CHANGES IN THE CONTINENTALITY INDICATORS OF THE NORTHWESTERN BLACK SEA CLIMATE IN THE CONTEXT OF GLOBAL CLIMATE TRANSFORMATIONS

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Global climate warming, which was recorded at the end of the 20th century and continues in the 21st century, requires the study of regional responses in Ukraine during the period of planetary climate change. Socio-economic and environmental problems that have arisen as a result of global climate transformations remain relevant today [1-4]. The widespread use of data on the thermal state of territories for scientific and practical purposes requires climatologists to study various indicators that will allow them to assess the dynamics of the thermal regime and continentality of the modern climate of individual regions of Ukraine.

As is known, one of the key characteristics determining the continentality of the climate is the annual amplitude of air temperature, which is an indicator of climate dynamics. It is also important for many industries and agriculture. Based on the annual amplitude of air temperature, scientists have developed some quantitative characteristics of climate continentality (continentality indices), which are based on one or another functional dependence on the annual amplitude of air temperature [5,6].

But for the Northwestern Black Sea Region, which is the leading highly developed industrial and agricultural region of Ukraine, this issue in the context of global climate change has hardly been studied, despite its importance and relevance. Underestimation of certain aspects of the spatiotemporal structure of the annual amplitude of air temperature and climate continentality (as an indicator of global climate transformations) is important from both scientific and practical points of view.

The research direction corresponds to the objectives formulated in the scientific and research works of the Department of Meteorology and Climatology of the Faculty of Hydrometeorology and Ecology of the Odesa I.I. Mechnikov National University, and in particular with the topic: “Zoning of Ukraine by degree of vulnerability to climate change and selection of optimal adaptation pathways” (No. DR 0125U001204). The subject of the study is the series of average daily air temperatures at stations in the Odesa region for the period 1901-1960 and 1991-2023 [7], standard norms of individual temperature indicators from the climatic Cadasters of Ukraine: 1961-1990 [8] and 1991-2020 [7]. Classic statistical methods of empirical data evaluation [9] were used, followed by their spatial and temporal generalization across the studied territory. The analysis of the dynamics of the annual air temperature amplitude was carried out by comparing the temperature components for two climatic periods: 1961-1990 and 1991-2020. The amplitude was determined as the difference between the average air temperature of the warmest and coldest months of the year [5].

Table 1 shows the average monthly air temperature in January and July and the annual air temperature range for 10 stations in the Odesa region. The highest values are shown in bold, and the lowest in bold italics; positive trends, determined by comparing two standard thirty-year periods, are marked with a “+” sign, and negative trends with a “-” sign.

As can be seen from Table 1, during the period 1961-1990, the annual amplitude varied across the Odesa region from 22.9°C (Vilkovo station) to 25.0°C (Lyubashivka station); in the following thirty years – from 23.1°C (Izmail station) to 25.4°C (Serbka station). The average for the region ranged from 24.0°C (1961-1990) to 24.5°C (1991-2020).

In addition, analysis of a long-term database for the period 1901-2023 shows that in the area of meteorological stations in the Odesa region, January remains the coldest month of the year with a recorded increase in the average monthly air temperature from the period 1961-1990 to the period 2001-2013, but with different growth rates in the north and south of the region. The same trends are observed in the region in terms of the warmest month of the year: in the period 1961-1990 and 2001-2010, it was July, while in 2013-2023, the highest temperatures were recorded in August. At the beginning of the 21st century, changes in the indicators that form the annual amplitude became more intense (compared to the period 1961-1990) in the south than in the north.

Table 1. Average monthly air temperature (t, °C) and annual amplitude (A, °C) for two standard climatic periods (ΔA, °C: 1991-2020 – 1961-1990)

No	Station	*1961-1990*			*1991-2020*			ΔA,°C
		Month		A, °C	Month		A,°C	
		01	07		01	07		
1	*Lyubashivka*	***-5,0***	***20,0***	**25,0**	***-3,1***	***21,8***	24,9	-0,1
2	*Zatyshshya*	-4,3	20,6	24,9	-2,7	22,4	25,1	***+0,2***
3	*Serbka*	-3,6	21,3	24,9	-2,2	23,2	**25,4**	+0,5
4	*Rozdilna*	-3,6	21,0	24,6	-2,3	23,0	25,3	+0,7
5	*Odesa*	-1,7	21,4	23,1	-0,4	23,4	23,8	+0,7
6	*B.-Dnistrovsky*	-1,4	22,1	23,5	-0,5	**24,2**	24,7	**+1,2**
7	*Sarata*	-2,0	21,6	23,6	-1,1	23,3	24,4	+0,8
8	*Bolgrad*	-2,2	21,6	23,8	-1,0	23,3	24,3	+0,5
9	*Vylkove*	**-0,7**	**22,2**	***22,9***	**0,4**	24,1	23,7	+0,8
10	*Izmail*	-1,7	21,8	23,5	-0,5	23,6	***23,1***	-0,4
Average for the region		-2,6	21,4	24,0	-1,3	23,2	24,5	+0,5

It was possible to identify certain details in the thermal dynamics during 1901-2023 by averaging the air temperature over shorter periods of time. As an example, Table 2 shows the annual air temperature amplitude at the Odesa station for five separate periods.

Table 2. Annual air temperature amplitude (A, °C) at Odesa

Indicator	*Period 1901-2023*					ΔA,°C		
	1901-1960	1961-1990	1991-2000	2001-2010	2013-2023			
	I	II	III	IV	V	V-I	V-II	V-IV
A,°C	24,2	***23,1***	23,8	23,6	**24,5**	0,3	1,4	0,9
Average	23.7			**24.1**				
ΔA,°C	between the periods 1901-2000 and 2001-2023					0,4		

As shown in Table 2, at Odesa station, the annual air temperature amplitude increased by 1.4°C in the period 2013-2023 compared to the period 1961-1990, and by 0.9°C compared to the previous decade. In addition, it should be noted that at the beginning of the 21st century, this indicator increased by 0.4°C compared to the previous 100 years. According to climatologists, the increase in the annual air temperature range in a given territory is due to the increased frequency of continental air masses.

The results of recent studies [3, 4] confirm the fact that, on a global scale, there have been changes in the general circulation of the atmosphere, which has led to a weakening of the zonal component and an increase in the southern component of meridional circulation in all seasons of the year in the temperate latitudes of the Northern Hemisphere.

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