UTICAJ EFEKTA STAKLENE BAŠTE NA KLIMATSKE PROMENE
THE INFLUENCE OF THE GLASS GARDEN EFFECT ON CLIMATE CHANGES

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Abstract

Sagorevanje fosilnih goriva i drugih ljudskih aktivnosti u cilju raščišćavanja zemljišta za potrebe zemljoradnje ili izgradnje naselja, dovode do povećane emisije, oslobađajući u atmosferu gasove koji zadržavaju toplotu unutar nje. Atmosfera, slično staklu, uglavnom propušta Sunčevo zračenje, ali je slabo propusna za zračenje Zemljine površine. Deo energije koji uđe u sistem Zemlja - atmosfera, ostaje u njemu i pretvara se u toplotnu energiju, zagrevajući Zemljinu površinu i niže slojeve atmosfere i dovodi do pojave efekta staklene bašte. Efekat staklene bašte je proces zagrevanja planete Zemlje koji je nastaje poremećajem energetske ravnoteže između količine zračenja koje Zemljina površina prima od Sunca i vraća u svemir. Deo toplotnog zračenja, koje stiže do Zemljine kore, odbija se u atmosferu i, umesto da ode u svemir, apsorbuju ga neki gasovi i ponovno zrače na Zemlju. Na ovaj način, temperatura Zemljine površine se povišava. Ovom fenomenu najviše diprinose gasovi ugljen-dioksid i metan koji se nagomilavaju u atmosferi, zadržavajući sve više toplote pri Zemljinoj površini, što uzrokuje otopljavanje. Kao posledicu toga, javljaju se nagle promene koje dovode da parametri globalnog zagrevanja i klimatskih promena postaju nepredvidivi u pojavama učestalih uragana, poplava, ciklona i ostalih vremenskih nepogoda, topljenja leda na polarnim kapama i glečerima, što uzrokuje porast visine mora i okeana, nemogućnost tačnog predviđanja vremenske prognoze i sl. Emisije gasova staklene bašte su od ključne važnosti za razumevanje i rešavanje klimatske krize i moraju se smanjiti do 2030. god., kako bi se ograničilo globalno zagrevanje na 1,5 °C u poređenju sa predindustrijskim nivoima do kraja veka.

Ključne reči: : atmosfera; emisija gasova; toplotna energija; efekat staklene bašte; klimatke promene

Abstract

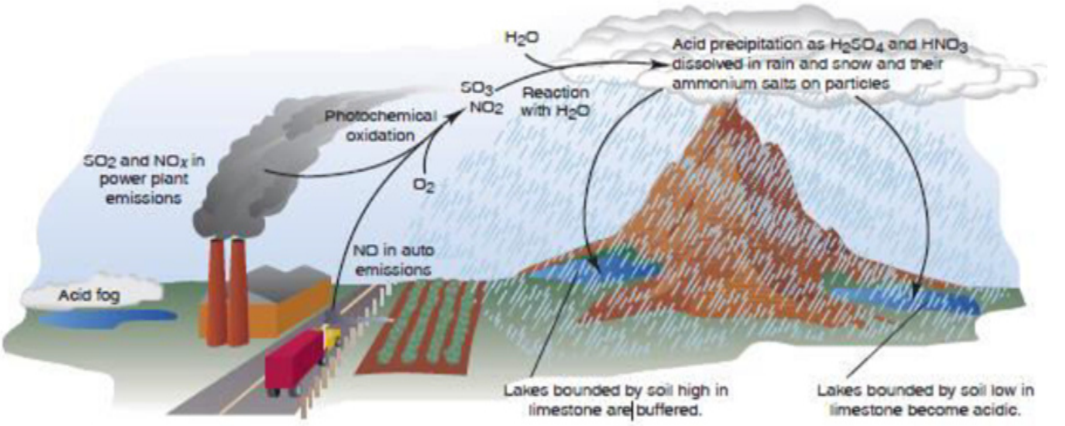
The burning of fossil fuels and other human activities in order to clear the land for the needs of agriculture or the construction of settlements, lead to increased emissions by releasing into the atmosphere gases that retain heat within it. The atmosphere, similar to glass, mostly passes the solar radiation, but it is poorly permeable to the radiation of the Earth's surface. Part of the energy that enters the Earth - atmosphere system remains in it and is converted into thermal energy, heating the Earth's surface and the lower layers of the atmosphere and leading to the appearance of the greenhouse effect. The greenhouse effect is the process of the planet Earth warming, caused by the disruption of the energy balance between the amount of radiation that the Earth's surface receives from the Sun and returns to space. Part of the heat radiation, which reaches the Earth's crust, is reflected into the atmosphere and instead of going into space, it is absorbed by some gases in the atmosphere and re-radiated to the Earth. In this way, the temperature of the Earth's surface rises. The gases that contribute the most to this phenomenon are carbon dioxide and methane and they build up in the atmosphere, trapping more and more heat near the Earth's surface thus causing the climate to warm. As a result, there are sudden changes, which lead to the parameters of global warming and climate change becoming unpredictable in the occurrence of frequent hurricanes, floods, cyclones and other weather disasters, melting of ice on the polar caps and glaciers, which cause an increase in the height of the seas and oceans, the impossibility of accurate prediction weather forecasts, etc. Greenhouse gas emissions are critical to understanding and addressing the *climate crisis and must be reduced by 2030 to limit global warming to 1.5 °C compared to pre industrial levels by the end of the century.*

Key words: atmosphere; emission of gases; greenhouse effect; heat energy; climate change,

1 INTRODUCTION

The atmosphere, similar to glass, mostly passes the Sun's radiation, but it is poorly permeable to the radiation of the Earth's surface, so part of the energy that enters the Earth-atmosphere system, as well as the greenhouse, remains in it and is converted into thermal energy, heating the Earth's surface and lower layers atmosphere. This natural phenomenon "heats" the Earth's surface, which has been going on for four billion years. However, today scientists are increasingly concerned that human activity could, to a certain extent, alter this all-natural process with very dangerous consequences. The term greenhouse effect itself, already established in the scientific literature, does not fully correspond in its meaning to the phenomenon it describes, and the phenomenon of the greenhouse effect has been studied since the 60s of the 20th century. Namely, the cause of the increased temperature inside the greenhouse is, first of all, the impossibility of mixing the air in the greenhouse with the surrounding air, and to a much lesser extent it originates from the absorption of long-wave radiation in the glass of the greenhouse walls. Therefore, even the term greenhouse gases cannot be related to the nature of the gases implied by this term.

Figure 1: Schematic representation of the greenhouse effect [1]



Today, scientists around the world monitor the concentration of greenhouse gases in the atmosphere and create forecasts of their consequences for global temperature. Sources of greenhouse gases, such as cars, factories and power plants, are monitored directly to determine their emissions. Information on climate systems is collected and this data is used in the aforementioned computer models that simulate climate change. Models can only provide approximations of values, and some predictions are often rejected by the scientific community.

Nevertheless, the basic concept of global warming is widely accepted by most climate change scientists.

In 1999, every fourth tree had about 25 % of damaged leaves, and acid rain dissolves marble and building materials, leading to the degradation of buildings. The process responsible for the destruction of the material has a positive effect in the lake water located above the limestone rocks:

$$CO_3^{2-}(aq) + H_3O^{+}(aq) = HCO_3^{-}(aq) + H_2O\,(l) \quad (1.1)$$

$$HCO_3^{-}(aq) / CO_3^{2-}(aq) \quad (1.2)$$

The presence of carbonate / bicarbonate ions has a buffering effect, contributing to the relative stability of the pH of the lake water. One of the ways to protect lakes located above slightly calcareous soil from acid rain is the addition of limestone. During the 1990s, tens of millions of dollars were spent in Sweden to sprinkle about 3,000 lakes with limestone.

This is only a temporary measure of protection due to the limited capacity of the buffering effect. A much more effective measure is the reduction of SO_2 and NOx emissions! Partial reduction of SO_2 to H_2S, which is then converted into elemental sulfur, is carried out in the thermal reactors:

$$16\ H_2S\ (g) + 8\ SO_2\ (g) = 24\ S\ (s) + H_2O\ (l) \qquad (1.3)$$

NOx is removed from the hot gases of the power plant using ammonia:

$$4NO\ (g) + 4NH_3\ (g) + O_2\ (g) = 4N_2\ (g) + 6H_2O\ (g) \qquad (1.4)$$

The sun heats the Earth with its rays that manage to reach the surface of our planet through the atmosphere. The surface heats up in this way and then radiates the heat back into the atmosphere. Gases that retain that heat as an insulator are the gases of the "greenhouse" effect. If they did not exist, the temperature on the Earth's surface would be about 30 degrees lower than it is now, so life as it exists now would be impossible. Unfortunately, civilization, especially its most developed part, produces too many of these gases, so they absorb more and more heat and heat up the Earth more and more and lead to the phenomenon that started under the name of global warming. The reliance of the entire development of civilization on the production of energy by burning fossil fuels has increased the emission of greenhouse gases into the atmosphere. One of the most common greenhouse gases is carbon dioxide. This gas is produced when burning any fossil fuel, burning wood, gasoline, oil, natural gas, etc. If the volume of burning of fossil fuels is reduced and forest cutting is slowed down, the amount of greenhouse gases around the Earth will most likely be reduced. Unfortunately, no matter what drastic measures are taken, it is now too late to stop global warming and climate change, although it is possible to influence the intensity of those changes. Clean air is the basis for the health and life of people and the entire ecosystem. Air is a mixture of gases that makes up the atmosphere, and it consists of approximately 4/5 nitrogen, 1/5 oxygen and very small amounts of noble gases, carbon dioxide, hydrogen, ozone, water vapor and various impurities. In acid precipitation, the presence of mainly three compounds:

Sulfuric acid - Sulfur dioxide (SO_2) is a product of burning coal with a high sulfur content. By dissolving in water, it forms sulfuric acid. One of the atmospheric pollutants is a strong oxidizing agent, hydrogen peroxide, which oxidizes sulfuric acid to sulfuric acid:

$$H_2O_2\ (aq) + H_2SO_3\ (aq) = H_2SO_4\ (aq) + H_2O\ (l) \qquad (1.5)$$

Sulfuric acid - Sulfur trioxide (SO_3) is formed in the atmosphere by the oxidation of sulfur dioxide. By dissolving in water, it forms sulfuric acid.

Nitric acid - Nitrogen oxides (marked NOx) are formed in the reaction between N_2 and O_2. NO is a product of combustion in internal combustion engines as well as in power plants. NOx is converted into N_2O_5 at night, which dissolves in water to form HNO_3. Coal used by factory plants contains up to 4 wt. % S, mainly in the form of minerals, for example pyrite, unpolluted rainwater - slightly acidic (pH about 5.6) due to the dissolution of CO_2:

$$CO_2\ (g) + 2H_2O\ (l) = H3O^+\ (aq) + HCO_3^-\ (aq) \qquad (1.6)$$

2 Basic concepts and concentrations of greenhouse gases

Large-scale warming affects many aspects of our lives, such as changes in temperature and changes in the distribution of precipitation, causing sea level rise and changes in the distribution of drinking water supplies. The impact on our health, the vitality of forests and other natural areas, as well as on agricultural production is also very significant. A warmer planet Earth accelerates the global water cycle, the exchange of water between the oceans, atmosphere and soil. A higher temperature causes greater evaporation, and the soil will dry out faster. More water in the atmosphere, in total, means more rain or snow. Such events can cause flooding, soil erosion and other problems. In some other areas, increased evaporation leads to drought, while other areas will experience excessive amounts of rain. Most of the long-wave radiation emitted from the Earth's surface is absorbed by the atmosphere, while some passes through the atmospheric window. The atmosphere in turn radiates energy into space and back to Earth. The temperature of the Earth's surface is 34 °C higher than expected. To understand the reasons for this higher temperature, the answer will be given by Wien's law, which gives the wavelength at which the blackbody spectrum has a maximum value as a function of absolute temperature.

$$\lambda\, max(\mu m) = \frac{2898}{T(K)} \quad (2.1)$$

We can represent the sun as a black body with a temperature of 5800 K, so that its spectrum has a maximum value of 0.5 μm. When radiant energy passes through the atmosphere, it is affected by various gases and aerosols in the air. These atmospheric constituents can transmit the emitted energy, they can scatter the energy by reflection, or they can absorb the energy. As atoms in gaseous molecules vibrate and move closer or further away from each other (vibrational energy), or as they rotate around each other (rotational energy), they absorb or emit energy at certain wavelengths. When the frequency of these molecular movements is close to the frequency of the energy falling on them, then the molecule can absorb that energy. Most of the long-wave energy emitted by the Earth is absorbed by a combination of active gases, the most important of which are water vapor (H_2O), carbon dioxide (CO_2), methane (CH_4), nitrous oxide (NxO), molecular oxygen (O_2), and ozone (O_3). Water vapor, which is the most important greenhouse gas, strongly absorbs thermal energy with a wavelength over 18 μm. Carbon dioxide has a strong absorption field centered around 15 μm, as well as fields centered around 2.7 μm and 4.3 μm. Between 7 μm and 12 μm there is a relatively clear sky for outgoing thermal radiation, which we call the atmospheric radioactive window. Radiation in these wavelengths easily passes through the atmosphere, with the exception of a small but significant absorption field between 9.5 μm and 10.6 μm related to ozone (O_3). All incoming solar energy with a wavelength less than 0.3 μm (ultraviolet) is absorbed by oxygen and ozone. This absorption of ultraviolet rays occurs in the stratosphere, protecting the Earth's surface from harmful ultraviolet radiation. Radioactive gases that absorb wavelengths above 4 μm are called greenhouse gases.

This absorption heats the atmosphere, which, in turn, re-radiates energy back to Earth and into space, reducing the loss of heat energy at the Earth's surface. These greenhouse gases act as a blanket around the globe, increasing the Earth's surface temperatures above the effective temperature.

The importance of water vapor as a greenhouse gas is most evident during clear nights, when the Earth cools much faster than during cloudy nights. If there was no greenhouse effect on Earth, the temperature of the Earth would be 254 K. That is, the planet would have an average temperature of -19 °C [1,2,3,4,5].

Actually, one way to quantify the greenhouse effect is to compare the effective temperature Te with the actual temperature of the Earth's surface Ts, Size of the greenhouse effect = Ts -Te. So the percent is real the Earth's temperature is 288 K, and its effective temperature is 254 K, we can say that the greenhouse effect adds 34 °C to the warming of the Earth's surface. If all carbon dioxide disappeared from the atmosphere, the Sun's radiation would be mostly reflected from the surface of the planet, and the Earth would be colder by about 400°C. If there was no greenhouse effect at all, the Earth would be a hardened stone in space, with a temperature of -730°C, while in the case of an intense greenhouse effect, the Earth would resemble Venus, with an average temperature of a hellish 5000 °C.

The Earth's atmosphere consists mainly of nitrogen (78 %) and oxygen (21 %). These two most abundant atmospheric gases have chemical structures that limit the absorption of infrared radiation, which is not the case for greenhouse gases. These gases are created naturally or artificially. The most common naturally occurring greenhouse gas is water vapor, followed by carbon dioxide, methane, and nitrous oxide. Man-made substances that behave as greenhouse gases include chlorofluorocarbons, hydrochlorofluorocarbons, and hydrofluorocarbons.

Scientists predict that the expected increase in the amount of greenhouse gases in the atmosphere will greatly increase the amount of infrared radiation retained in the atmosphere, leading to additional, artificial, warming of the Earth's surface.

Water vapor - is found in the largest amount in the atmosphere, comparing it with other greenhouse gases. It absorbs long-wave radiation the most, contributing 60 to 70 % to the creation of the greenhouse effect. Man has no major direct influence on the amount of water vapor in the atmosphere. However, as human activity increases and affects the concentration of other greenhouse gases, the evaporation of oceans, lakes and rivers, as well as the transpiration of plants become more intense and increase the amount of water vapor in the atmosphere.

Carbon dioxide - continuously circulates in a large number of natural processes known as the carbon cycle. Volcanic eruptions and the decomposition of plant and animal remains release this gas into the atmosphere. By breathing, animals indirectly break down food, which releases the energy needed to maintain cellular activity. One of the products of respiration is carbon dioxide, which animals exhale. Oceans, lakes and rivers absorb carbon dioxide from the atmosphere. In the process of photosynthesis, plants take in carbon dioxide to produce starch, incorporating it into new plant tissue and releasing oxygen into the environment as a byproduct. To provide energy to heat homes, run cars, and power plants, humans burn carbon - containing substances, such as fossil fuels (coal, oil, and natural gas), wood, and some solid materials. During their combustion, carbon dioxide is released into the air. At the same time, man additionally "complicates the situation" by uncontrolled felling of large forest areas in order to provide wood or land for the needs of farming or settlement.

Methane - occurs in many natural processes, and is also known as natural gas. The decomposition of many carbon-containing substances in an environment without the presence of oxygen, such as waste, releases this gas. Ruminant animals such as cattle and sheep release methane into the air as a byproduct of the digestion process. Microorganisms that live in moist soil, such as rice fields, produce methane when they break down organic matter. Methane is also released in coal mines and during the production and transportation of other fossil fuels. The amount of methane has doubled since 1750, and according to estimates, it may double in the next century. Atmospheric concentrations of methane are much lower than carbon dioxide concentrations, and methane remains in the atmosphere for only about a decade. However, scientists believe that methane is a very effective greenhouse gas (one molecule of methane is 20 times more effective at trapping infrared radiation reflected from the Earth's surface than a molecule of carbon dioxide).

Nitrous oxide - this gas is released during the burning of fossil fuels and in automobile exhaust gases. Also, many farmers use nitrogen-based fertilizers to provide nutrients to plants. When these fertilizers reach the soil, they emit nitrogen - suboxide into the air. In addition, this gas is also released by plowing the soil from the roots of plants. Since 1750, the concentration of this oxide has increased by 17 % in the atmosphere.

Although this increase is smaller than the increase in the concentration of other greenhouse gases, one molecule of this gas retains about 300 times more heat than carbon dioxide and can remain in the atmosphere for up to a hundred years.

Fluorine compounds - are some of the most dangerous greenhouse gases, they are produced only by man and are used in many production processes. One molecule of each such compound is several thousand times more dangerous than one molecule of carbon dioxide. Chlorofluorocarbons, first synthesized in 1928, are widely used in the production of various sprays, as dissolving agents and as cooling agents. Non-toxic and safe for use in many processes, these compounds are harmless to the lower atmosphere. However, in the higher layers, ultraviolet radiation breaks them down, releasing chlorine. In the mid -70 s, scientists began to notice that high concentrations of chlorine were destroying the ozone layer. Ozone protects the Earth from harmful ultraviolet radiation, which can cause tumors and otherwise damage plants and animals. Due to such a dangerous effect, scientists have developed substitutes for these compounds, which also have a harmful effect on the atmosphere, but to a much lesser extent.

Synthetic substances - experts are concerned about precisely these industrial chemicals that have a great potential for the greenhouse effect. In 2000, scientists observed an increase in the previously unmonitored substance trifluoromethyl-sulfur pentafluoride. Although it is present in very small amounts in the environment today, this gas is extremely dangerous because it traps long-wave radiation much more effectively than all other greenhouse gases. The exact sources of this gas produced in industrial processes, the factors influencing the greenhouse effect have not yet been determined with certainty.

Aerosols - particles that float in the atmosphere, absorb, scatter and reflect radiation back into space. Clouds, wind-blown dust particles, and smoke particles from volcanic eruptions are examples of natural aerosols. Human activity, including the burning of fossil fuels, further contributes to the accumulation of aerosols in the atmosphere. Although aerosols do not retain heat radiation, they certainly affect the transfer of heat energy from the Earth to space. The impact of aerosols on climate change is still debated, but scientists believe that light-colored aerosols cool the Earth's surface, while dark-colored ones do the opposite [1,2,3,4,5].

3 The mechanism of action of the greenhouse effect

The greenhouse effect is the result of the interaction of solar radiation and the layer of the Earth's atmosphere that extends up to 100 km above the Earth's surface. Solar radiation contains a spectrum of radiation at different wavelengths, known as the solar spectrum, which includes visible, infrared, gamma, X-ray, and ultraviolet radiation. When solar radiation reaches the atmosphere, 25 % of the energy it carries is reflected by clouds and other atmospheric components back into interplanetary space, about 20 % is absorbed by the atmosphere. Gas molecules in the highest layers of the atmosphere absorb the Sun's gamma and X-ray radiation. The sun's ultraviolet radiation is absorbed by the ozone layer, which is located at a height of 19 to 48 km above the Earth's surface. About 50 % of the Sun's energy, mostly in the form of visible light, passes, as short-wave radiation, through the atmosphere and reaches the Earth's surface. Land, plants and water surfaces (primarily oceans) absorb about 85 % of this heat energy, while the rest is reflected into the atmosphere, mostly by highly reflective surfaces such as snow, ice and sandy deserts. Further, part of the Sun. Of the total solar radiation that reaches the Earth's atmosphere: ~25 % is reflected from clouds back into space, ~20 % of energy is absorbed by clouds, gases and various particles, ~5 % is reflected from the surface of the Earth into space,b~50 % reaches Earth and is allocated to soil heating, snow and ice melting, water evaporation, photosynthesis. The heating of the soil by solar energy causes it to act as a source of thermal radiation. Only a small amount of this radiation goes into space, and most of it is absorbed by the so-called greenhouse gases in the atmosphere. Excited gases re-emit heat radiation, 90 % of which returns to Earth, where it is absorbed again. The process continues as long as there is long-wave radiation. If there were no greenhouse gases, the temperature would be about 30 degrees lower, like on Mars, and life could not exist.

However, if the amount of these gases is too large, overheating occurs, as on Venus, where the atmosphere is composed of ~98 % carbon dioxide, and the average temperature is about 450 °C.

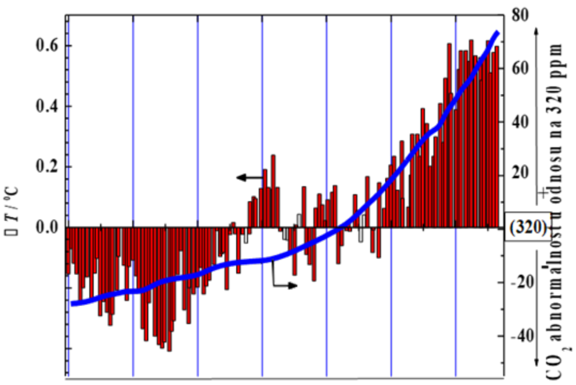


Figure 2. Increase in CO_2 concentration in the atmosphere [1]

Figure 2 shows, as an example, the increase in the concentration of carbon dioxide in the atmosphere for the past one hundred and thirty years. The concentration of carbon dioxide is greater than 20 %, which is the main reason that leads to an increase in the average annual temperature on Earth, initial global warming and climate change. Initial global warming leads to faster evaporation of water from water surfaces and further acceleration of warming, which leads to a chain reaction that can hardly be slowed down and predicted. The main gases that form a greenhouse are carbon dioxide, water vapor, methane, as well as sulfur and nitrogen oxides.

Also, various chlorinated or fluorinated organic substances (freons and halons) that are used, or were previously used, in cooling devices and for filling sprays, in addition to increasing the greenhouse effect, also lead to the destruction of the ozone layer, which significantly prevents the passage of extremely harmful UV radiation to the Earth's surface. It is believed that the most consequences for global warming are:

a. Carbon dioxide (CO_2) - it is believed that this gas participates with about 50-55 % in global warming. The main reason for the increase in the concentration of this gas in the atmosphere is the increasing use of fossil fuels (coal, oil, gas) and deforestation.
b. Chloro-fluorocarbons (CFCs) and halons - participate with about 25 % in global warming. CFC compounds are used to make plastics and in refrigeration equipment.
c. Methane (CH_4) - about 12 % of the share, is created by the decomposition of organic compounds and during the digestion of food by herbivorous ruminants, but the largest amount of methane in the atmosphere comes from industrial plants and volcanic activity.
d. Nitrogen (I) oxide - participates with 6 % in global warming. Most of it is released in industry, but large amounts of this gas are also released in volcanic eruptions.

4 Negative consequences caused by the greenhouse effect

The change of seasons conditions the periodic growth of plant crops. In the northern hemisphere, during the spring and summer, vegetation flourishes, which in the process of photosynthesis consumes atmospheric carbon dioxide and releases oxygen. During autumn and winter, there is a partial death of the plant mass with rotting, whereby part of the carbon dioxide is returned to the atmosphere. The opposite process takes place in the southern hemisphere of the Earth, and this is how carbon dioxide circulates in nature cyclically.

However, due to the disturbance in the concentration of carbon dioxide, due to the burning of enormous amounts of fossil fuels, and the uncontrolled cutting of forests, there was a disturbance in the composition of the atmosphere and the conditions for the formation of the "greenhouse". The impact of the greenhouse effect on nature is enormous and has a cumulative and domino effect. The primary consequence of the greenhouse effect is an increase in the average temperature of the atmosphere. With the increase in temperature, there is melting of ice sheets and glaciers, which have been formed for tens of thousands of years. By reducing the area covered by the ice sheets, the ability to reflect the primary radiation of the Sun decreases and the absorption of radiation on the darker surfaces under the ice and snow increases, which leads to additional warming. During the thousands of years of snow and ice deposition, a huge amount of once atmospheric carbon dioxide was trapped in them, which melts back into the atmosphere. The deposition of atmospheric soot particles on ice sheets has the same effect. Also, the melting of the ice around the polar caps leads to a rise in the sea level. If all the ice were to melt, the level of the seas and oceans would rise by eighty meters. The retreat of the ice sheet leads to the melting of permafrost, huge expanses of frozen land in which there is a large amount of plant matter. An increase in temperature creates ideal conditions for the anaerobic rotting of plant matter, whereby methane is formed and released, which is a far more harmful gas than carbon dioxide. The key to Earth's climate lies in the circular flow of water masses from the North Atlantic to the North Pacific - the Gulf Stream. At the ends are two key reversal zones. In the Atlantic, warm and very salty water cools and sinks, so the cold water in the form of a deep salty sea current flows around the entire planet towards the Pacific. There, it gradually warms up and rises, so that it can then flow again along the surface towards the Atlantic. This current is the main air conditioner of the Earth, whereby the equatorial parts are cooled and the polar parts are heated, which is the main reason for the relatively moderate temperatures on Earth.

If the polar ice caps were to melt, the Gulf Stream would stop circulating and the temperature in the equatorial part would reach very high values, while the northern and southern hemispheres would cool down and favorable conditions for a new ice age would be created. Secondary negative effects of greenhouse gases are reflected in the impact on plant and animal life. The rise in temperature and the melting of the ice drastically affect the change in the habitat of various plant and animal species. The expression "endangered like a polar bear" has already become popular.

The presence of sulfur and nitrogen oxides in the atmosphere leads to the appearance of acid rains, which have negative consequences on the development of various plant cultures, the death of forest areas, and the like.

The impact on human health, and on the animal world as well, is more than documented. Also, the negative consequences are reflected in the decrease in the mass of phytoplankton, which are the first link in the food chain of marine animals, and in the death of microscopic feraminophores, whose 8 shells consist of calcium carbonate created in the reaction with dissolved carbon dioxide [1-9].

5 Conclusion

Scientists, however, hope that as the evidence of global warming accumulates, states will be more motivated to participate more intensively in preventing changes in the Earth's climate. Burning large amounts of fossil fuels increases the amount of this gas in the air, and cutting down trees only worsens this problem, because it reduces the number of "consumers" of carbon dioxide. The heat energy of the Sun heats the Earth's surface, and after it warms up, it begins to release a certain amount of heat into the air. The layers of carbon dioxide above the Earth prevent heat from escaping into space, so the Earth's surface overheats. Global warming of the planet has dramatic consequences for nature and all living things on Earth, so it is necessary to take all measures against the further deterioration of this phenomenon. Greenhouse gas emissions are critical to understanding and solving the climate crisis and must be halved by 2030 if we are to limit global warming to 1.5 °C compared to pre-industrial levels by the end of the century.

Carbon dioxide (CO_2), methane and nitrous oxide are gases we need to worry about. CO_2 remains in the atmosphere for up to 1,000 years, methane for about a decade, and nitrous oxide for about 120 years.

Measured over a 20-year period, methane is 80 times more potent than CO_2 in causing global warming, while nitrous oxide is 280 times more potent. Switching to renewable energy, putting a price on carbon and phasing out coal are important elements in reducing greenhouse gas emissions.

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