GEOGRAPHICAL SCIENCES

MODERN SEASONAL FEATURES OF THE RISK MODE ON THE TERRITORY OF ODESA REGION

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Abstract. *The article presents the results of the analysis and estimation of the spatial-temporal distribution of atmospheric precipitation in the Odessa region, which is known to be an area with insufficient humidification. For solving a scientific problem, time data was used for 00, 06, 12 and 18 hours. The features of the regime of wetting of the territory of the Odessa region during 2000-2009 and 2010-2015 were considered for 10 and 9 stations of the region, respectively, for the periods indicated, for each month of the main and transition seasons of the year. The analysis of the statistical structure of atmospheric precipitation series indicates certain regularities in the spatio-temporal scale, which is associated with modern changes and climate fluctuations.*

Keywords: *climate, climatic resources, atmospheric precipitation, statistical structure.*

Introduction. The climatic conditions of the Earth are constantly changing and this is confirmed by the entire history of the planet [4]. But the changes that took place at the end of the 20th century are substantial [1] and their cause, according to scientists, can be both natural and anthropogenic factors [1].

Studies of the climate system point to real, valid, physically consistent fluctuations in the thermal regime of the active layer of the ocean, land, and atmosphere, as well as the magnitudes of the surface and general atmospheric circulation [1,2]. Especially significant changes in the climate were observed in the zone 40-60 ° North. sh in 1951-2000 [1, 2-4]. The reliability of these estimates is confirmed by data on the increase in the incidence of abnormal and extreme events [1, 5]. Changes also affected precipitation, which increased by 0.5-1 % in the last decade of the 20th century on most continents in the middle and high latitudes of the Northern Hemisphere, and their decrease was observed at 0.3 % in ten years at tropical latitudes. The frequency of observations of extreme low air temperatures decreased [1].

According to the Intergovernmental Panel on Climate Change, the global average surface air temperature will increase to 1,4-5,8 ° C by 2100, which in turn will increase the sea level by 0,09-0,88 m. Therefore, it is possible to to draw a conclusion on the threat to humanity of existing changes in climatic conditions [1].

The issue of global climate change and spatial hydrometeorological phenomena is constantly at the center of the attention of the World Meteorological Organization (WMO) and scientists of the main areas of climate research, including dangerous and spatial hydrometeorological phenomena [6]. The research of the GHG is based on modern ideas about the theory of climate, the main provisions of which have found their further development in the study of changes and fluctuations in the current climate [2, 6, 7].

Object and methods of the study. An important component of the global and regional climate is atmospheric precipitation. They act as one of the most important characteristics of humidification and relate to the most variable meteorological quantities both in space and in time. The rainfall in different regions of Ukraine differs significantly in terms of quantity, character of distribution, annual flow, intensity, duration, etc. [8]. The formation and precipitation of rain in Ukraine is the result of complex macro-circulation processes that determine the heat and moisture exchange in the atmosphere. The distribution of rainfall in some areas and, first of all, in the Odessa region, indicates a significant heterogeneity of this field, due to different conditions of precipitation formation. Knowledge about atmospheric precipitation is necessary for mankind to provide work of various spheres of economic activity of any country. This is the construction, communal sphere and needs of many other units, in which it is necessary to take into account the climatic

features when planning the socio-economic development of the region, in the design of industrial and residential construction.

Atmospheric precipitation is a part of the climatic resources that influences the objects of agricultural production, which is the most significant (along with the air temperature), and is an important factor for substantiating the maintenance and coverage of agricultural systems, growing of field crops, etc. Seasonal peculiarities of agricultural production combined with agro- meteorological and agro-climatic information indicate a steady need and rural production in it [7].

In order to find out the changes in the spatio-temporal distribution of the monthly rainfall, in comparison with the climatic norm [12], the time data was used for 00, 06, 12 and 18 hours. The features of the humidification regime of the Odessa region at the beginning of the XXI century during 2000-2009 and 2010-2015 were considered for 10 and 9 stations of the region, respectively, for the periods indicated, for each month of the main and transitional calendar seasons of the year.

In order to find out the nature and patterns of precipitation distribution in the territory of the Odessa region, statistical methods of processing the source information were used.

Results of the study. Taking into account the practical significance of forecasting atmospheric precipitation in conditions of changes and fluctuations in the climate, it was advisable to estimate their spatial-temporal distribution in the Odessa region, which is known to be an area with insufficient humidification, that is, there is a high probability of arid years. The lowest rainfall in Ukraine falls here (400-500 mm) and on the coast - less than 400 mm [8].

Comparison of the duration of periods in spatially-temporal distributed rainfall at stations located at different distances from each other, indicates its general causes, which may be multi-cycle cycles in changes in solar activity or oscillations of the macroscopic circulation of the atmosphere. In addition, the amount of precipitation, its repetition and intensity depends on many factors: the place of formation, stage of development, power, trajectory of motion, moisture content of the cyclone, as well as the physical and geographical conditions of the orography, local features of the territory. The standard climatic period of 1961-1990 proposed by the World Meteorological Organization allowed to reveal peculiarities of changes in both daily sums and monthly amounts of precipitation in the territory of the Odessa region at the beginning of the XXI century.

Diagrams are constructed for each month in order to find out the dynamics of precipitation regime in the Odessa region. As examples in Fig. 1 and 2 shows changes in the monthly rainfall in the spring (March-May) and autumn (September-November) seasons. Dynamics of the regime of atmospheric precipitation of the studied region in spring is presented in Fig. 1. As it follows from rice. 1a, in the first month of the calendar spring at six stations of the region in the period of 2010-2015 there is a decrease in the monthly rainfall, compared to the climatic norm, and at the stations of B.-Dnistrovsky, Sarat and Bolgrad, the monthly rainfall was almost in line with the norm. In the previous decade (2000-2009), precipitation growth (as compared to the norm) was recorded at eight stations in the oblast, except for the two northern ones. Lyubashevka and Art. Calm. In April (Fig. 1b), in the period of 2010-2015, almost all the stations in the oblast saw a decrease in the amount of precipitation compared to the climatic norm. Exceptions are the stations of Lyubashevka, Zatyshya and Bolgrad. In the first decade of the XXI century, the amount of precipitation (except for the Zatyshya station) was lower compared to the period 1961-1990. The dynamics of the precipitation regime in the territory of the Odessa region in May is shown in Fig. 1st As it follows from rice. 1, a significant increase in the amount of precipitation in the last six years considered, was observed at five stations: Lyubashevka, Serbka, Rozdilna, Sarata and B.-Dnistrovsky. At Zatsushi, Odesa, Bolgrad and Izmail stations there is a reverse trend.

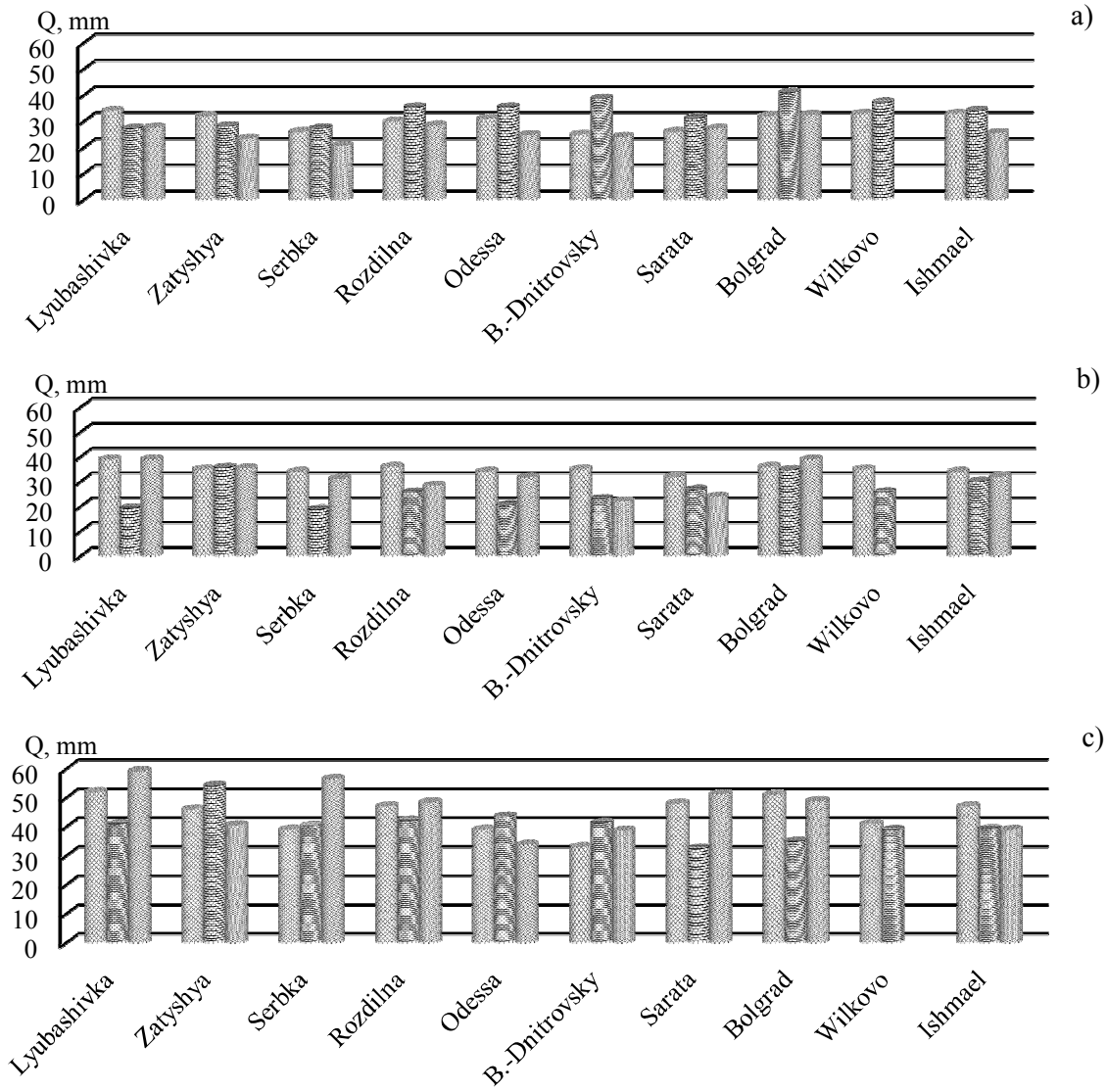
Thus, at the beginning of the XXI century, the monthly rainfall in the territory of the Odessa region in spring has a different month-by-month tendency to change compared with the climate norm. In March and April, at most stations in the region, the monthly precipitation decreased (compared to the norm), and May became more humid at the northern stations of the region: Lyubashevka, Serbka, Rozdilna; on st. Saratov and Art. The amount of precipitation in the Bolgrad region was within the limits of the climatic norm.

In the summer season of 2010-2015 there are sharp and opposite trends in rainfall changes. If you compare the dynamics of the rainfall regime in June and August - they have different trends. Thus, in June, at all stations in the Odesa region rainfall increased compared to the climatic norm, and in August, on the contrary. In July of this period only at three stations in the region the amount of precipitation was much less than the norm: Art. Lyubashevka (28 mm), art. Serbka (15 mm) and Art. Lull (13 mm). At the stations of Rozdilna, Izmail and Bolgrad, rainfall was almost the norm. In July, at three stations in the oblast, the amount of precipitation significantly exceeds the climatic norm: Odessa (35 mm), Sarata (15 mm), B-Dniester (about 10 mm). In the period of 2010-2015, for most stations in the Odesa Oblast, the maximum

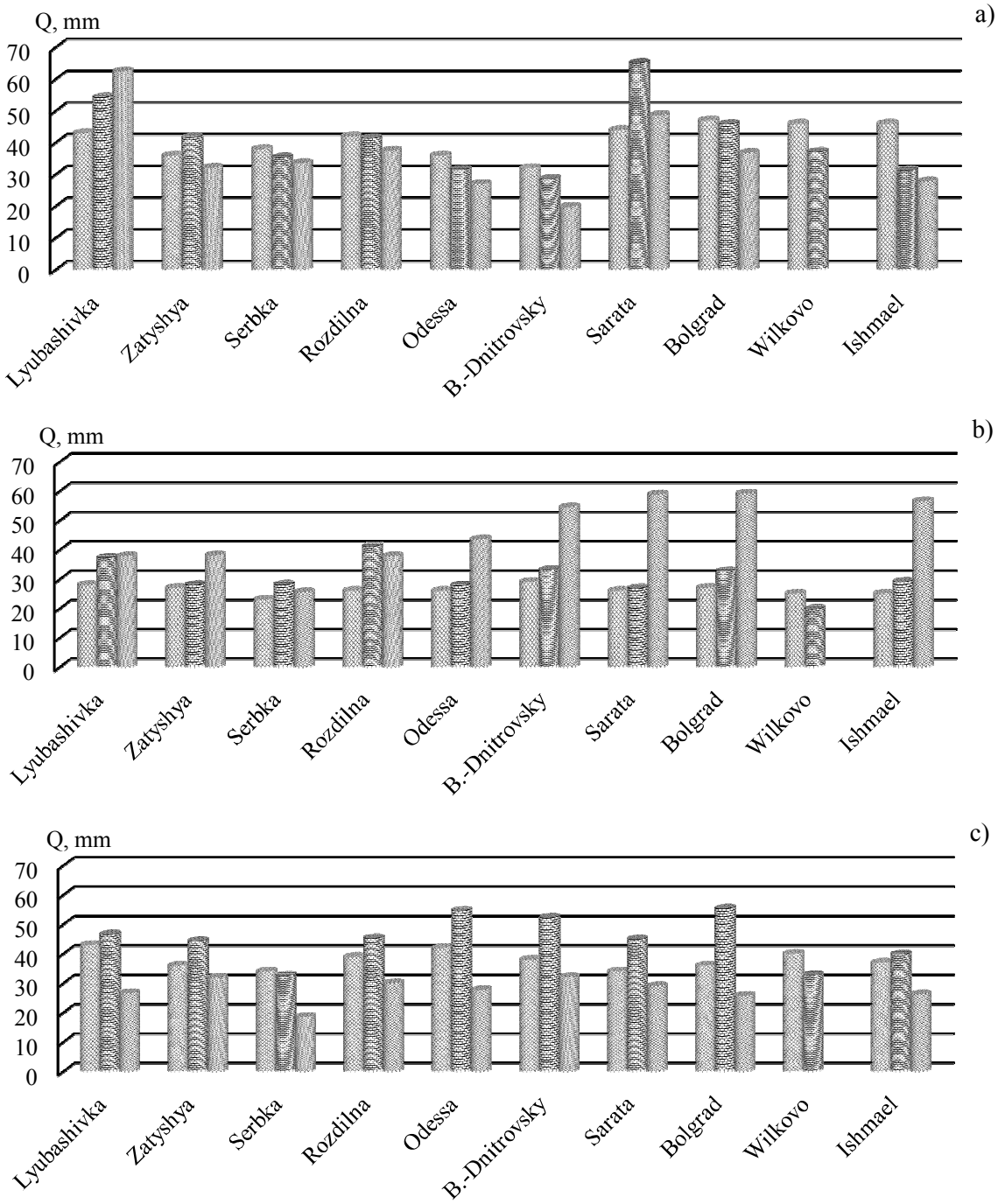
monthly rainfall for the summer season falls to June, and only at three stations in the oblast (Odesa, B.-Dnistrovsky, Saratov) July (next to June) remains the "hottest" month of the year.

Analyzing the spatio-temporal distribution of atmospheric precipitation at stations in the studied region in the autumn (Figure 2), it should be noted that the entire territory of the Odessa region this season received the highest moisture (compared with the climatic norm) in October 2010-2015. In September (Fig. 2a) only at two stations (Lyubashevka and Sarata) monthly rainfall exceeded the norm. The moon of autumn with the least rainfall in the investigated region was the November of the period 2010-2015.

In the first month of winter (December) there is a significant increase in the monthly precipitation in the period 2010-2015 at all stations in the Odessa region (compared with the climate norm), and the highest rainfall in December of this period was recorded in Art. Bolgrad (67 mm). It should be noted that rainfall in this month of 2000-2009 was almost the same throughout the oblast (20-30 mm). Therefore, one can state that in this decade of the XXI century, the monthly rainfall is the smallest of the periods considered. The analysis of the dynamics of monthly rainfall in the central month of the winter season indicates an increase in the amount of precipitation in the period 2010-2015 throughout the oblast, in comparison with the climatic norm. Most of their growth occurred at three stations: Odessa, B.-Dnistrovsky, Rozdilna. For the last decade of the XXI century. (2000-2009), rainfall at all stations in the Odessa region did not differ much from the climate norm. These differences fluctuated within



Periods, years - 1961-1990 - 2000-2009 - 2010-2015
a) March; b) April; c) May
Fig. 1. Monthly precipitation (mm) at stations in the Odessa region. Spring



Periods, years - 1961-1990 - 2000-2009 - 2010-2015
a) September; b) October; c) November
Fig. 2. Monthly precipitation (mm) at stations in the Odessa region. Autumn

5 mm at 9 stations, except for art. Serbka, on which during this period there was an increase in the amount of precipitation (in comparison with the climatic norm) by 16-17 mm. In February, we observe a significant (up to 15-17 mm) decrease in rainfall in the period 2010-2015 at all stations in the Odessa region, except for Art. Serbian, where the amount of precipitation, in comparison with the climatic norm, has increased by 10 mm. The decrease in the amount of precipitation (relative to the norm) is observed in the previous period (2000-2009) at seven stations, and at the stations Serbka, Odesa, B.-Dnistrovsky, on the contrary. Thus, in the Odessa region two months of the winter season (December, January) have become more damp during the last six years, as compared to the period of 1961-1990, and in February, on the contrary, a decrease in rainfall was recorded.

Today, the impact of climate change on the economy of the country and society is manifested through an increase in the occurrence of adverse and natural phenomena observed in the most varied shells of the Earth - the atmosphere and the hydrosphere. According to WMO, 90 % of all natural disasters that suffer from humanity have a hydrometeorological origin [4, 7]. Therefore, in conditions of rapid scientific and technological progress, humanity's dependence on climate has not diminished, but, on the contrary, has substantially increased due to which the study of climate variability acquired a clearly defined practical significance. An analysis of empirical evidence suggests that global climate change can change the absolute values of air temperature, precipitation, seasonal course of these variables and contribute to changing the species composition of vegetation, displacement of natural zones [3, 4, 8, 9]. In separate seasons and for a year in a significant part of Ukraine, as a result of these changes, the regional temperature increased 1.5-2.5 times relative to the global one. The general regularity of the change in the amount of precipitation remains significant fluctuations from year to year, as well as great variability in the territory [3, 5, 10, 11].

At present considerable progress has been made in collecting, systematizing and summarizing empirical information that characterizes the climate of various spatial and temporal scales. But the dispersion of source information complicates the study of the structure and variability of the current climate and requires a statistical approach that can be used to explore the multi-year data archive, which is a significant reserve for improving the quality of long-term weather forecasts. Therefore, at the next stage, the method of research of non-stationary time sequences was used to find out the long-term changes in the distribution of monthly rainfall in the territory of the Odessa region and to determine the statistical structure of these climatic series.

As is known, most meteorological quantities represent non-stationary random processes. The main reason for this is that, under the influence of different incoming solar radiation in the course of the day, season, year, the quantities have a daily, seasonal, annual flow, etc. The long-term changes in the nature of climate-forming factors lead to the emergence of trends, that is, unidirectional changes in meteorological values over a long period of time. The study of the statistical structure of atmospheric precipitation was based on the sequence of their values in the form of equidistant time series with a discrete one month. They were depicted as the sum of the deterministic and random X3 (t) component. In turn, the deterministic component consisted of the trend X1 (t) and the periodic component X2 (t), which reflects the seasonal (annual) progress of the process X (t) [19].

So,

$$X(t) = X1(t) + X2(t) + X3(t). \quad (1)$$

The deterministic basis of the random process is extracted by filtration (or smoothing) of the output time series. One of the types of smoothing is the sliding averaging, which in general can be depicted as follows:

$$\hat{X}(t_k) = \frac{1}{n} \sum_{i=k-n/2}^{k+n/2} \alpha_i X(t_i) \quad (2)$$

Where αi is the weight factor;

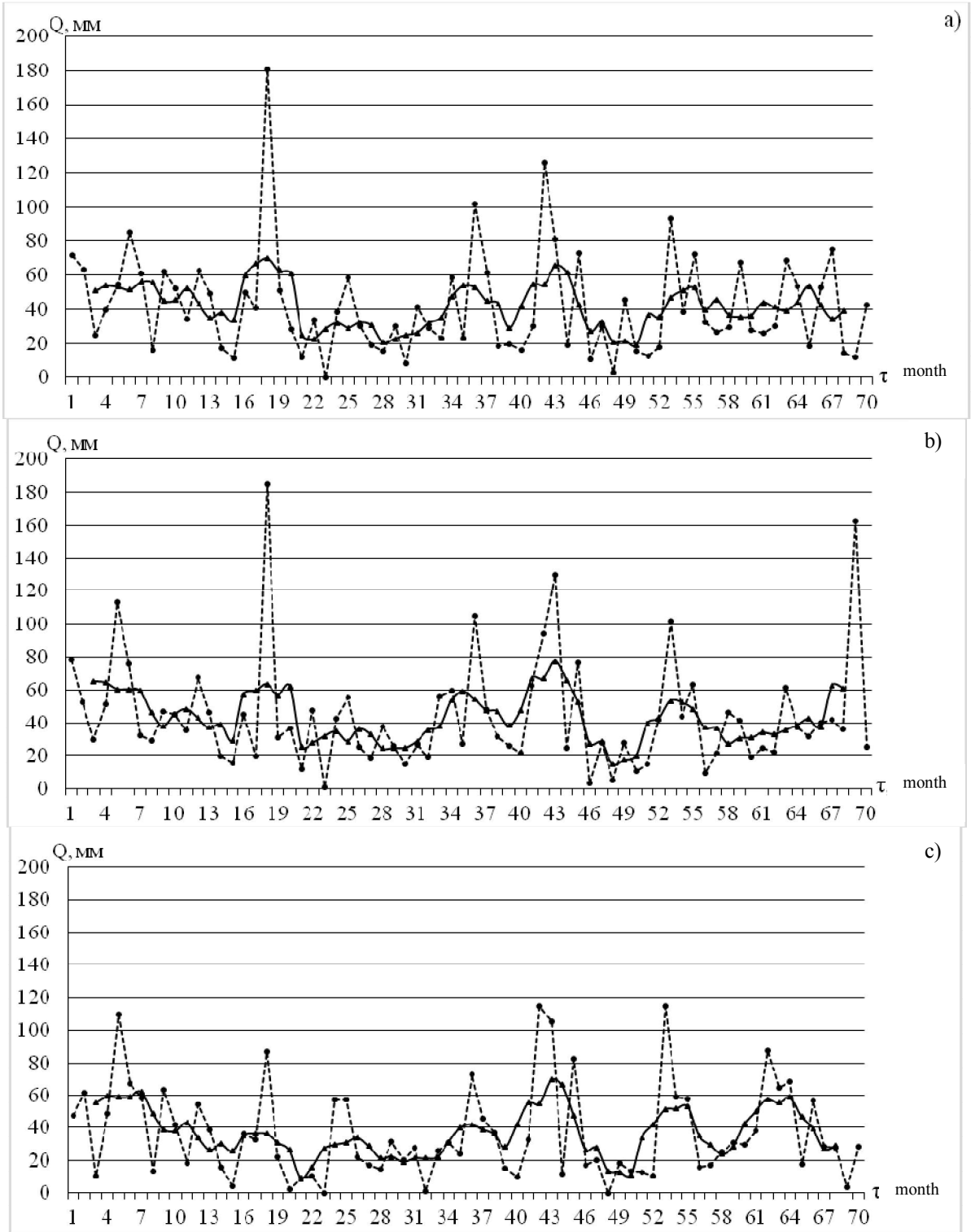
n - number of points at which smoothing is performed:

$$k = 1 + n / 2; 2 + n / 2; ...; N + n / 2; N = N (n-1)$$

Accepted in equation (2) αi = 1, which means that the smoothing operator determines a simple moving averaging in which the weight of all points that participate in calculations of the mean value on the interval [k - n / 2; k + n / 2] is the same.

According to the statistical structure of atmospheric precipitation series, the study area is divided into five regions:

1) the coast is the station: Odessa, B.-Dnistrovsky, Chornomorsk;
2) the southern region is the stations: Saratov, Bolgrad, Izmail;
3) the northwest area is the station: Zatyshya, Rozdilna;
4) north - st. Lyubashevka;
5) eastern - st. Serbka



---- time series ____ smoothed row
a) north-western region; b) the northern region; c) the eastern region

Fig. 3. Time and smoothed rows of monthly rainfall (mm)
where, N- is the number of members of a row

Time and smoothed rows of atmospheric precipitation were constructed for all identified areas of the Odessa region.

As examples in Fig. 3 shows time and smoothed rainfall levels for three areas: northwest, northern, and eastern.

The analysis of the deterministic component for all territories indicates clearly defined both trend and periodic components in the long-term mode. They include fluctuations with periods from quasi-monthly to quasi-old. These components require further research to determine the local features of certain areas of the Odessa region, which led to the division of the studied region into five regions in terms of spatial-temporal distribution of atmospheric precipitation.

Conclusions. 1. Geographical location of the Odessa region forms the complex nature of atmospheric processes and, accordingly, the distribution of precipitation in its territory at the beginning of the XXI century in conditions of modern changes and fluctuations in the climate.

2. The study of the dynamics of monthly precipitation in the late 20th and early 21st centuries, which was conducted on the long-term data of the three periods of averaging (1961-1990, 2000-2009, 2010-2015), indicates the ambiguity of the complex changes in the distribution of atmospheric precipitation in different seasons of the year and in different regions of the Odessa region, which requires further research in solving a scientific problem.

3. According to the peculiarities of the statistical structure of atmospheric precipitation series in the Odessa region, five regions are defined: southern, northwest, northern, eastern and coastal.

4. Non-stationary time sequences of the studied climatic characteristics include both trendy and periodic (from quasi-monthly to quasi-long-lived) components in the long-term mode of precipitation in the territory of the Odessa region.

REFERENCES

1. Climate Change 2007: The Physical Science Basis. Summery for Policymakers – Geneva: JPCC, 2007. – 18 p.

2. Гончарова Л. Д., Косолапова Н. І. Вплив основних телеконекцій Північної півкулі на режим опадів по території України // Вісник ОНУ. Сер: Географічні та геологічні науки. 2017. Т. 22. Вип. 1 (30). С. 11-27.

3. Гончарова Л. Д. Режим зволоження території Одеського регіону протягом XX століття (осінній та весняний сезони) // Вестник Гидрометцентра Черного и Азовского морей. Одесса. 2009. № 1 (9). С. 77-83.

4. Гончарова Л. Д. Динаміка режиму зволоження на території Одеського регіону протягом XX століття // Вестник Гидрометцентра Черного и Азовского морей. Одесса, 2009. № 4 (8). С. 94-100.

5. Гончарова Л. Д. Особливості зміни місячної кількості атмосферних опадів на території Одеської області протягом XX століття // Укр. гідрометеорол. ж. Одеса, 2009. Вип. 5. С. 77-83. http://uhmj.odeku.edu.ua/wp-content/uploads/2016/08/8-Goncharova.pdf

6. Стихійні метеорологічні явища на території України за останнє двадцятиріччя (1986-2005 рр.) / за ред. В. М. Ліпінського, В. І. Осадчого, В. М. Бабіченко. К., 2006. 311 с.

7. Польовий А. М., Трофімова І. В., Кульбіда М. І., Адаменко Т. І. Вплив зміни клімату на сільське господарство півдня України // Метеорологія, кліматологія та гідрологія: Міжвід. наук. зб. України, 2008. Вип. 49. С. 252-261.

8. Кліматичні ресурси Одеської області для сталого розвитку: науково-практичний довідник / ред. Ж. В. Волошина. Одеса: Державна гідрометслужба України, 2010. 180 с.

9. Івус Г. П., Гончарова Л. Д., Косолапова Н. І. Характер розподілення атмосферних опадів в Одеському регіоні на початку XXI століття // Тези доповідей Першого Всеукраїнського гідрометеорологічного з'їзду з міжнародною участю (22-23 березня 2017 р., м. Одеса, Україна). Одеса, 2017. С. 210-211.

10. Косолапова Н. І., Івус Г.П., Гончарова Л. Д. Просторово-часове розподілення добової кількості опадів в Одеському регіоні на початку XXI століття // Матеріали наукової конференції молодих вчених ОДЕКУ (03-12 травня 2017 р.). 2017. С. 176.

11. Івус Г. П., Хоменко Г. В., Міщенко Н. М., Косолапова Н. І., Сухов О. О. Кількісна оцінка інтенсивності літніх атмосферних фронтів над Україною // Scientific Journal (Science Rise). 2016. Вип. 7 / 1 (24). С. 16-21.

12. Кліматичні стандартні норми (1961-1990 рр.). К., 2002. 446 с.