

MAIN TRENDS IN CLIMATE CHANGE IN THE HOLOCENE EPOCH OF THE ANTROPOGENIC PERIOD IN THE WORLD AND IN THE CAUCASUS

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Abstract

The article is devoted to the problem of climate change on Earth, and in particular in the Caucasus. The main trends in climate change are traced during the Holocene epoch of the Quaternary period. Attention is focused on the most noticeable periods of cooling and warming - the medieval warming period, the Little Ice Age, the newest warming period, which began at the end of the 19th century. The issue of global warming is also touched upon.

Keywords: climate, Holocene era, ice age, global warming, Caucasus, greenhouse effect

I. Introduction

Climatic changes have occurred in almost all geological eras. Climate change is recorded by paleontological finds (changes in fauna and flora), changes in archaeological cultures, etc. etc. However, the use of archaeological data for the stratification of sediments and the study of other issues is possible only for the Anthropogenic (Quaternary) period, since the most important event - the appearance of man - is associated with this period [1-2]. Fossil remains and traces of human material culture are the guiding paleontological finds for individual divisions of the Quaternary period, which makes it possible to use the archaeological method together with the paleontological method for research purposes in various fields of knowledge, including climatology.

II. Methods

The Anthropocene (Quaternary) period is divided into the Pleistocene and Holocene eras. The Holocene is a modern geological era that began after the Pleistocene, approximately 11-15 thousand years ago. The Pleistocene era, in turn, is divided into a number of glacial and interglacial stages: the Günz, Mindel, Ris and Würm glacial; Günz-Mindel, Mindel-Ries, Riess-Würm interglacial stages [Ist. geology]. Based on its characteristic climatic features, the Holocene is usually classified as an interglacial era due to its many similarities with more ancient interglacial eras [3-4]. The main trend of Holocene climate change was the transition from the cold climate of the end of the Pleistocene to a warm one with maximum warming about 6 thousand years ago. In general, the Holocene climate was quite stable, although, as many researchers note, it was very diverse.

III. Results

The Holocene is an era in the Quaternary period of the Cenozoic era. According to the decision of the VIII Congress of the International Association for the Study of the Quaternary Period (Paris, 1969), the lower boundary of the Holocene is considered to be 10 thousand years ago. (11700±99 years relative to 2000). The period of time between the end of the last Würm glaciation (17 thousand years ago) and the beginning of the Holocene (10 thousand years ago) is called the Late Glacial.

Rising temperatures, melting glaciers and destruction of ice sheets began 16,000 years ago. This climate warming was global in nature [5]. It was accompanied by the degradation of the Würm ice sheets of Europe and North America, but this process was not monotonous. The Late Glacial period was characterized by an extremely unstable climate: warming periods, called Raunis (Ra), Bølling (Bø) and Allerød (A1), were interrupted by five sharp and deep cold snaps - Port-Bruce, Dryas I (13.2 thousand years ago), Fjoros- Neva (12.8 thousand years ago), Dryas II (12.2 thousand years ago) and the most severe cooling of Dryas III about 10.8–10.5 thousand years ago. During the Bølling and Allerød warming periods, air temperatures in temperate latitudes were close to modern ones or even slightly higher [6]. In Western Europe and Taimyr, forest vegetation was restored. However, during cold snaps and especially during the Dryas III, landscapes returned to the time of the maximum of the Würm glaciation: in North-West Europe, in Britain and in the north of the Russian Plain, forests degraded and were replaced by vegetation of cold steppes and tundra. In Siberia, during Dryas III, woody vegetation retreated southward by 700–800 km, and the temperature dropped by 5–6 °C compared to modern times. The cooling was global in nature, its traces were noted in South America, New Zealand and Antarctica.

New global warming began about 10.3–10.2 thousand years ago. Thus, the Holocene began with intense warming. As a result, the disappearance of the Scandinavian ice sheet occurred about 8.5 thousand years ago, and the North American ice sheets - about 6.5 thousand years BC. In the boreal period, taiga forests continued to push the tundra to the north [7]. They were followed by deciduous forests, which occupied Southern and partly Northern Europe. Remains of the Laurentian Ice Sheet persisted on the Ungava Peninsula until 5.5 thousand years ago.

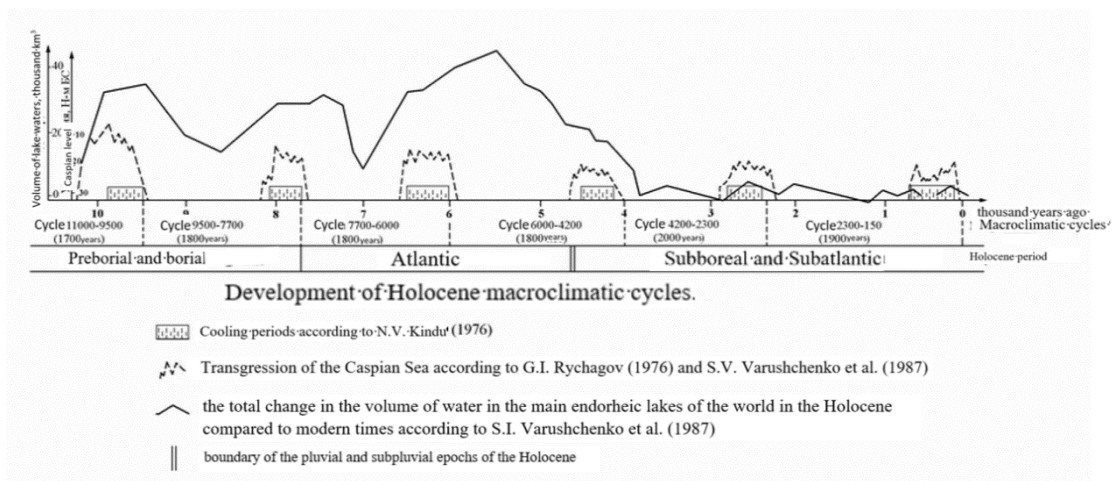


Fig. 1: *Development of Holocene macroclimatic cycles*

Some researchers, based on paleoclimatic studies, note that the humid, warm climate (humid) characteristic of the 4th millennium BC. during the 3rd millennium BC changed to hot and dry (arid) [Idrisov, 2010]. By the middle of the 3rd millennium BC. The sedentary agricultural Kura-

Araks inhabitants are replaced by new ones with a completely different economic structure [cit. according to Kornienko, 2013].

Many other researchers also connect changes in archaeological cultures with those in climate [Munchaev et al., 2012]. Warm period since 250 BC to 400 AD known as the Roman Climatic Optimum. This period marked the rise of the Roman Empire [8].

IV. Discussion

Period from the 7th century. (according to other sources from the 10th century) to the 13th century is called the medieval warm period, or in another way, the medieval climatic optimum. This era of relatively warm climate in the northern hemisphere was characterized by mild winters, the expansion of arable land, and a marked increase in agricultural production and population [9]. According to some American scientists, as a result of prolonged droughts during this period, the death of the classical Mayan civilization occurred[Average climate.optimum]. In the Caucasus, there was a significant reduction in the glaciers of the Greater Caucasus, the replenishment of mountain rivers with water (due to the melting of glaciers), a drop in the level of the Caspian Sea, the formation of deflation basins and other processes characteristic of periods of climate warming [Phys. geog. CR, 2006].

And the time from the 14th century to the middle of the 19th century. called the Little Ice Age, when the volume of soil cultivation and pastures was significantly reduced. During this period, the advance of glaciers and an increase in their size were observed everywhere [10-11]. In 2021, B. Fagan published a book entitled "Little Ice Age: How Climate Changed History. 1300 - 1850"[2021]. However, some researchers, in particular A.S. Monin et al. consider this name inappropriate, based on the fact that during the designated historical time there was no continuous period of cooling [Monin et al., 1979]. The Little Ice Age in the Caucasus was manifested by the rise of the Caspian Sea, the weakening of the continental climate, an increase in the amount of precipitation and other signs [Phys. geog. CR, 2006].

After this period from the end of the 19th century. a period of warming began, which manifested itself especially strongly in the 20-30s. XX century During this period, in many regions of the world (in the Caucasus, Pamirs, Tien Shan, Altai, Himalayas, etc.) there was a retreat of glaciers with a reduction in their areas. Thus, the area of glaciers in the Caucasus from 1890 to 1946 decreased by 8.5% [inter.res.Modern climate.]. According to other data, in particular according to the results of long-term monitoring by the High Mountain Geophysical Institute (Nalchik), the area of glaciers in the Greater Caucasus has decreased by 40% over the past 100 years.

But already in the 1940s. the warming process gave way to cooling, the peak of which occurred in the mid-1960s. By the beginning of the 1960s. The area of glaciers has increased significantly.

Since the 1970s a new stage of warming has begun, which continues to this day [Internet resource; Monin, 1979]. Since the 1990s There was an increase in precipitation, a rise in the levels of the Caspian Sea and groundwater, a reduction in the area of glaciers, etc [12]. During this period, information appears about future global warming of the Earth's climate. Currently, there are different versions of the causes and possible consequences of climate change.

First version. The climate on Earth is changing due to human activities. Warming is recorded with an increase in the scale of production using hydrocarbon fuels, which leads to the so-called greenhouse effect.

Second version. Global warming is not associated with the consequences of human industrial activity, but is associated with cosmogenic causes.

Third version. Global warming is associated with the synergy of technogenic (greenhouse effect) and cosmogenic factors (natural process) [13]. According to academician V.M. Kotlyakov, the greenhouse effect exists, but it is impossible to determine its share in global climate change. The main contribution to the greenhouse effect comes from carbon dioxide. Its reduction to a certain extent can be achieved by partially replacing traditional energy sources based primarily on the use of hydrocarbon raw materials with non-traditional renewable ones. The main global agreement to combat global warming is the Kyoto Protocol of 1997, obliging the industrialized countries of the world to reduce CO₂ emissions [Global warming...Internet resource].

Thus, climate change is primarily a natural process that has been observed in all geological periods. At the same time, the technogenic factor plays a certain role in climate change. In the Holocene era, after a series of glacial and interglacial periods in the previous Pleistocene era, a number of long periods of warming and cooling were observed, replacing each other. In turn, they included short-term episodic phases of cooling and warming. The last phase of warming, as noted above, began in the 1970s, which continues to the present day.

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