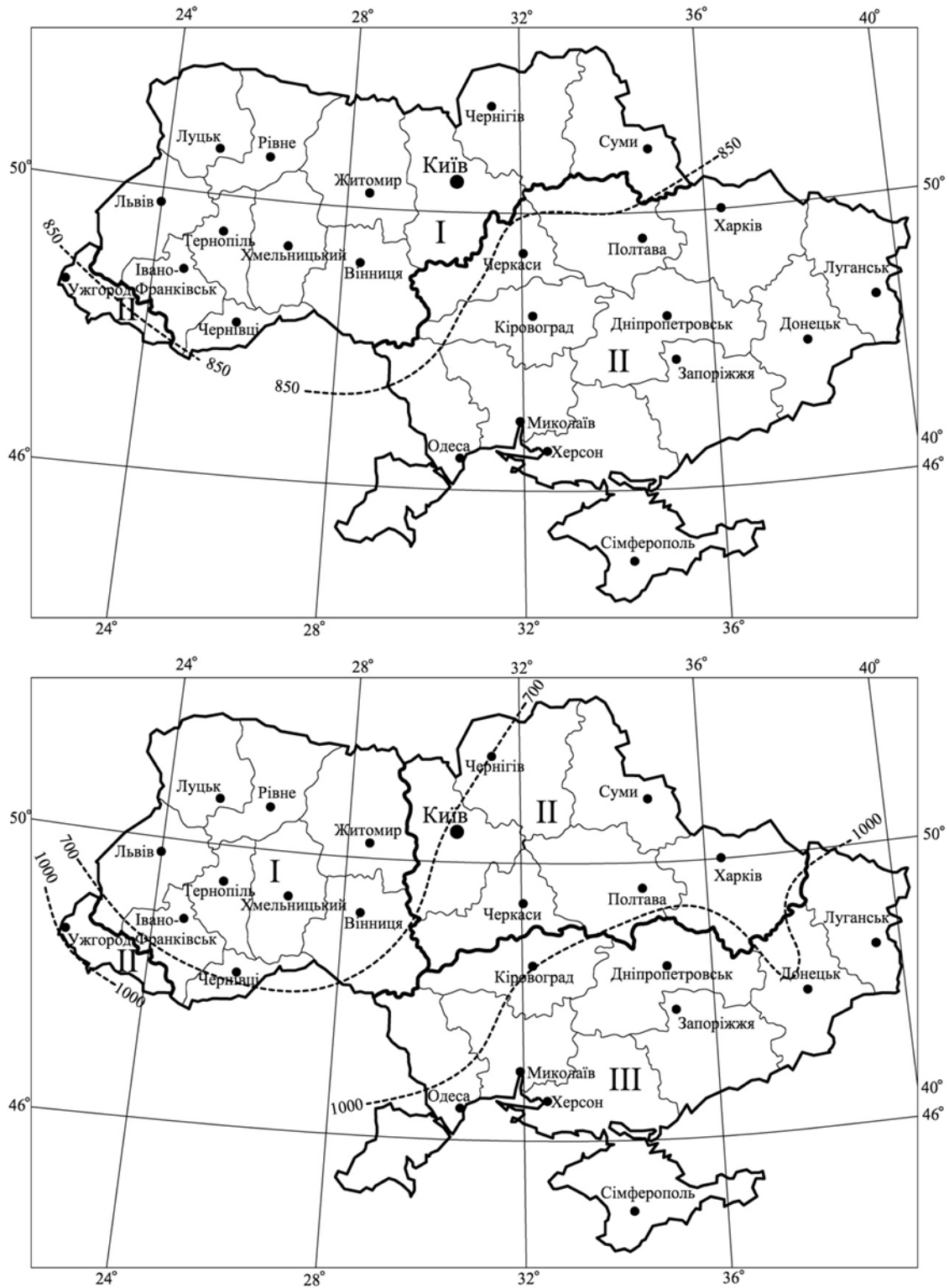


Fig. 1. Examples of climatic zoning of the Ukrainian territory according to the cooling period with basic temperature 21 °C  
 a - in two areas; b - in three areas.

*Conclusions.* Application of the proposed zoning of Ukraine according to the cooling period with basic temperature of 21 °C will enable

more correctly determine the energy efficiency class for the certification of buildings. But for this purpose it is better to use the duration value of the cooling period directly from the table 1 for the regional center.

In the future determining the cooling period in each climatic area, depending on the orientation of the facade areas, is planned. For this you can use the integrated solar maps.

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