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## **ANALYSIS OF FEATURES OF CHANGES IN THE LEVEL OF ATMOSPHERIC CARBON DIOXIDE DURING CURRENT GLOBAL WARMING**

**Summary.** *The results of an analysis of the increase in the level and growth rate of atmospheric carbon dioxide as a key agent in the mixture of greenhouse gases are presented. Features of the behavior of the Earth's global average temperature anomaly are considered in the context of changes in the level of carbon dioxide emissions of anthropogenic origin.*

**Key words:** *climate security, global warming, temperature anomaly, greenhouse gases, atmospheric carbon dioxide.*

**Problem statement.** Changes in the Earth's climate have approached pre-critical conditions, the so-called "orange danger level". In this regard, issues of

climate security are becoming increasingly relevant [1; 2]. The need for assessments of the state of the Earth's climate system, forecasts of its changes, etc. led to the emergence and further development of corresponding climate models. These models are constantly becoming more complex, becoming more accurate and adequate. Calculations using some modern models have shown that an increase in carbon dioxide levels leads to an increase in the temperature of the surface atmosphere. This leads to the need for a comprehensive analysis of this issue.

One of the main indicators of climate change is the value of the anomaly of the global average temperature of the Earth's surface.

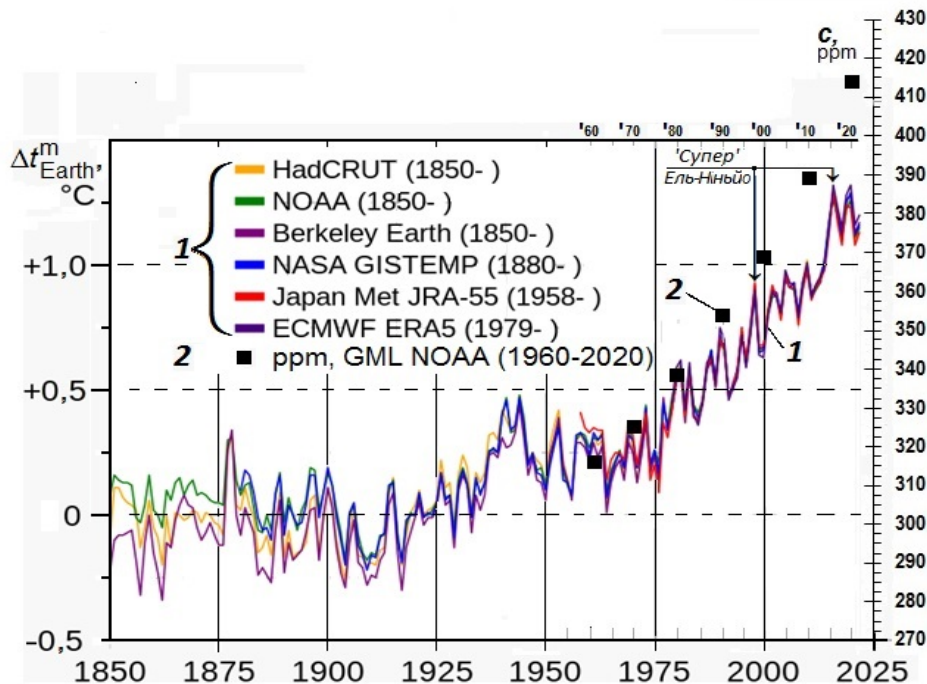
**The purpose of the article** is to analyze the features of changes in carbon dioxide in the earth's atmosphere and anomalies in the global average temperature of the earth's surface in the format of global warming.

**Presentation of the main material.** Greenhouse gas emissions of anthropogenic origin are the most influential climate-forming factor [3; 4-8]. Below we consider the features of the influence of this factor on the anomaly of the global average temperature of the Earth's surface.

The anthropogenic impact-factor in the form of steadily increasing global annual concentrations of greenhouse gases, according to the findings of the World Meteorological Organization and the International Panel on Climate Change (IPCC), is the main cause of thermal climate anomalies. The key agent in the greenhouse gas mixture is carbon dioxide. There is a high consistency between the general evolution of the global anomaly surface temperature of Earth  $\Delta t_m^{\text{Earth}}$  and the level of atmospheric carbon dioxide (Fig. 1).

Figure 2 shows the results of an analysis of the increasing of the level and growth rate of atmospheric carbon dioxide. The presented results were obtained based on the processing of primary data from the Mauna Loa Observatory, Hawaii, in the Global Monitoring Laboratory of the National Oceanic and Atmospheric Administration [9-10].

For the purpose of clarity, the information in Fig. 2 is shown on a grid of horizontal ladder lines, which corresponds to the average annual sample primary concentration values from 1960, 1970, and so on. The graph (inset a) shows annual growth rates  $c$  throughout the entire range of climate change in the format of modern global warming (60s of the 20th century... 20s of the 21st century) [12].

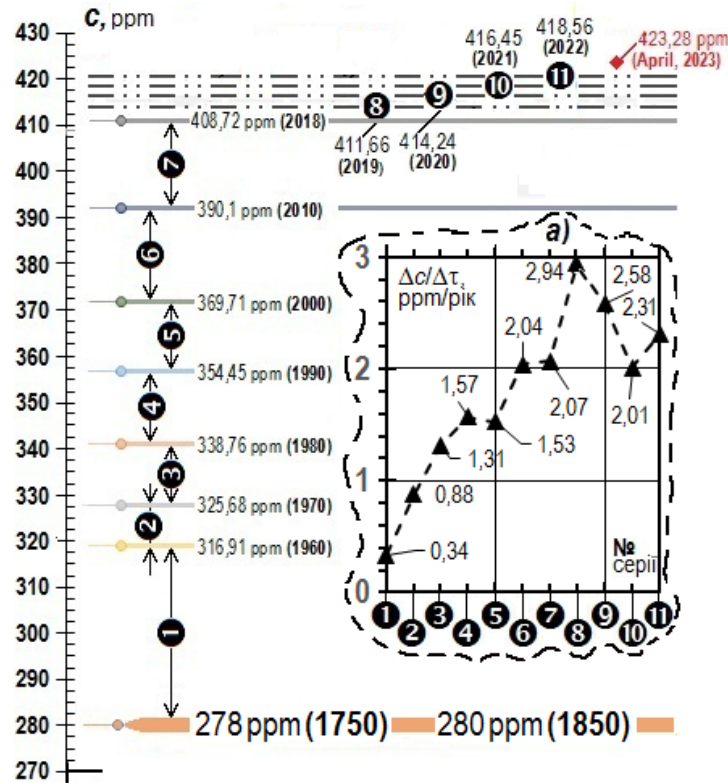


**Fig. 1. Change in time of the anomaly of the global average temperature of the Earth's surface  $\Delta t_m^{\text{Earth}}$  according to data from various sources (1) and the concentration of atmospheric carbon dioxide (2)**

Data in Fig. 2 (inset a) on the rate of change in the increment of  $\text{CO}_2$  level are obtained by dividing the values of  $\text{CO}_2$  concentration corresponding to the end points of the time interval by the value of this interval.

According to the results presented in Fig.2 (inset a), there is an acceleration in the growth of atmospheric carbon dioxide levels, starting from the 60s of the last century until the start of the Covid19 pandemic, inclusive. The maximum acceleration was achieved in the “pre-COVID” year of 2018 (2.94 ppm/year); in the two “war” years (2020-2021), there was some reduction in this acceleration.

It was 2.58 and 2.01 g ppm/year in 2020 and 2021, respectively. From the end of 2021, the previous trend towards an increase in the growth rate of atmospheric CO<sub>2</sub> levels returns. As for the average "gross" - the rate of increase in CO<sub>2</sub> content from March 1958 to March 2023, it is estimated at 1.62 ppm/year (0.51%/year).



**Fig. 2. Average annual values of atmospheric carbon dioxide concentration on a grid of step-like lines; inset (a) – change in the growth rate of atmospheric carbon dioxide concentration in time intervals**

Sources of initial data: [11; 10; 12]

**Conclusions.** In the context of climate security, an analysis was made of the development of the physical foundations of climate change and a study of the behavior of the anomaly of the global average temperature of the Earth's surface and the level of carbon dioxide in the Earth's atmosphere. The results of an analysis of the increase in the level and growth rate of atmospheric carbon dioxide as a key agent in the mixture of greenhouse gases are presented. According to the data presented, there is an acceleration in the growth of its level, starting from the 60s of the last century until the start of the COVID 19 pandemic inclusive, with

maximum acceleration in the “pre-Covid” 2019, its reduction in the “Covid” years (2020-2022) and a return from the end of 2021 to the previous trend of increasing the growth rate of atmospheric CO<sub>2</sub>.

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