HSR (LONDON),
HOUGHTON STREET REVIEW JOURNAL
ISSN: 2058-5519|Impact factor-15.9
http://houghtonstreetreview.com/index.php/hsr

INTENSITY OF CLIMATE TRANSFORMATIONS AND THE LAW OF THEIR PERIODICITY (ALIKHANOV, SANGINOV AND SOKOLOV'S LAW)

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doi:**https://doi.org/10.5281/zenodo.22865275**

Abstract. This article analyzes the intensity of climate change under the conditions of global warming and climate transformations in various regions of the world, particularly in the Aral Sea region, where the impacts of climate change are more intense due to Aral Sea disaster. A critical review of various available research platforms at international institutions showed us that there are not available proper methods for assessing the intensity of climate change. That is why we are proposing a unique formula for intensity of climate change assessment and explanations how those changes periodically transforming over time.

Key words: global temperature, climate, intensity of climate change, climate transformations, Aral Sea region, Aral Sea disaster, Paris Agreement, greenhouse effect, melting of glaciers, air temperature, rate of warming, ecosystem, El Niño.

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The ongoing environmental and climate turbulence at the global level requires an adequate assessment of the intensity of climate change in order to properly develop strategies and plans to adapt to these changes and minimize their negative impacts in specific regions of the world.

Research results published in 2026 in the international journal Earth System Science Data (ESSD) demonstrate an unprecedented rate of thermal energy accumulation in the Earth's climate system. By the end of 2025, the global temperature had exceeded pre-industrial levels by 1.37°C. This brings the planet very close to the critical 1.5°C threshold set by the Paris Agreement [1].

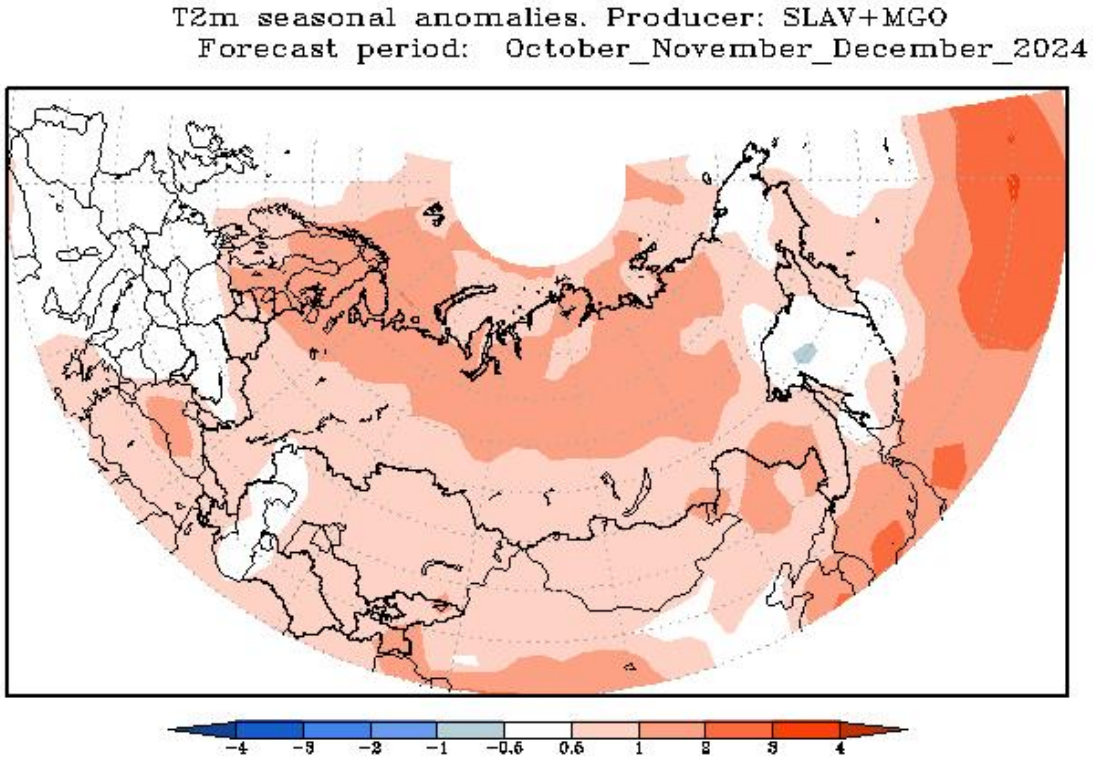


Figure 1.

Therefore, we conducted a critical review of existing methods for assessing the intensity of climate change across various available research platforms of international institutions.

For this purpose, we examined materials from sources such as the Climate Change Adaptation Planning, Research, and Practice Platform and the World Bank Group's Climate Change Knowledge Portal. The analysis also focused on best practices in climate change impact assessment and climate data and tools on international and regional websites (e.g., the official UNFCCC country portal on greenhouse gas emissions [2], the WMO Climate Data Catalog [3], the scientific and methodological guidelines of the Russian Hydromet Climate Center, the website of the National Oceanic and

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Atmospheric Administration (NOAA)—a federal agency within the US Department of Commerce that conducts various types of meteorological and geodetic research and forecasts for the United States and its possessions, studying the world ocean and atmosphere, the Central Asia Climate Information Platform, and the Central Asia Water and Environmental Knowledge Portal (CAWater-info) [4].

As a result of a thorough analytical review, we were unable to find adequate approaches for assessing the intensity of climate change. This formed the basis for developing our own understanding of complex climate change processes.

Previously, we proposed to determine the intensity of climate change (Ji) using the following formula [5], [6], [7]:

Ji = ∑t=10 (**T** x **V**) x **R** x **G** x **Kk** x **Kc** x **Knr**

where the following values (parameters) are taken:

T – the annual measured surface air temperature (or ground surface temperature) – seasonal average (for at least ten years t=10 years); the base coefficient is taken as equal to 1.0. An increase above 1 means a rise in the average temperature.

V – atmospheric air humidity; the base coefficient is taken as equal to 1.0. An increase above 1 means a rise in air dryness; a drop below 1 means a rise in humidity.

R – the prevailing wind direction (mode). For the conditions of the Aral Sea basin, it is proposed to adopt the coefficients for the intensity increase depending on winds by season: a) the wind comes from the west and north (north-west) most of the year, so it is proposed to take Rnw = 1.3 (cold season) and the south-west index Rnw = 1.7 (warm season).

G – the region's geographical location (tropical, equatorial, temperate, polar). Based on the CMIP1 forecast, which states that the highest intensity will occur in the temperate and polar zones, the following coefficients are proposed for these regions: temperate zone G = 2, polar zone G = 1.5. For the tropical and equatorial zones, the index will be 1.25. This approach to estimating the geographic coefficient is associated with the response of radiation reflected from clouds. Total radiation is the total incoming solar radiation on the horizontal surface of the Earth. The annual incoming radiation fluctuates from 40 kcal in the Polar circle to 100 kcal in the Mediterranean and Central Asia.

Kk – the correlation indicator, taking into account the specifics of the territory: mountainous and forested area K = 1.0; desert K = 1.5; rural area K = 1.7; urbanized K = 2.

Kc – the cycle index characterizing the number of recurrences of floods, droughts, fires, abnormal natural phenomena (rainstorms, tornadoes, volcanic eruptions, dust storms, etc.). The base coefficient is taken as equal to 1.0. An increase above 1 means the presence of extraordinary events, their frequency and amount of damage.

[1] World Climate Research Program. URL: https://www.wcrp-climate.org

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Knr – the index of the reduction (loss) of natural resources that characterizes the number of lost types of resources (flora and fauna, water resources and other types of natural resources). The base coefficient is taken as equal to 1.0. An increase above 1 means a rise in biodiversity losses.

The average global value of the "ideal" index (with an average 1 oC temperature increase) is J = 4.0.

(It should be noted that the authors' ownership of this method is confirmed by a Copyright Certificate [9]).

Observations in Uzbekistan have shown that warming trends are recorded at all Uzhydromet stations with long-term records of average annual air temperatures. At most stations in the country, the increase in average annual air temperatures since 1950 is statistically significant, with the warming trend almost twice as high as natural variability. The highest rates of warming are observed in the north of the country and in large cities (0.30-0.43°C over 10 years), while the lowest are in the mountainous zone (0.10-0.14°C over 10 years).

Moderate rates of warming are observed in areas where irrigated lands were established during the period under review. Since the early 1950s, the average temperature increase in Uzbekistan has been 0.27°C per decade, which is almost twice the rate of global warming. The increase in average annual air temperatures in Uzbekistan is occurring against a backdrop of natural variability, causing significant interannual fluctuations.

At the same time, due to the Aral Sea disaster, climate change is occurring even more rapidly and severely. The Aral Sea region's climate was characterized by the high frequency and long duration of salt-dust and sand-dust storms. Overall, it should be noted that Uzbekistan and Central Asia as a whole are becoming hotter and drier year after year. Observations show that abnormally hot days were recorded in 1983 (a record high of +48-49°C in Kyzylkum Desert), 1997 (an absolute record high of +44.6°C in Tashkent in July), and in 2019 (when extremely high temperatures persisted for 14 consecutive days). And prolonged waves of excessive heat in the summer period in 2021, 2024, 2025 and, especially, in 2026 (43-48°C for 8 days) convincingly confirm this trend.

In particular, according to meteorologists, the average monthly air temperature in July across most of the republic exceeded the norm by 1.3–2.3 degrees, and in some northern and desert regions by 2.5–2.8 degrees. The highest temperature in July was recorded in Uchkuduk (Kyzylkum Desert) – 49.7 degrees. This is a record high [10].

Furthermore, over the past 25 years, there has been a decrease in summer precipitation and an increase in aridity (Fig. 2).

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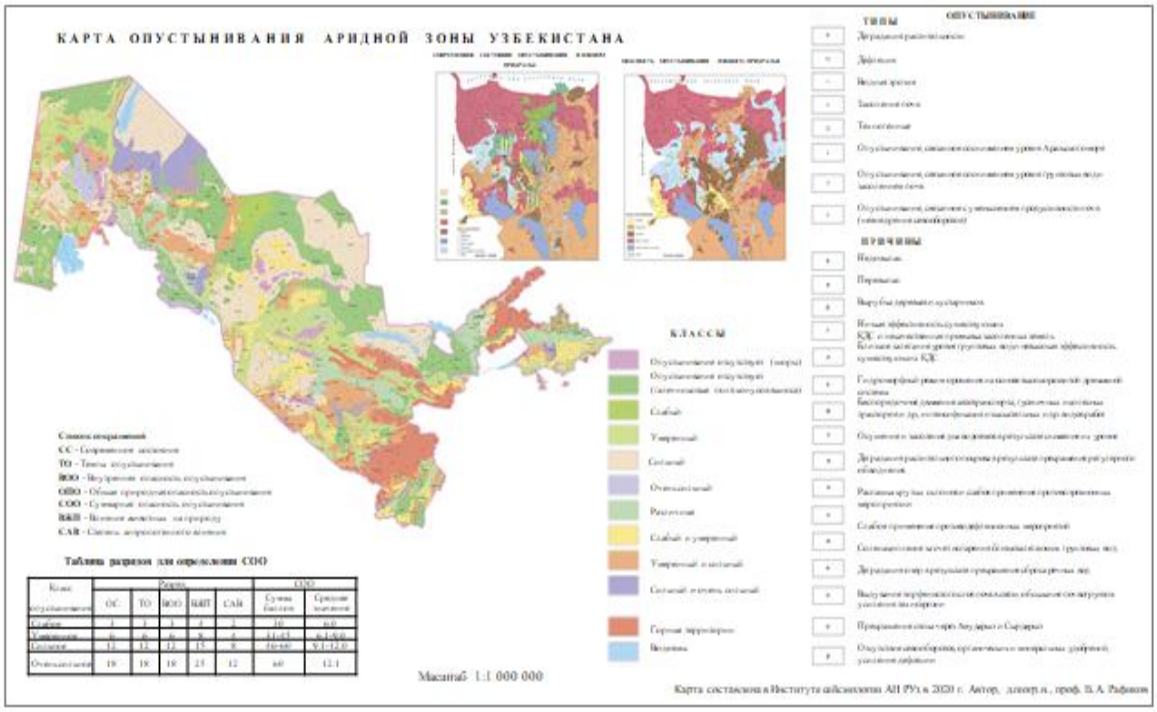


Figure 2. Map of desertification in the arid zone of Uzbekistan

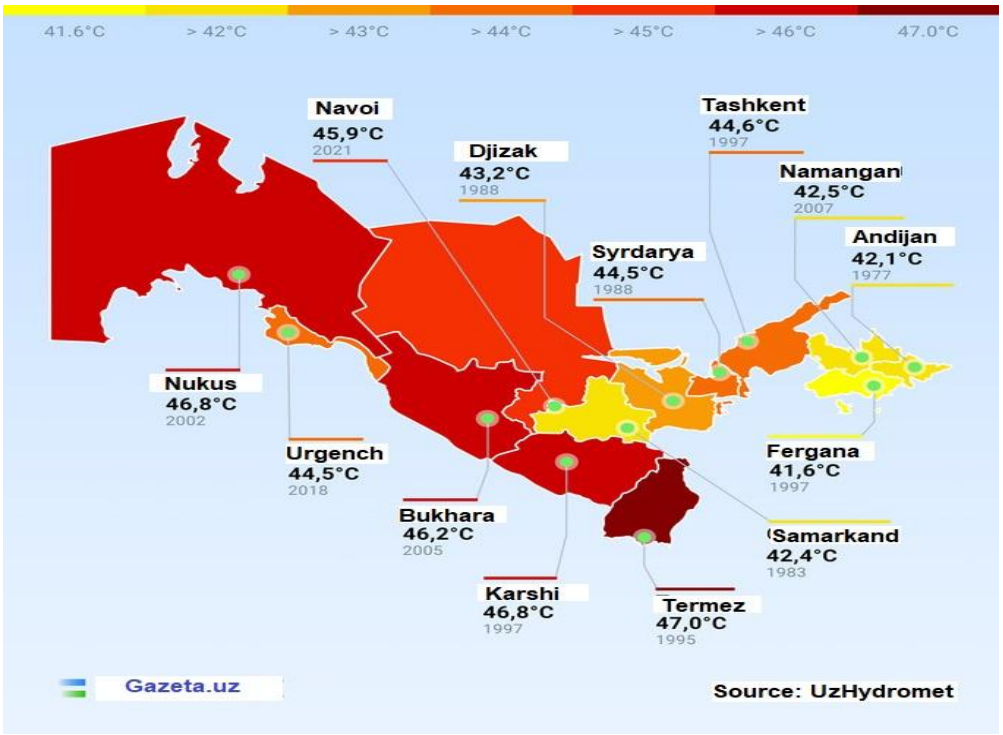


Figure 3. Infographic: how the summer temperature has changed in Uzbekistan over half a century

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The most dangerous result is the rapid melting of glaciers (the region currently has 46 glaciers, with an average volume loss of 32% over the past 45 years). This trend is observed in all regions of the world. For example, Greenland, which has the world's largest ice sheet, loses approximately 260–270 gigatons (billion tons) of ice annually, and during record warming periods, this figure reached 500–600 billion tons [11].

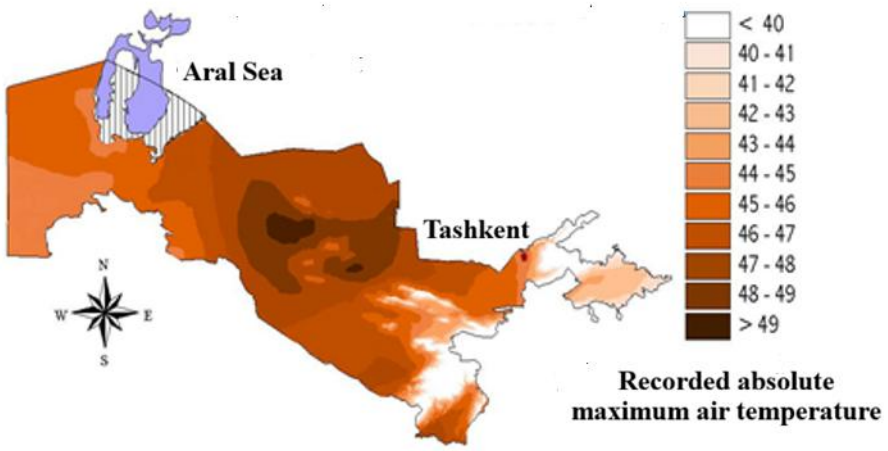


Figure 4. The consequences of the disappearance of the Aral Sea on climate change in the region - the maximum temperature has increased

These trends necessitate enhanced joint efforts to find and implement solutions to mitigate the negative impacts of climate change in the region. It is crucial to develop innovative approaches to stabilizing glaciers and upper watershed ecosystems, increasing water resources, improving their efficient use, further stabilizing the Aral Sea basin, halting desertification, and reducing the impact of droughts. In this regard, the application of the climate change intensity assessment method can serve as a useful guide for experts in these areas.

Furthermore, long-term research into climate change processes in the Central Asian region and globally has revealed a consistent relationship between various climate-related processes and uneven increases in air temperature. Furthermore, while temperatures increase arithmetically, processes such as glacier melting, plant transpiration, and evaporation from water bodies, among others, change exponentially.

This relationship can be determined using the formula:

1) $Qn+1 = Qn + d$

d - is the difference of the arithmetic progression

2) q - is the denominator of the geometric progression

[bn] - is the geometric progression

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bn = b, qn-1

Table 1. The growth rate (linear trend coefficient, °C/10 years) of the average seasonal temperatures in the countries of Central Asia for 1976–2022 [12]

Country	Annual	Winter	Spring	Summer	Autumn
Republicof Kazakhstan	0.33	0.26	0.65	0.22	0.23
Kyrgyz Republic	0.25	0.27	0.48	0.13	0.12
Republicof Tajikistan	0.20	0.19	0.35	0.07	0.09
Turkmenistan	0.38	0.47	0.48	0.38	0.24
Republicof Uzbekistan	0.34	0.39	0.58	0.31	0.15

Rising air temperatures trigger global climate change, increasing glacier melt, moisture evaporation, and extreme weather events. These processes directly lead to rising sea levels, frequent droughts, and water shortages [13].

This is because rising heat accelerates the transition of water from liquid to vapor, increasing the air's moisture capacity. Excess moisture triggers heavy downpours, storms, and devastating floods in some regions, while in others, soil rapidly loses moisture, expanding arid lands and triggering desertification.

Rising temperatures also result in the melting of mountain glaciers and polar ice caps. In turn, melting ice and thermal expansion of water raise sea levels, threatening coastal zones.

Furthermore, shifting temperature zones leads to the extinction of vulnerable animal and plant species, disrupting the natural balance of biodiversity. The question naturally arises: how is climate change related to rising temperatures?

As greenhouse gas emissions blanket the Earth, they trap solar heat, causing the planet to warm, causing climate change. The Earth is currently warming faster than ever before in recorded history. Rising temperatures over time alter weather patterns and disrupt the natural balance, leading to a host of other changes.

It should be noted that, as early as 20 years ago, Uzbek scientists analyzed climate characteristics, assessed possible changes in climate elements, hazardous hydrometeorological phenomena, and the potential impact of climate change on agricultural productivity and the country's water resources [14].

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Analysts believe that for the environmental sector, this means adapting ecosystems to climate change must become a top priority. We are moving beyond preventative measures: landscape planning must now take into account inevitable shifts in climate zones. For businesses, this is a clear signal of impending stricter carbon regulations [15], [16].

There is another aspect to the problem: as a new study has shown, identifying a group of previously ignored chemical compounds that significantly contribute to the greenhouse effect, unaccounted pollutants, such as fugitive pollution sources (landfills, municipal waste dumps), are also responsible for warming. They account for approximately 15% of observed global warming [17].

This discovery creates new opportunities for climate policy. Focusing solely on carbon dioxide is insufficient. Pressure on industry to control these "hidden" emissions could have a rapid climate impact, providing new leverage in negotiations with the corporate sector [18].

Furthermore, there are other problems: scientists have discovered that climate change is disrupting breeze circulation and increasing ozone levels [19]. Why is this important? Researchers believe that climate change is transforming the dynamics of onshore winds. This leads to stagnation of air masses and local increases in ground-level ozone concentrations in coastal regions. Ground-level ozone is known to be toxic to both humans and vegetation, reducing ecosystem productivity. This factor will need to be taken into account when creating green buffers in coastal zones [20].

It should be noted that today's information picture clearly demonstrates the transition of global ecology from the "risk assessment" stage to the "forced adaptation" stage. A record temperature of 1.37°C and evidence of declining viability of wild plant seeds indicate that ecosystems are already in a state of profound stress. Under these conditions, traditional conservation approaches are no longer effective: the conservation community must shift to proactive landscape planning, exemplified by the creation of climate-resilient corridors for snow leopards in Kyrgyzstan [21].

Scientific observations of the planet's state over 150 years have shown that this year could see a repeat of the dramatic effects of the 1887 El Niño climate change. The 2026 El Niño is characterized by active development, the potential for a strong or "super" phase at elevated altitudes, and a significant increase in global heat in the second half of the year. According to the World Meteorological Organization, the likelihood of this climate phenomenon occurring is estimated at approximately 80%. The likelihood of its peak is expected in the fall and winter of 2026–2027. The year 2026 has a high potential to be one of the hottest on record [22].

Prolonged summer and autumn heat waves are expected across various continents. In Central Asia, precipitation is predicted to increase above normal in the second half of the year. There is a high risk of widespread droughts, wildfires, and extreme flooding in several areas of the planet. Scientists are warning of threats to ecosystems, as well as the possibility of a global food shock and rising prices for key commodities (coffee, fish, and seafood) due to deteriorating harvest and aquaculture conditions.

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Climatologists are warning of a whole range of extreme weather events on the horizon, as a powerful El Niño phenomenon has coincided with global warming.

New UN climate forecasts indicate that the Earth will, with overwhelming probability, repeatedly exceed internationally recognized safe climate thresholds over the next five years, breaking global temperature records along the way [23].

The El Niño climate phenomenon, firmly established in the Pacific Ocean, could become the strongest on record. The Australian Bureau of Meteorology and global experts are monitoring the anomaly with growing alarm: climate models are producing "stunning" results for the coming months, and, combined with global warming, this factor could make this year or 2027 the hottest on record.

These changes are being driven by unusually warm waters in the tropical Pacific Ocean. Observations show that ocean surface temperatures in key areas are gradually approaching El Niño thresholds. At the same time, a significant amount of heat has accumulated in the subsurface layers of the ocean—temperatures there are approximately six degrees Celsius above normal, further fueling the surface warming process.

This phenomenon manifests itself as abnormal heating of the ocean surface, triggering powerful storms in some regions of the planet and severe drought in others. The historical maximum temperature anomaly in the key equatorial zone of Niño 3.4 was +2.6 degrees Celsius (January 1983). However, current models indicate that the peak of the emerging El Niño will reach between +2.2 and a record-breaking +3.3 degrees Celsius, and even higher.

Scientists note that current temperature maps show a giant "tongue" of anomalously warm water off the coast of South America. Climatologist Zeke Hausfather emphasizes: El Niño will not only be the strongest since reliable observations began, but could surpass previous records by a shocking margin, far beyond anything previously recorded. The main global impact will be a colossal release of heat from the ocean into the atmosphere. For Australia, this means that from August to October, much of the country will experience its highest temperatures on record. In major metropolitan areas (Sydney, Melbourne, Brisbane, Perth, and others), the likelihood of extreme heat and drought exceeds 80%.

Additional concerns arise from the situation in the Indian Ocean, where cooling of the water northwest of the continent (a positive dipole) is predicted. The combination of this process with El Niño has previously led to catastrophic consequences—it was precisely this combination that caused the "gunpowder" drought and massive forest fires in Australia (the "Black Summer" of 2019-2020).

Although the absolute strength of the phenomenon does not always directly determine the severity of local weather impacts, experts are waiting with bated breath. The volume of heat accumulated by the ocean will inevitably lead to a large-scale restructuring of climate processes worldwide [24].

Experts warn that El Niño could intensify global warming, increasing the risk of extreme heat, droughts, heavy precipitation, and other dangerous weather events. Its impacts could be particularly noticeable against the backdrop of recent record-breaking warmth.

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The UN Secretary-General António Guterres called for the development of El Niño to be considered an urgent climate warning. "El Niño conditions will add fuel to the fire of global warming," he stated in a video message. According to him, the impacts will be felt more quickly and widely than before, and an effective response requires accelerating the transition to renewable energy sources, protecting the most vulnerable populations, and developing early warning systems [25].

Thus, our research demonstrates that as atmospheric temperatures increase exponentially, due to the cumulative effect (heat retention), the rate of processes such as glacier melting, water evaporation from the surface of the hydrosphere, and plant transpiration increases exponentially.

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