Global warming and long-term climatic changes: a progress report

L. F. Khilyuk · G. V. Chilingar

Abstract The authors believe that recent global warming of Earth's atmosphere is not due to an increase in anthropogenic carbon dioxide emission but rather to long-term global factors. The human contribution to the CO_2 content in the atmosphere and the increase in temperature is negligible in comparison with other sources of carbon dioxide emission. Discussed in this paper are sources, avenues of migration, and the amounts of naturally produced carbon dioxide and methane (greenhouse gases) and long-term changes in the Earth's climate, which are necessary for understanding the causes of current temperature trends.

Keywords Global warming · Climatic changes · Gas migration

Introduction

The temperature of Earth's atmosphere is increasing. During the 20th century, the mean global surface temperature has increased by approximately 1 °F (Fig. 1). According to the proponents of conventional global warming theory, over the same period of time, the concentrations of water vapor, carbon dioxide, methane and other greenhouse gases (nitrous oxide, tropospheric ozone) in the atmosphere increased as a result of the human utilization of oil, gas, and coal. The increasing concentration of carbon dioxide from 1960 to 1997, for example, is illustrated in Fig. 2.
Increasing concentrations of greenhouse gases may also accelerate climate changes. Environmentalists predict that the global surface temperature could rise 1–4.5 °F in the next 50 years, and 2.2–10 °F in the next century (Kyoto Protocol 1997; http://www.epa.gov/globalwarming/climate/index.html). Because of the rising temperature, evaporation will increase, which, in turn, will increase global precipitation. The intense rainstorms around the world will become more frequent. Ice melting will increase the global sea level, which will be likely to rise 0.6 m in the next 50 years around the world. These disastrous climatic changes are usually attributed to the greenhouse effect. The latter is commonly blamed on the increase in man-induced CO_2 emission.

The greenhouse effect

Energy radiated from the Sun heats the Earth's surface and determines the Earth's climate. In turn, the heated Earth reradiates (at longer wavelength) part of this energy back into space. Some of this reradiated energy is absorbed and reemitted in all directions by the molecules of greenhouse gases[1] in the atmosphere. When the concentration of greenhouse gases in the atmosphere increases, the portion of the trapped energy increases, heating the Earth and changing the Earth's climate. A schematic diagram of the solar radiation and the effect of greenhouse blanket of gases is shown in Fig. 3. The commonly used term for this phenomenon is the greenhouse effect.
According to many scientists, without the greenhouse effect, the present-day Earth's global temperature would be only 5°F instead of 59°F. This phenomenon has been going on throughout the Earth's history over the past 4 billion years and is recorded for about 200 years. At the end of the 19th century, Arrhenius (1896) presented a hypothesis on heating the atmosphere as a result of increasing content of the carbon dioxide. For a long time this hypothesis was accepted as true and was used to explain the atmospheric phenomena practically without verification (Budyko 1997; Kondratiev 1992; Greenpeace 1993).
Joint analysis of Figs. 1 and 2 creates a mesmerizing effect for the believers of the Arrhenius hypothesis. Their explanation is very simple and powerful: (1) the

[1]Estimated contribution of various gases to the greenhouse "blanket" (Fig. 3) is as follows: $CO_2 \approx 65\%$; $CH_4 \approx 25\%$; $NO \approx 10\%$. Atmospheric lifetime of greenhouse gases: CO_2– few 100 years; CH_4 – 10 years; NO ≈150 years.

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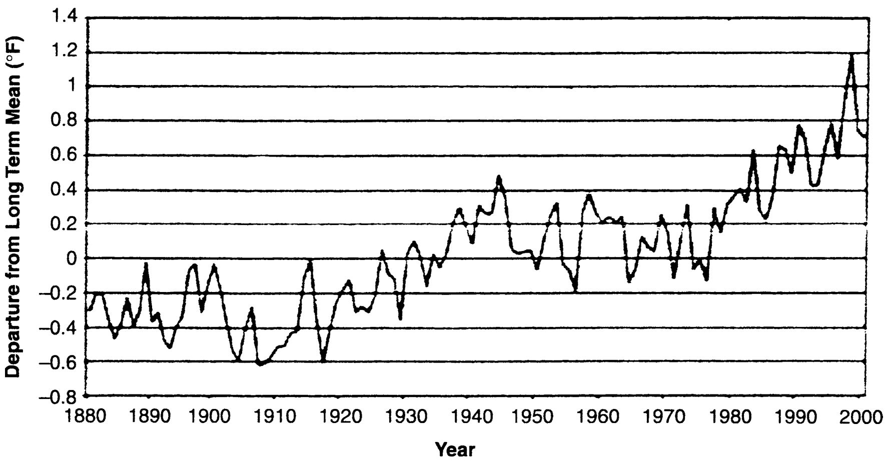


Fig. 1
Global average temperature changes in the 20th century (modified after EPA Global Warming Site: Climate. U.S. National Climatic Data Center, 2001)

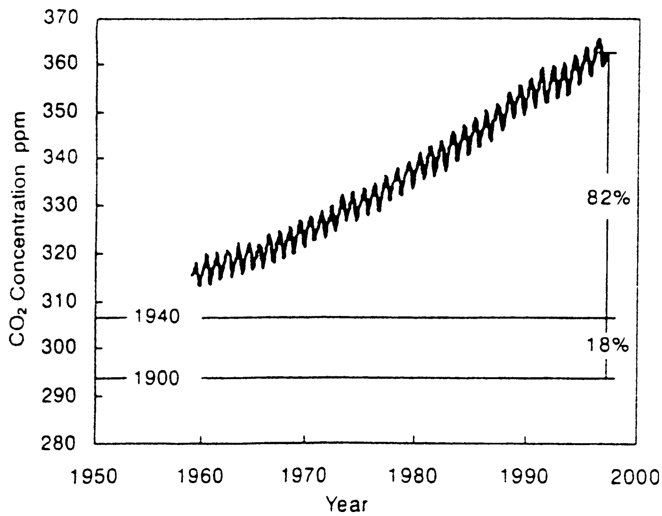


Fig. 2
Changes in atmospheric CO_2 concentration in parts per million (ppm) at Mauna Loa, Hawaii (modified after Keeling and Whorf 1997). The approximate global level of the atmospheric CO_2 in 1900 and 1940 is also shown

temperature is rising because of the increasing greenhouse effect, (2) the increasing greenhouse effect is due to the rising concentration of carbon dioxide (and other greenhouse gases) in the atmosphere, and (3) the rising concentration of carbon dioxide is due to an increase in the burning of fossil fuels by humans to generate more power. Their recipe for cooling is also simple and powerful: considerable cuts in human-induced CO_2 emission, which means drastic cuts in energy production and consumption for developed countries. Unfortunately, this recipe is incorrect because forces of nature leading to atmospheric heating (or cooling) are much stronger than current human influence (either positive or negative).
The rates and levels of the admissible emission for various countries were defined in the frame of the Kyoto Protocol of 1997, which required a worldwide 5% cut in the carbon dioxide emission. This, in turn, translates into corresponding cuts in energy production and consumption. The latter will inevitably seriously damage the economies of developed countries. The greatest damage would be done to the United States economy. To achieve the required carbon dioxide emission cuts by the year 2012, the USA would have to reduce its projected 2012 energy use by 25%. "Most economic studies indicate that the cost of the Kyoto carbon dioxide emission cuts to the US would amount to between $100 billion and $400 billion per year" (Baliunas 2002).

Sources and sinks of carbon dioxide

First doubt on the leading role of the human-induced CO_2 emission into the atmosphere is cast if one superposes the graphs of CO_2 concentration in the atmosphere and CO_2 emission to the atmosphere due to burning fossil fuel (Fig. 4). In this figure, one can clearly see that in the time interval from 1958 to 1978 the average concentration of CO_2 rose at the same average rate and was proportional to the CO_2 emission into the atmosphere due to burning fossil fuels. In 1978, however, the CO_2 emission into the atmosphere due to the burning of fossil fuels stopped rising and was relatively stable for about 9 years. If the burning of fossil fuels were the main cause (or one of the main causes) of the steadily increasing CO_2 content in the atmosphere, then the atmospheric concentration should also stop rising or at least its rate of rise should be reduced. This did not occur. This example shows that burning fossil fuels is not the major source of carbon dioxide in the atmosphere and, therefore, is not the main cause of the greenhouse effect.
The second natural step is identifying and evaluating the volumes of carbon dioxide inflow from the major natural sources[2] into the atmosphere—ocean system of the Earth. The rate of total human-induced CO_2 emission to the Earth's atmosphere is currently about 5–7 billion tons/year (Schimel 1995; Robinson and others 1998, personal communication). Yet, estimates by Yasamanov (2003) show that the CO_2 emission only from the volcanic activity at the mid-ocean ridges accounts for about 20–30 billion

[2]Earth's carbon inventory (billion tons): CO_2 in the atmosphere – ≈700; land plants and soil – ≈2,200; surface ocean water – ≈600; ocean sediments – ≈3,800. Sources of greenhouse CO_2 (billion tons per year): ocean – ≈100; land – ≈50; fossil fuel use – ≈5–7.

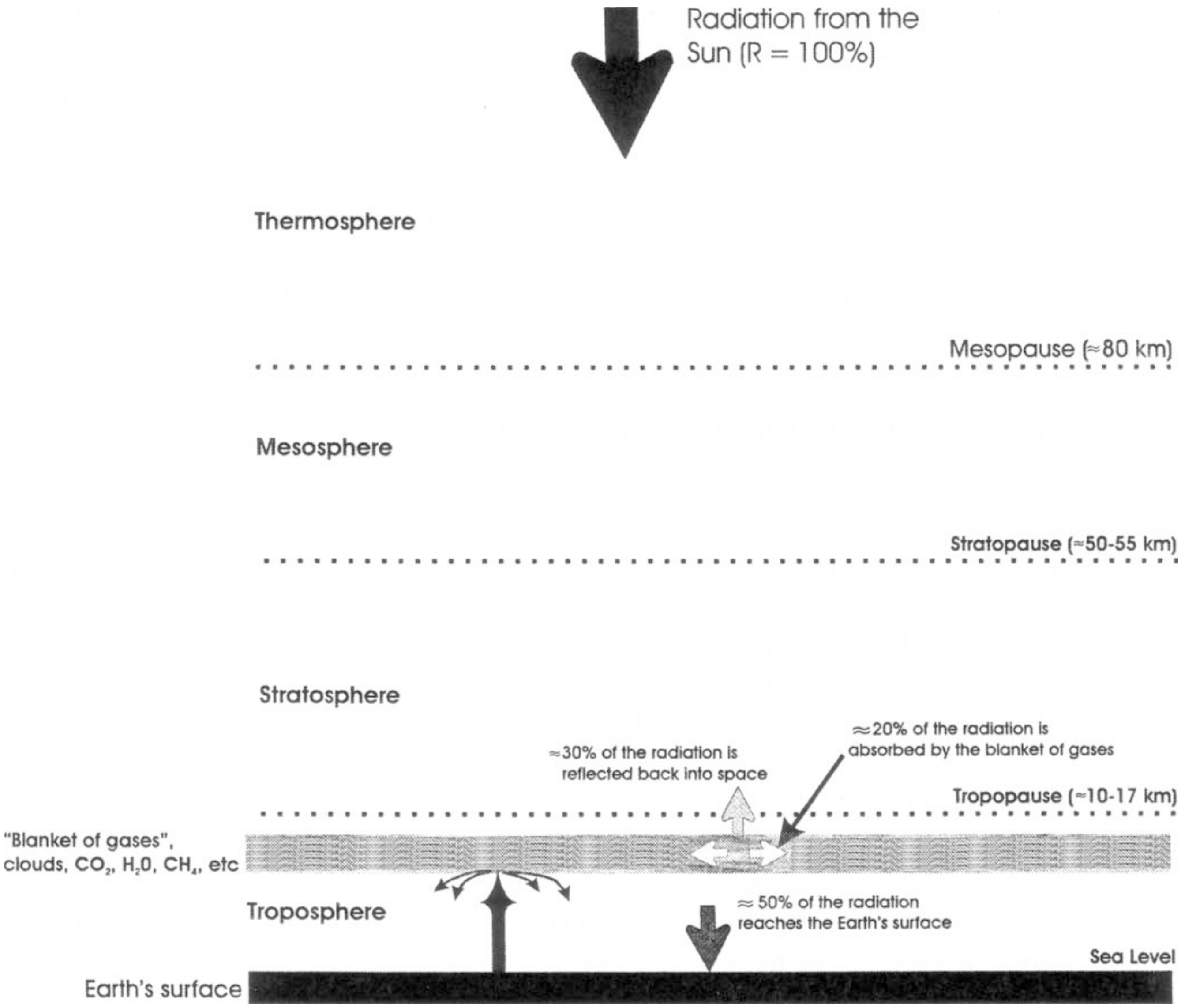


Fig. 3
The greenhouse effect (modified after the World Resources Institute, Changing Climate: A Guide to the Greenhouse Effect, 1989)

tons/per year. The oceanic water contains 50–60 times more CO_2 than the atmosphere and is a major supplier of carbon dioxide to the atmosphere. As was recently shown (Sorokhtin 2002; Khilyuk and Chilingar 2003; Khilyuk and others 2003), a rising temperature drives huge volumes of carbon dioxide from the ocean water to the atmosphere. In a recent publication (Caldeira and Wickett 2003), researchers at the Lawrence Livermore National Laboratory have stated that "continued release of carbon dioxide during the next several centuries would increase ocean acidity more rapidly than during the past 300 million years" (http://www.llnl.gov06news). This conclusion was made based on computer models. Once again, the burning of fossil fuels was named as a dominating source of increase in the carbon dioxide concentration (and carbonic acid) in the ocean water "because eventually the ocean absorbs most of this carbon dioxide" (http://www.llnl.gov06news).

At this point, it should be noted that the world ocean plays a dual role in the carbon cycle (putting aside living matter involved in the carbon transformation). Depending on the changing climatic conditions, oceans can be either a "sink for" or "source of" the atmospheric CO_2. If, for example, the global temperature rises, then solubility of the carbon dioxide in the oceanic water decreases, and part of the oceanic carbon dioxide will be transferred to the atmosphere to maintain continuous dynamic equilibrium.

One of the major sources of oceanic carbon dioxide is volcanic activity at the mid-ocean ridges. During the oceanic eruptions, not all of the gases reach the atmosphere. Most of the emanated CO_2 dissolves in the oceanic water due to the high solubility of this gas (especially under high pressure) (volume ratio of 1/1 in water at the sea level, and 30/1 at 7,000 psi or a depth of 4,575 m). Due to the high solubility of carbon dioxide in water and its high molecular weight, CO_2 accumulates in great volumes in deep waters and may escape into the atmosphere by sudden eruption.

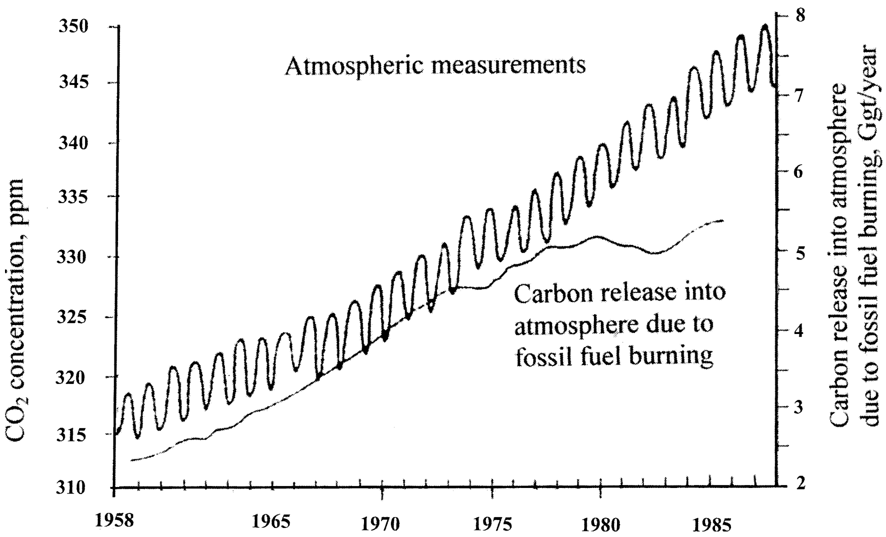


Fig. 4
Changing atmospheric concentration of CO_2 concentration and release of CO_2 due to fossil fuel burning into atmosphere during the second part of the 20th century (modified after Yasamanov 2003)

On August 21, 1986, a sudden release of gas from the Lake Nyos in Cameroon, West Africa, killed at least 1,700 people and 3,000 cattle (Bunce and Hunt 1987). At first, the event was identified as a volcanic eruption. Six days after the eruption, a US team of geologists and environmentalists arrived at the site to investigate the causes of the disaster. It was determined that the gas released was carbon dioxide of magmatic origin. It became clear that the magmatic CO_2, seeping upward and dissolving in the lake water, had accumulated during centuries in the deep undisturbed layers of lake water.

Under the pressure of upper layers of water, carbon dioxide stayed dissolved as long as the deep waters were not disturbed. On the day of eruption, the stable layered water was disturbed (supposedly by a rock slide), and the deep water saturated with the carbon dioxide rose to the surface instantly releasing a great volume of carbon dioxide into the atmosphere. It was estimated that about 1 km^3 of CO_2 was released as a result of this eruption, causing abrupt suffocation of people and animals. One can only hypothesize on the huge volumes of CO_2 stored in the stagnant waters of deep oceanic trenches of the world ocean.

Heat transfer in the atmosphere

Huge potential damage to the world economy led to the revision and subsequent serious critique of the basic assumptions made in the studies on global warming (Robinson and others 1998, personal communication; Sorokhtin 2001; Baliunas 2002). Thorough examination of the alarming predictions showed that until recently the theory of greenhouse effect did not exist, and all the numerical calculations and predictions were based on simplified mathematical models with rough estimates of the important parameters.

One of the simplified one-layer models was presented by Dr. Z. Mester (Mester 1996, personal communication; in Khilyuk and Chilingar 2003). In this model one-layer atmosphere was assumed to be confined by two imaginary surfaces: bottom (representing the Earth's surface absorbing and reradiating back to space the solar radiation) and top (representing reflecting properties of the Earth-atmosphere system, or Earth's albedo – fraction of the solar radiation that is reflected back into space). The Stefan-Boltzmann Law (Landau and Lifshits 1979) was applied for calculation of the surface temperature of the planet for several global warming scenarios with various parameters of the Earth's albedo, atmospheric attenuation of the solar radiation, and the greenhouse effect. Mester's model showed that the greenhouse effect did contribute to the global warming.

The above discussed model counts on the heat transfer in the atmosphere by radiation only. It is worth noting that the heat transfer by radiation dominates in the upper diffuse layers of the stratosphere, mesosphere and thermosphere only. Meantime, Earth has a relatively dense atmosphere (Marov 1996), and the heat transfer in its lower, denser, layer (troposphere) mostly occurs by convection (Sorokhtin 2001). Indeed, in the troposphere, with the air pressure exceeding 0.2 atm, heat transfer by convection is dominating. When the temperature of a given mass of air increases, its volume also increases. As the hot air expands, it becomes less dense, and rises. In turn, the denser cooler air drops and replaces the warmer air (Khilyuk and Chilingar 2003). This system works in the Earth-atmosphere system as a continuous surface cooler. The cooling effect of the air convection in the troposphere can considerably surpass the warming greenhouse effect. The most important conclusion from this observation is that the temperature distribution in the troposphere has to be close to adiabatic taking into consideration the fact that the air mass expands and cools while rising, and compresses and heats while dropping (Sorokhtin 2001). This hypothesis was indirectly verified by comparison of theoretical and experimental distributions of the temperature in the troposphere of the Earth (and Venus) that was done by Sorokhtin and Ushakov (1999).

For adiabatic transformation, the temperature dependence on gas pressure can be presented in the following form (Landau and Lifshits 1979):

$$T = C^{\alpha} p^{\alpha} \quad (1)$$

where C^{α} is a constant defined separately.
The exponent α in Eq. (1) is defined by

$$\alpha = (C_p - C_v)/C_p \quad (2)$$

where C_p and C_v are the thermal capacities of the gas at a constant pressure and for a constant volume, respectively. For CO_2 and H_2O, α=0.2308; whereas for O_2 and H_2, α=0.2857. Water vapor condensing in the troposphere emits the heat that increases the air temperature. Because of that, the adiabatic exponent α decreases. For example, for the humid Earth's troposphere α=0.1905 (Sorokhtin and Ushakov 1999).

Water vapor condensing in the troposphere produces cloudiness, which is a leading factor that determines the Earth's albedo. This forms a strong negative feedback between the solar radiation and the Earth's surface heating, which stabilizes the troposphere temperature. Under these circumstances, one can assume that the troposphere temperature is a linear function of the *effective radiation temperature* (temperature of absolutely black body at a distance from Sun to Earth). Combining this condition with Eq. (1), one can write a formula that determines the "average Earth's surface temperature" at any altitude of the troposphere as an exponential function of the pressure at the same altitude:

$$T(h) = bT_e p^{\alpha}(h) \quad (3)$$

where *p(h)* is the pressure of the atmosphere at the altitude *h*, *T(h)* is the "average surface temperature" at the altitude *h*, T_e is the effective radiation temperature, and *b* is a scaling coefficient.

For Earth, T_e =278.8 K; contemporary temperature at the sea level is equal to 288 K; *T(0)*=288 K; and the atmospheric pressure *p*(0)=1 atm. Substituting these data into Eq. (3) (288= $b \times 278.8 \times 1$), one can determine the scaling coefficient *b* (*b*=1.033). Thus, rewriting Eq. (3) in a more convenient form, one obtains:

$$T(h) = 1.033 T_e p^{\alpha}(h), \quad (4)$$

$$\text{or } T(h) = 288 p^{\alpha}(h) \quad (5)$$

This allows the construction of the temperature distribution for the troposphere (if the exponent α is known). Under such approach, the focus of modeling is shifted to the definition of parameter α, which determines the adiabatic heat transfer in the troposphere.

Sorokhtin and associates computed the values of α for typical conditions of the troposphere: for the absolutely dry and transparent troposphere α=0.286; and for the humid, heat-absorbing troposphere α=0.1905 (Sorokhtin and Ushakov 1999). The temperature distributions in the troposphere for these two conditions are shown in Fig. 5. In this figure, one can see that for the same atmospheric pressure the near-surface temperature of the dry and transparent troposphere is always greater than the near-surface temperature for the humid, heat-absorbing troposphere.

The heat absorption by the greenhouse gases causes further increase in this difference. This leads to paradoxical (at first sight) conclusion that absorption of the infrared radiation by the Earth's atmosphere does not increase, but, on the contrary, decreases the near-surface temperature of the atmosphere. Using the adiabatic model, the explanation becomes simple: with increasing effective thermal capacity of the air (that occurs if the emission of the greenhouse gases to the atmosphere increases), the adiabatic exponent α decreases, and the atmospheric temperature decreases (in accordance with Eq. 4). Physical explanation of the latter lies in the high efficiency of heat transfer by convection from the planet surface to the lower layers of the stratosphere from which the heat is rapidly emitted to space by radiation. The major flaw of the radiation theory of global warming is that it ignores completely the heat transfer in atmosphere by convection. Of the total heat transfer from the Earth's surface to the troposphere, convection accounts for 67%, radiation accounts for 11%, and the condensation of water vapor in troposphere accounts for 22% (Sorokhtin 2001).

Is human-induced carbon dioxide emission changing the Earth's climate?

The concentration of CO_2 in the Earth's atmosphere has been increasing in the 20th century as shown in Fig. 2. The carbon content in the atmosphere was increasing by approximately 3 billion tons/year at the end of the century. The rate of the total human-induced CO_2 emission to the Earth's atmosphere is currently about 5–7 billion tons/

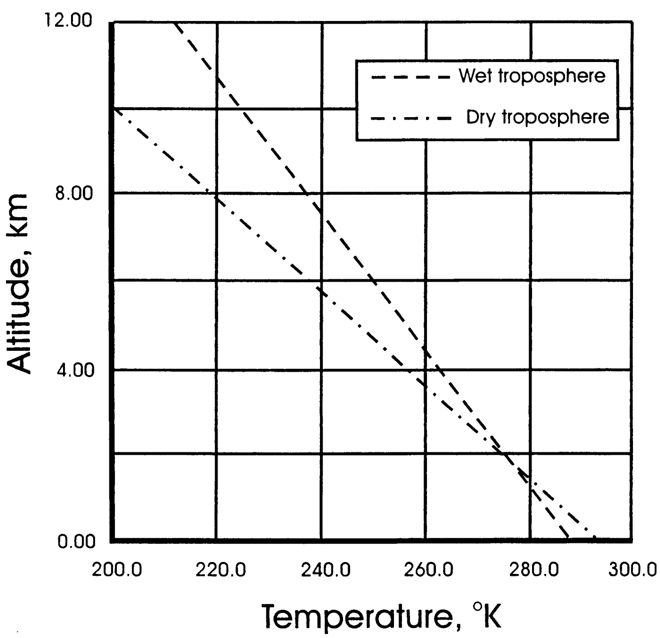


Fig. 5
Adiabatic temperature distribution in troposphere for dry troposphere (α=0.286) and wet troposphere (α=0.1905) (modified after Sorokhtin 2001)

year (Schimel 1995; Robinson and others 1998, personal communication). This amount of carbon dioxide not only changes the gas composition of the atmosphere, but also slightly increases the atmospheric pressure.

One can use the adiabatic model together with the sensitivity analysis (Khilyuk and others 1994; Katz and others 1996) to evaluate the effect of human-induced emission of the carbon dioxide on the global temperature. Taking logarithms of both sides of Eq. (5) results in:

$$\ln T = \ln 288 + \alpha \ln p \tag{6}$$

Introducing notation $A(\alpha, p)$ for the right part of Eq. (6), one can find the sensitivity functions of ln T as partial derivatives of $A(\alpha, p)$ with respect to parameters α and p. Differentiating Eq. (6), one obtains:

$$\frac{1}{T} dT = \frac{\partial A(\alpha, p)}{\partial \alpha} d\alpha + \frac{\partial A(\alpha, p)}{\partial p} dp \tag{7}$$

Substituting partial derivatives of $A(\alpha, p)$ and multiplying both sides of Eq. (7) by T, the following equation is obtained:

$$dT = T\left(\ln p d\alpha + \frac{\alpha}{p} d\alpha\right) \tag{8}$$

Transition to finite differences in differential Eq. (8) yields:

$$\Delta T \approx T \ln p \Delta\alpha + T\frac{\alpha}{p}\Delta p \tag{9}$$

Equation (9) is convenient for the analysis of the effect of human-induced emission of greenhouse gases on the global temperature. If, for example, the concentration of CO_2 in the atmosphere increases two times (from 0.035 to 0.07%), which is expected by the year 2100, then the pressure will increase by $\Delta p = 1.48\times10^{-4}$ atm, and $\Delta\alpha = -4\times10^{-6}$ (Sorokhtin 2001). At the sea level, if the pressure is measured in atmospheres, then p =1, and ln p=0. Thus,

$$\Delta T \approx T\alpha\Delta p \tag{10}$$

After substitution of T=288 K, α =0.1905, and $\Delta p = 1.48\times10^{-4}$ atm into Eq. (10), one finds $\Delta T \approx 8.12\times10^{-3}$ K. Thus, the increase in the surface temperature at the sea level caused by the human-induced CO_2 emission will be less than 0.01 K, which is negligible compared to the natural temporal fluctuations of the global temperature.

This increase will be slightly higher at the higher altitudes, where the pressure is less than one atmosphere, and its logarithm is negative. Multiplication of ln p by the negative value of $\Delta\alpha$ will increase ΔT (the global temperature change) (Eq. 9). If, for example, h= 10 km, then the barometric pressure $p \approx 0.24$ atm and the temperature is about 200–220 K (FMH-1 1995). Substituting all necessary data (T=220 K, $p \approx$ 0.24 atm, ln $p \approx -1.4286$, $\Delta p = 1.48\times10^{-4}$ atm, α =0.1905, $\Delta\alpha = -4\times10^{-6}$) into Eq. (9), one obtains $\Delta T \approx 2.710\times10^{-2}$ K, which is less than 0.03 K.

From these estimates, one can deduce a very important practical conclusion that even considerable increase in the human-induced emission of carbon dioxide and other greenhouse gases practically does not change the global atmospheric temperature. Thus, the hypothesis of current global warming resulting from the increased emission of greenhouse gases into the atmosphere is a myth. Humans are not responsible for the increase in the global surface temperature of 1°F≈0.56 K during the last century, and one should look for natural sources for heating of the atmosphere.

Does the increase in concentration of atmospheric carbon dioxide constitute cause or effect of global warming?

Proponents of the greenhouse global warming theory usually point out that the increased emission of greenhouse gases is accompanied by the increase in global temperature, and, consequently, the increased emission causes the global warming. Yet, increase in the carbon dioxide concentration closely follows a 300-year warming trend.

Figure 6 shows that the global surface temperature is directly correlated with the solar activity. The greater the solar activity, the greater the Sun's radiation, and, consequently, the Earth's surface absorbs more radiation from the Sun. This leads to an increase in the surface temperature and consequent warming of the atmosphere by convection, water vapor condensation, and radiation.

Figure 7 shows that on the large historical scale the surface temperature deviations lead the corresponding changes in the atmospheric carbon dioxide concentrations. Apparently, the temperature changes cause the changes in the carbon dioxide concentration: the higher the temperature, the greater the concentration of carbon dioxide (Sorokhtin 2002; Robinson and others 1998, personal communication). For example, during the Devonian and Silurian times, the atmospheric CO_2 pressure was high because of high global temperatures. Lush vegetation prevailed, and Ca/Mg ratio of ocean water was low (due to high CO_2 pressure), with abundant dolomite formation (Chilingar 1956; Chilingarian and Wolf 1988). Thus, Ca/Mg ratio can provide valuable indirect information on the atmospheric concentration of CO_2.

Long-term climatic changes

Contemporary rising trend in the atmospheric CO_2 concentration (Fig. 2) is mostly the effect of increasing global temperature that most probably can be attributed to increased solar radiation in the rising phase of the latest 80 to 90-year cycle of solar activity (Khilyuk and Chilingar 2003). There are, however, many other powerful factors

Fig. 6
Moving 11-year average terrestrial temperatures (northern hemisphere) shown as deviations in °C from the 1951–1970 mean value (*left vertical axis and thick line*) and the solar magnetic cycle lengths (*right vertical axis and thin line*) (modified after Jones PD 1986; Grovesman BS; and Landsberg HE 1979; Baliunas S and Soon W 1995; in Robinson AB, Baliunas SL, Soon W, Robinson ZW (1998). Environmental effect of increased atmospheric carbon dioxide, personal communication, 8 pp, Fig. 3)

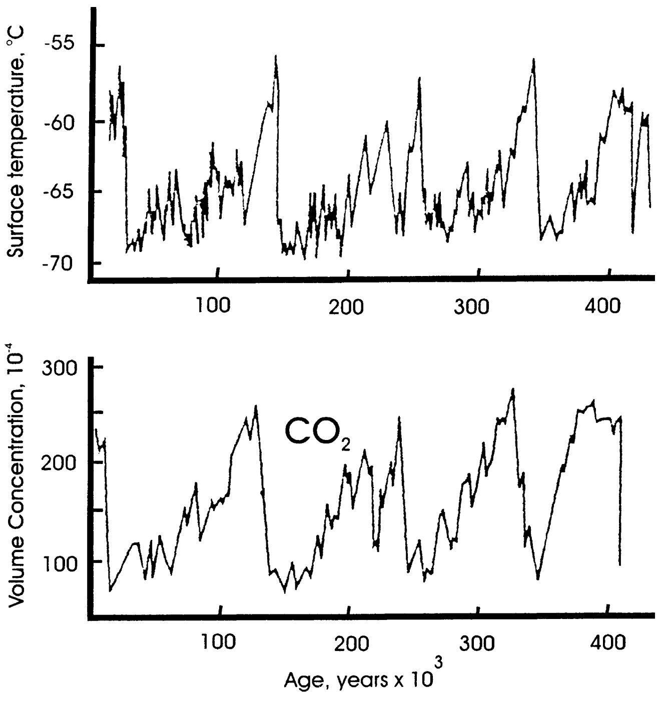


Fig. 7
Correlation of the changes in concentrations of carbon dioxide with the changes in air temperature (*upper graph*) for the last 420,000 years at the Antarctic station "Vostok". Data were obtained from the well logs by drilling in ice to a depth of 3,623 m (modified after Sorokhtin 2001; Fig. 3; Kotlyakov and Danilov 1999)

that result from the long-term variations in the Earth's conditions.

Contemporary Earth's atmosphere is the result of the long-term evolution process that began about 4.5 billion years ago. The early atmosphere with abundant carbon dioxide was considerably denser than the present one, and the average surface temperature ranged from 85 to 110°C (185 to 230 °F) (http://www.research.umbc.edu/~tokay/chapter1.html). The primary source of atmospheric gases was volcanic activity that began about 4 billion years ago. The gases, emanating from the hot molten rock, consisted mostly of CO_2, with nitrogen, water vapor, and traces of methane, ammonia and sulfur dioxide. At that time, the high concentration of carbon dioxide in the atmosphere could not be attributed to human activity.

The Earth's climate varies on time scales ranging from decades to millions of years. Decade-long variations are attributed to variations in solar activity and interactions among different components of the planet system: continental plates, world ocean, atmosphere, and ice cover. On the century-time scale, the Earth's warming and cooling are determined by long-term oscillations in solar activity and the orbit disturbance. The greater orbital deviations, that can be caused by redistribution of the moving masses in the Universe, are related to the glacial-interglacial cycles. "Ice ages occur about every 150 million years and last several million years" (EPA 2002), (http://www.epa.gov/emfjulte/tpmcmaia/html/climate.html).

Trying to understand climatic changes attributed to anthropogenic CO_2 emission into the atmosphere, one can analyze climates of the past epochs that obviously were not influenced by the human activity (Pearson and Palmer 1999). One of these observations relates to the persistent periodic oscillations of temperature throughout the Pleistocene (Raymo and others 1998), in which variations of (a) 3 to 4.5°C occurred during the glacial periods and (b) 0.5 to 1°C occurred during interglacial periods (Oppo and others 1998).

Pagani and others (1999) reconstructed the history of atmospheric CO_2 concentration throughout the Miocene (25 to 9 million years ago). They found that CO_2 concentrations in the Miocene were similar to those observed during the Pleistocene (180–290 ppm). In the middle of the Miocene, however, deep water and high-latitude surface ocean water were 6°C warmer than they are today. These authors stated that the "uniformly low" CO_2 concentration during the Miocene time "appears in conflict with greenhouse theories of climate change".

During the Archaean time (4 billion years ago) with hot (about 90°C) and dense atmosphere the main component of the Earth's atmosphere was carbon dioxide. The oceanic waters were hot (about 55°C) and acidic (pH= 3–5) (Sorokhtin 2002). All the carbon dioxide content was formed by the Earth's outgassing due to a high level of tectonic activity. [Outgassing: upward migration of gases (carbon dioxide, methane, radon, etc.) from the Earth to atmosphere.] This suggests that the main source of atmospheric CO_2 on the Earth was, and may continue to be the tectonic activity.

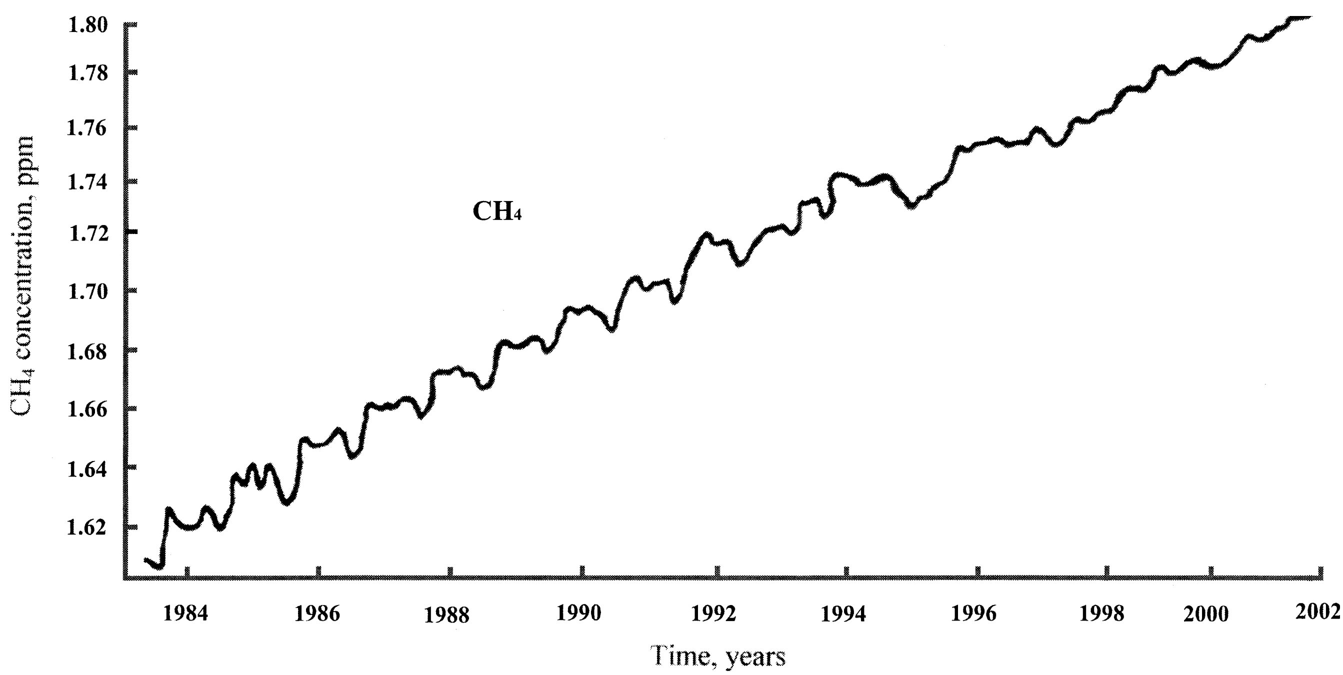
Methane emission effect

Yasamanov (2003) believes that the methane gas is a major source of CO_2 in the Earth's atmosphere. The concentration of methane in the atmosphere is continuously increasing (Fig. 8). Due to high volatility and low density, the methane released at the Earth's surface rapidly rises into the stratosphere. This methane, being exposed to solar radiation, reacts with the ozone (depleting the ozone layer) and transforms into hydrogen, water vapor, and carbon dioxide (Possible reaction: $CH_4 + O_3 +$ Solar radiation $\rightarrow CO_2 + H_2O + H_2$). Hydrogen rises into the stratosphere, whereas water vapor and methane form light clouds in the upper layers of the troposphere (at the border of the troposphere and stratosphere). Formed in the upper layers of the troposphere, carbon dioxide can contribute to the greenhouse effect. It should be remembered that the life-time of CO_2 (several hundred years) is much longer than that of CH_4 (7–10 years).

The main sources of methane on the Earth are: (1) volcanic activity, (2) marshes and tundra, (3) rice paddies, (4) cattle, (5) oil and gas production, and (6) natural gas migration (through faults and fractures) to the Earth's surface.

A great volume of methane is emanated as a result of volcanic eruptions. Yasamanov (2003) estimates about 5×10^{15} g of CH_4 are released yearly to oceanic water at the spreading zones of mid-ocean ridges. The amount of methane released to the atmosphere from marshes and tundra is estimated between 5×10^{13} and 7×10^{14} g annually. From tundra, the amount of CH_4 released is about 4×10^{13} g/year. Enteric fermentation contributes 2×10^{13} to 2×10^{14} g/year. The total amount of methane released annually into the atmosphere from the natural sources is estimated at the level of $2–3\times10^{15}$ g. Methane is also generated as a result of human activities. Rice paddies produce about 5×10^{14} g of methane annually. Oil and gas production and related operations add up to 9×10^{14} g of methane annually, which is only one order of magnitude lower than the amount of methane released from the natural sources. A great amount of methane is released to the atmosphere as a result of gas migration to the Earth's surface from coal, oil, and gas deposits and the Earth's mantle (Khilyuk and others 2000). The total amount from the latter source has not been estimated at the present time. Probably, it is around 5×10^{15} g/year, whereas the fossil fuels burning contributes only 1×10^{13} g/year of methane to the atmosphere.

Fig. 8
Growing atmospheric concentration of CH_4 at the end of the 20th century (modified after Yasamanov 2003)



Discussion

Investigating influence of the current anthropogenic carbon dioxide emission on global warming, the writers concluded that this influence is insignificant in comparison with the natural factors (such as solar activity for example) (Khilyuk and Chilingar 2003; Khilyuk and others 2003). There are many large-scale natural factors that can contribute considerably to the current atmospheric heating.

The Earth's atmosphere was formed by outgassing about 4 billion years ago. This process goes on continuously on the geologic time-scale playing a leading role in changing the contents and concentrations of the gaseous components of the atmosphere through geologic time. The amounts and avenues of migration of CO_2 and CH_4 seeping from the subsurface and entering the atmosphere and oceanic water should be carefully studied. This will enable one to evaluate the role and relative input of anthropogenic CO_2 and CH_4 released into the atmosphere in the global warming process. The origins of various gases and the avenues of their migration to the surface from the subsurface layers of the Earth are being studied (Khilyuk and others 2000).

One of the most widespread components of the migrating gases is methane. Yasamanov (2003) concluded that large volumes of methane released to the atmosphere should contribute considerably to the total greenhouse effect that results in heating of the Earth. He pointed out that the present geodynamic activity of the Earth is increasing and will continue to increase in the near future, releasing huge volumes of methane into the oceanic water and atmosphere.

Understanding and evaluating carbon cycle transformations are very important issues to investigate. For example, the human-induced CO_2 release into the atmosphere is "mostly" absorbed by the living matter. But what does "mostly" mean in terms of absolute quantities? This question must be investigated thoroughly, with corresponding quantitative estimates, if one wants to reach sound conclusions. In the 1980s, 7.1 billion tons of carbon were released into the atmosphere as a result of fossil fuel burning. About 3.3 billion tons remained in the atmosphere and 3.8 billion tons cannot be accounted for (http://www.atmos.millersville.edu/~syalda/envweb.html). Practically all of the CO_2 (which can be only roughly estimated) released in the process of underwater volcanic eruptions is dissolved in the oceanic water. This CO_2 content enters the atmosphere if the global temperature rises. What are the amounts of carbon dioxide released to the ocean water and what are the quantities of this gas entering the atmosphere?

Conclusions

Based on the above analysis (Khilyuk and Chilingar 2003), the writers conclude that the anthropogenic carbon dioxide and other greenhouse gases have a very small effect on the atmospheric warming. Thus, the following question arises: should the developed countries reduce their carbon dioxide emission in compliance with the Kyoto Protocol? The answer is negative.

Firstly, because the effect of these cuts will be negligible. Secondly, because these cuts will result in the economic disaster for the developed countries (first of all for USA), causing huge economic losses and job cuts.

As a result of increased temperature, CO_2 from the ocean water is transferred to the atmosphere. Thus, one can see that "cause" and "effect" are reversed, as presented by proponents of the theory of global warming due to an increase in CO_2 emission by humans. The adiabatic model presented here adequately describes the heat transfer in the Earth–atmosphere system and, together with the sensitivity theory, may be used for the quantitative analysis of temperature changes in the atmosphere due to contents of gases and their concentrations. The effect of increasing concentration of carbon dioxide caused by the human-induced emission is very small. It can be neglected and should not be considered in making political decisions at present or in the near future. Thus, it appears that it is not mankind but global natural climatic factors that are responsible for the heating of the Earth's atmosphere during the last century. Among such factors, the writers include changes in the solar activity, orbital deviation, universal mass redistribution, and outgassing. Outgassing should be thoroughly studied and quantitatively evaluated.

In the light of latest discoveries on the role of methane on the process of atmospheric heating, finding a political solution to the problem of global warming seems to be very difficult if at all possible. Following the logic of the authors of the Kyoto Protocol, all the countries around the world must dramatically cut, not only the energy production, but also cattle growing, rice production, and production of oil, gas, and coal, because all of these activities produce huge amounts of methane. Consequently, severe restrictions will be imposed on the rate of the world population growth.

Will the restrictions on the methane-producing activities lead to tangible cooling of the atmosphere? The answer is negative, because the rate of the anthropogenic methane production is at least one order of magnitude lower than the rate of the Earth's outgassing due to natural tectonic activity. Therefore, the impact of these controls on the global warming process will be negligible in comparison with the forces of Nature. Due to the oncoming natural climatic changes, scientists should map the geographic zones with (1) suitable and (2) unbearable life conditions. This will enable community leaders to develop strategies and techniques for survival.

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