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REGIONAL FEATURES OF ATMOSPHERIC CIRCULATION IN GEORGIA AND THEIR RESPONSE ASYMMETRY

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Abstract. *The paper discusses the features of global and regional processes of atmospheric circulation in the conditions of Georgia. The main synoptic formations affecting the climate of Georgia are presented, and their seasonal repeatability and the asymmetric nature of the impact on the western and eastern regions of the country are shown. The natural hydrometeorological events that developed in Georgia as a result of circulation processes and their socio-economic consequences are given. Attention is focused on measures to mitigate climate risks. The study is based on long-term synoptic materials and literary sources, which makes it possible to reveal the complex and diverse nature of atmospheric processes in the country.*

Key words*: Circulatory processes, regional features, response asymmetry.*

Introduction

Georgia is geographically located in the temperate zone of the Eastern Hemisphere and is a region where atmospheric circulation processes manifest themselves in a complex and diverse manner. The compact territory of the country is distinguished by sharp geographical and climatic contrasts, which are due to its complex relief, as well as the proximity of the Black Sea and the barrier role of the Caucasus Range. It is against the background of this multifactorial natural environment that circulation processes in the region acquire local features, which creates a sharply expressed asymmetry in response, both at the climatic, ecosystem, and social levels.

The present work aims to analyze the regional characteristics of circulation processes in the space of Georgia and to focus on the asymmetry that is manifested in the climatic response. The analysis presented in the article is based on both modern climatological studies, as well as long-term meteorological data and literary sources, which makes it possible to identify the asymmetric response in the space of Georgia.

Main part

Atmospheric circulation is the large-scale movement of air masses over the Earth's surface, which is caused by the uneven distribution of solar energy between the equator and the poles and forms various types of winds and pressure systems, which play an important role in the distribution of energy between climatic zones.

Scientists working in Georgia: K. Papinashvili, E. Napetvaridze, V. Gigigneishvili, I. Chogovadze, E. Studies by Elizbarashvili and others have shown that the atmospheric circulation of Georgia is a multifactorial and complex system, which is simultaneously affected by global-scale synoptic processes – the Mediterranean depression, the Azores anticyclone, the Icelandic depression, the Siberian and Arctic anticyclones and the Asian depression, as well as regional and local modifications (Fig. 1), which determine sharply different meteorological conditions in different regions of the country and in different seasons [1-2]. Against this background, an asymmetric climatic response is created between Western and Eastern Georgia, which is especially noticeable in the distribution of precipitation and temperature regimes [3].

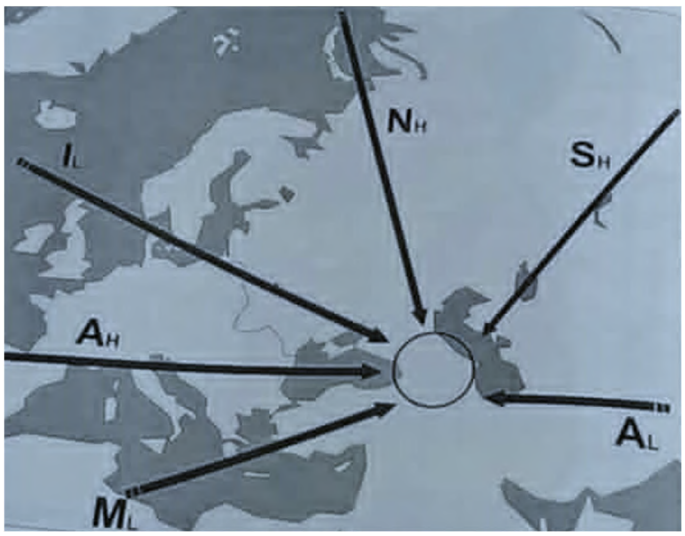

Fig. 1. Influence of circulation processes on Transcaucasia [4].

Georgia is located in the temperate zone and is affected by both air masses coming from the west (Atlantic fronts) and tropical or continental air masses coming from the east and south (Fig. 1). During the year, there is an alternation of the western circulation and bordering anticyclones (Azores or Siberian anticyclones), which have certain seasonal characteristics. For example, the Siberian anticyclone causes the influx of cold, dry air to eastern Georgia in winter, while in the west it flows with humid air through the Black Sea, which is why winters are relatively mild in the western regions. In summer, warm continental air masses often dominate, which is often accompanied by drought in eastern Georgia, while in western Georgia, humid sea air causes relatively frequent precipitation. In summer, the movement of air masses often occurs from north to south or from west to east.

Based on synoptic data published in literary sources [4national], a seasonal distribution table of the frequency of impacts of the mentioned circulation processes on Georgia was compiled.

Table 1. Frequency of impacts of circulation processes on Georgia by season (%)

Process	Spring	Summer	Autumn	Winter
Mediterranean Depression, M_L	26.7	6.1	26.2	41.0
Azores Anticyclone – A_H	17.8	49.3	23.5	9.4
Icelandic Depression – I_L	25.5	25.8	28.2	20.5
Arctic Anticyclone – N_H	30.7	30.6	26.1	12.6
Siberian Anticyclone – S_H	24	-	27.4	48.7
Asian Depression – A_L	19.4	68.4	12.2	-

Table 1 clearly shows that different circulation processes are distinguished by different activity depending on the seasons. For example, in summer, the Asian depression and the Azores anticyclone are observed with the highest frequency, with recurrences of 68.4% and 49.3%, respectively, and in winter, the Siberian anticyclone (48.7%) and the Mediterranean depression (41%). In spring and autumn, all processes affect the territory of Georgia with almost equal recurrence. It should be noted that cyclones from the Black Sea region cause heavy precipitation, often floods, while anticyclones, especially in summer, cause droughts and periods of high temperatures. In addition to the global circulation, regional and local circulation processes also have a significant impact on the climate of Georgia. For example, Georgia is characterized by orographic circulation, which is formed by the influence of local relief – especially the Caucasus and the Lesser Caucasus. These processes are complemented by the microclimatic effects of the Black Sea, which determine the high humidity in Western Georgia. It is also worth noting the presence of such phenomena as warm and cold advection, frontal systems, wave disturbances, microcirculation processes (local breezes and thermal circulations, mountain and plain circulations), etc.

The seasonal dynamics of circulation processes largely determine the occurrence and spread of natural hydrometeorological events – hail, floods and flash floods, strong winds, avalanches, and droughts. These events often cause significant economic damage, pose a threat to infrastructure, agriculture, and the population [5-6].

Table 2 provides a small list of natural events caused by various synoptic processes in the territory of Georgia, with the damage and casualties caused by them.

Table 2. Natural hydrometeorological events that occurred in Georgia

Synoptic Processes	**Natural event**	**Date**	**Spreading area**	**Losses in million GEL**	**Victims**
High Pressure Area	Drought	03-07 2000	All of Georgia	450.0	
Frontal Process	Flood -waterfall	20-30.04, 05-10.05, 27-30.05, 14-16.06. 2002	All of Georgia	78.7	
Frontal Process	now avalanche	01-05, 11-12.2005	Georgian Military Road	3.0	
Southern Wave, Intramassive, Westerly Fronts	Hail	08-10.05, 29 -31.05, 03.06, 12.06, 02.07, 09.07, 23-24.07, 21.08, 16.09, 18.09, 25.09 2005	Imereti, Racha-Lechkhumi, and all of Eastern Georgia	69.0	
Westerly and Eastward Process	Strong wind	23-25.01, 11.02, 05.06, 07.06, 19-20.06,20.08, 16.12 2009	All of Georgia	8.0	8
Heavy Rain	Flood	13.06.2015	Tbilisi, Vere River Gorge	50	22

As can be seen from Table 2, drought is mainly caused by a high-pressure field, floods and flash floods by frontal processes, hail by a southern wave, internal massive processes, and western cold fronts. Strong winds are observed during bilateral invasions, western and eastern processes.

Against the background of modern climate change, the fact that the frequency and intensity of circulation processes may change is of particular importance, which will further increase risks in the future. Studies indicate that more frequent and prolonged impacts of the Asian depression are expected in the summer, which will exacerbate the problem of droughts in Eastern Georgia, while in winter, an increase in the intensity of the Mediterranean depressions and the Siberian anticyclone may increase the risks associated with heavy precipitation and cold [7,8].

Under these conditions, it is particularly necessary to:

- Improve systems for monitoring circulation processes and increase the accuracy of synoptic forecasts;
- Timely identification of hydrometeorological hazards and development of early warning mechanisms;
- Implement measures to adapt ecosystems and agriculture (e.g., anti-hail technologies, optimization of water supply);
- Continue long-term research taking into account climate change scenarios.

Conclusion

The results of the study showed that the atmospheric circulation of Georgia is closely related to global climate systems, although its regional characteristics differ markedly due to the relief, the barrier role of the Black Sea, and the Caucasus Range. The seasonal dynamics of circulation processes determine both the spatial asymmetry of precipitation and temperature distribution, as well as the frequent occurrence of hydrometeorological natural events (drought, hail, floods, avalanches, strong winds, etc.). These events cause signifi-

cant damage to both ecosystems and socio-economic systems. Accordingly, a detailed study of the regional characteristics of atmospheric circulation is necessary for assessing climate risks and planning effective measures to prevent natural events.

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