SPE 109292

Humans Are Not Responsible for Global Warming

G.V. Chilingar, SPE, and L.F. Khilyuk, University of Southern California

This paper was prepared for presentation at the 2007 SPE Annual Technical Conference and Exhibition held in Anaheim, California, U.S.A., 11–14 November 2007.

Abstract

The global drivers that determine the Earth's climate are: (1) solar radiation as a dominant energy supplier to the earth, (2) the Earth's outgassing as a major supplier of gasses to the hydrosphere and atmosphere, and, (3) possibly microbial activities generating and consuming atmospheric gases at the interface of lithosphere and atmosphere. The authors provide quantitative estimates of the scope and extent of their effects on the Earth's climate. Comparison of these estimates with the corresponding anthropogenic effects shows that the human-induced climatic changes are negligible with respect to global forces of nature. One should not ignore the fact that peaks in solar irradiation precede peaks in CO_2 concentration. Using the adiabatic model developed by the famous Russian Scientist, Dr. O.G. Sorokhtin, the authors show that the increase in CO_2 concentration in atmosphere will result in cooling rather than warming. Thus, the attempts to alter the global climatic changes (and drastic measures prescribed by the Kyoto protocol) have to be abandoned as meaningless and harmful.

Introduction

Understanding and evaluation of the global forces of nature driving the Earth's climate is crucial for establishing adequate relationship between people and nature and for developing and implementing a sound course of actions aimed at survival and welfare of human race. The latter is especially important in the light of present-day broad public debates on causes and ways of mitigation of current global atmospheric warming.

The traditional theory of global warming assumes that release of carbon dioxide into atmosphere (partially as a result of utilization of fossil fuels) leads to an increase in atmospheric temperature because the molecules of CO_2 (and other greenhouse gases) absorb the infrared radiation from the Earth's surface. This statement is based on the Arrhenius hypothesis (Arrhenius, 1886) which was never verified.

After the Kyoto Protocol (solely based on the Arrhenius hypothesis) had been introduced in 1997, many scientists around the world criticized its provisions (that imposed drastic restrictions on anthropogenic carbon dioxide emission, especially in developed countries) as meaningless and catastrophic. Logical and quantitative comparison analyses presented in the publications of Robinson et al. (1998), Soon et al. (2001), Bluemle et al. (2001), Baliunas (2002), Sorokhtin (2001), Sorokhtin and Ushakov (2002), Gerhard (2004), and Khilyuk and Chilingar (2003, 2004, 2006) proved that the theory of currently observed global atmospheric warming as a result of increasing anthropogenic carbon dioxide (and other greenhouse gasses) emission is a myth. The estimates of the effect of anthropogenic influence on the Earth's climates show that even in the case of doubling of the present anthropogenic CO_2 emission the corresponding effect on the average surface temperature would not exceed 0.01 K (Khilyuk and Chilingar, 2003; 2004). Moreover, as we are going to show further, the release of large amounts of carbon dioxide into the atmosphere results in its cooling rather than warming.

The Earth's climate is a generic term for a relatively stable long-term state of Earth's atmosphere. The main parameters that describe the Earth's climate quantitatively are the atmospheric temperature and pressure averaged over certain areas and chosen time intervals. They are determined by the energy and matter flows from inside and outside of the terrestrial body, matter transformation over the Earth's surface (at the interface between lithosphere and atmosphere), and parameters of the Earth's atmosphere and the World Ocean.

Solar radiation supplies the major energy influx to the Earth's atmosphere that determines the Earth's heating and cooling, whereas outgassing provides the major matter influx to the Earth's atmosphere that determines its chemical composition and physical properties.

The matter transformation at the Earth surface and in the World Ocean is caused by evolutionary physical changes, chemical reactions, and activities of live matter. In addition to these factors, the terrestrial body experiences orbital deviations and spatial mass redistribution that influence the Earth's climate considerably.

Global climatic drivers

The total average solar energy flux currently reaching the Earth's surface, S_0 (= 1.75×10^{24} erg/s), is determined by the so-called solar constant s (≈ 1.37 kW/m^2 = 1.37×10^6 erg/cm^{2}s) (Horrell, 2003). The total heat flux through the Earth's surface due to energy generated in the mantle and crust is estimated at about 4.3×10^{20} erg/s (Sorokhtin and Ushakov, 2002), which is approximately 0.0257% of the total solar irradiation reaching the Earth's surface. The World total energy production in the year of 2003 was equal to 1.34×10^{20} erg/s (Key World Energy Statistics, 2004), which is about 0.0077% of the total solar irradiation reaching the Earth's body. Comparison of the above figures clearly shows that the solar irradiation is dominant source of energy supply to the Earth's atmosphere and hydrosphere. One can easily estimate that the solar irradiation supplies more than 99.95% of total energy driving the World climate. Thus, heating and cooling of the atmosphere is mostly due to variations in insolation of the Earth (Hoyt and Schaten, 1997).

The Sun is about 4.65 billion years old. Its luminosity has been gradually increasing throughout the time of its existence and the present-day energy output is about 40% higher than that at time of its formation (Gribbin, 1991). This energy output is expected to increase by about 15% in the future 1.5 billion years. The Sun radiates the electromagnetic energy throughout the entire electromagnetic spectrum from gamma-rays to radio waves. The Earth's atmosphere absorbs and reflects the solar radiation and, consequently, one needs to use the satellite technology for measuring the total solar irradiance (TSI) at the distance of Earth from Sun. These observations are necessary for development of a quantitative climatic theory and explanation of the Earth's climatic changes. The data of direct satellite measurements are available since 1978 (Willson and Mordvinov, 1997). In lieu of direct satellite measurements before this time, one can use various variables correlated with TSI: for example, the number of Sun spots, which was recorded since 1610, or solar magnetic activity (Baliunas and Soon, 1996), or even the core samples of mud from the bottom of deep Western Canadian fjords (Patterson et al., 2004). The Solar irradiance is strongest at the peak of magnetic activity and the total irradiance varies directly with the intensity of Sun's activity.

The effect of solar irradiation on global atmospheric temperature can be evaluated using the adiabatic model of heat transfer in the Earth's atmosphere (Sorokhtin, 2001; Khilyuk and Chilingar, 2003; Sorokhtin et al., 2007). To analyze the temperature changes attributed to variations in energy and matter flux, one can use the following convenient form of this model:

$$\frac{T(h)}{T_0} = \left(\frac{S}{S_0}\right)^{1/4} \left(\frac{p(h)}{p_0}\right)^{\alpha} \tag{1}$$

where $T(h)$ is the global atmospheric temperature at any given altitude h; T_0 is the present-day global temperature at sea level; T_0 = 288 K; S is the total solar energy flux reaching the Earth's surface; S_0 is the total present average solar energy flux (S_0 = 1.75×10^{24} erg/s); *p(h)* is the global atmospheric pressure at the altitude *h*; and p_0 is the global average atmospheric pressure at sea level (p_0 = 1 atm).

For a rough estimate of global atmospheric temperature change at sea level attributed to variations in insolation *S*, Eq. 1 can be rewritten in the following form:

$$\Delta T = T - T_0 = T_0\left[\left(\frac{S}{S_0}\right)^{1/4} - 1\right] \qquad (2)$$

Data in Table 1 computed using Eq. 2 allow one to translate the variations in Earth's insolation into corresponding changes in the Earth's global temperature at sea level.

Table 1. Global temperature changes attributed to variations in Earth's insolation

S/S_0	0.85	0.90	0.95	0.99	1.00	1.01	1.05	1.10	1.15
ΔT,K	-11.5	-7.49	-3.77	-0.86	0.00	0.86	3.77	7.49	11.5

As shown in Table 1, one percent increase in current solar radiation reaching the Earth's body translates directly into approximately 0.86 K increase in the Earth's global temperature. Using Eq. 2, one can also find an upper estimate for possible atmospheric temperature increase due to anthropogenic activities. Even if the entire World energy generated by humans (1.34×10^{20} erg/s) would be utilized only for heating the Earth's atmosphere, the corresponding atmospheric temperature increase would not exceed 0.01 K at sea level. If, in addition, one takes into consideration that changes in the global atmospheric temperature are closely correlated with the changes in solar activity, then one has to conclude that the solar irradiation is the dominant energy supply driving the Earth's climate (see also Hoyt and Schatten, 1997; Kondratiev, 1992).

Parameters of the elliptic Earth's orbit (orbital eccentricity, obliquity, and precession index) have been changing over geologic time. The terrestrial mass redistribution also results in the changes of orbital parameters, especially of the precession index (Marov, 1986). Changes in the orbital parameters result in corresponding changes in Earth's insolation. The effect of orbital and rotational changes has been known for a long time (Milankovitch, 1957). Paleoreconstructions show (Barron, 1994) that the variations in global average Earth's insolation attributed to the planet's orbital deviations can reach up to 10% of the "long-term" average radiation level (Fig. 1). Therefore, maximal orbital deviations result in exactly the same effect on global temperature as 10% change in solar irradiation.

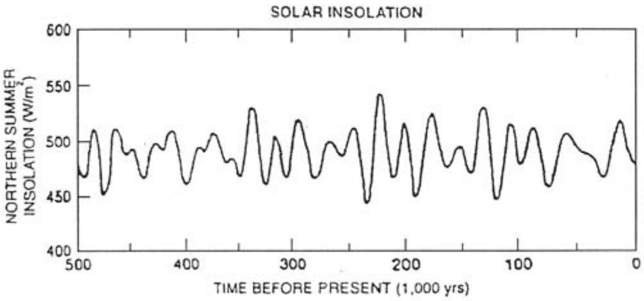

Figure 1. Variations in insolation (W/m^2) due to deviations of the Earth's orbital parameters. (Modified after Barron, 1994, fig. 13.)

The resulting effect of orbital deviations on global temperature can be evaluated using the same adiabatic model of Earth's atmosphere. Analyzing Fig. 1 and using Eq. 2, one can determine that during the last 500,000 years the global temperature deviated 7.5 °C (from the long-term average value) at least 4 times, and more than 20 times this deviation was about 4 °C due to changes in the Earth's orbital parameters. This leads one to an important conclusion on considerable natural variability of Earth's climate over geologic time due to changes in the Earth's insolation caused by orbital deviations and geologic insignificance of recent global warming period with the global temperature increase of 1 °F ≈ 0.56 °C during the last century (EPA Global Warming Site, 2001).

Atmospheric gases are generated in the inner layers of Earth (mostly in the mantle) over geologic history and are transferred to the atmosphere and hydrosphere by outgassing. Outgassing is a process of upward migration of various gases generated in the mantle and Earth's crust and seeping through the Earth's surface into the atmosphere and the World Ocean

(Khilyuk et al., 2000). Various gasses (methane, carbon dioxide, water vapor, hydrogen, helium, etc.), formed in the process of chemical reactions at different physicochemical conditions, are continuously migrating upward and have been forming the atmosphere throughout the geologic history. The Earth's atmosphere and hydrosphere were formed about 4 billion years ago by outgassing (Vinogradov, 1967; Holland 1984; Sorokhtin and Sorokhtin, 2002). This process is going on at the present time.

The rate of outgassing is determined by the rate of tectonic activity. As a universal measure of the rate of global tectonic activity, one can use the rate of heat flux through the Earth's surface, because its level indicates the magnitude of total energy generated in mantle. If, for some reason, it is not possible to estimate the value of heat flux, then the rate of oceanic floor spreading (in the spreading zones) can be substituted for it. The rate of spreading is directly translated into the rate of displacement of tectonic plates that presently averages 4.5 – 5 cm/year (Sorokhtin and Ushakov, 2002).

Main gasses generated in the mantle and on the ocean floor are carbon dioxide, methane, and hydrogen. Carbon dioxide (CO_2) dissolves mostly in the oceanic water and transforms to abiogenic methane (CH_4) and carbonates ($CaCO_3$, $MgCO_3$) (Sorokhtin and Sorokhtin, 2002) through the following chemical reactions:

$$\begin{aligned}&4Fe_2SiO_4 + 12Mg_2SiO_4 + 18H_2O + CO_2 \rightarrow\\ &4Mg_6(Si_4O_{10})(OH)_8 + 4Fe_2O_3 + CH_4 + 183.47\frac{kcal}{mol}\\ &\quad(Serpentine)\qquad(Hematite)\end{aligned}\qquad(3)$$

$$\begin{aligned}&4Mg_2SiO_4 + 4H_2O + 2CO_2 \rightarrow\\ &(Olivine)\\ &Mg_6(Si_4O_{10})(OH)_8 + 2MgCO_3 + 72.34\frac{kcal}{mol}\end{aligned}\qquad(4)$$

$$\begin{aligned}&2CaAl_2Si_2O_8 + 4H_2O + 2CO_2 \rightarrow\\ &(Anorthite)\\ &Al_4(Si_4O_{10})(OH)_8 + 2CaCO_3 + 110\frac{kcal}{mol}\\ &\ (Kaoline)\end{aligned}\qquad(5)$$

These reactions are accompanied by a huge amount of heat release. The released heat contributes considerably to the heat flux through the Earth's surface. Thus, the rate of abiogenic CH_4 generation on the ocean floor in the spreading zones can be used as a measure of global tectonic activity. In turn, the rate of the Earth's tectonic activity can be used as a measure of the Earth's outgassing rate.

Because of high solubility, CO_2 is almost completely dissolved in oceanic water in the form of HCO_3^- ions raising the water acidity. Therefore, one can also use the acidity of oceanic water as a measure of tectonic activity (assuming that the global atmospheric temperature is not decreasing). Thus, the current increase in acidity of ocean water should be interpreted as an indicator of rising tectonic activity at present time. Caldeira and Wickett (2003) discovered the phenomenon of rising oceanic water acidity and traditionally explained it by the increase in anthropogenic carbon dioxide emission to the atmosphere. Due to a high level of current tectonic activity, there is a pronounced increase in the methane gas generation at oceanic floor. Yasamanov (2003) estimates that about 5×10^{15} g/year of CH_4 are currently released to oceanic water at the spreading zones of mid-ocean ridges only.

Gases accumulating in the atmosphere and the rate of outgassing determine the properties of gaseous atmospheric mixture, in particular, changing the density and thermal capacity of air. One can assume that: the greater the rate of outgassing, the higher the atmospheric pressure. According to the adiabatic theory of heat transfer in the atmosphere, the higher atmospheric pressure leads to an increase in the global atmospheric temperature.

Studying the origin and evolution of Earth's atmosphere, one needs to take into consideration that the primordial Earth's matter contained only traces of volatile elements (H_2, He) and compounds. All other volatile components (H_2O, CO_2, O_2, HCl, HF), except possibly N_2, were mostly degassed out of the Earth mantle throughout geologic history (Sorokhtin and Ushakov, 2002). Thus, the main masses of nitrogen, carbon dioxide, oxygen, and water in the atmosphere and hydrosphere of the Earth were degassed out of the mantle.

Outgassing could start only after fusion of the upper layers of the Earth's matter and beginning of the Earth's tectonic activity (about 4 billion years ago). Under plausible assumption that the rate of outgassing is proportional to the Earth's tectonic activity and with realistic estimates of the original amounts of volatile components in gaseous primordial atmosphere and the Earth's solid, Sorokhtin and Sorokhtin (2002) modeled degassing of N_2, CO_2, H_2O, and O_2 out of the mantle and their accumulation in atmosphere and hydrosphere. The results of their modeling demonstrated, for example, that the nitrogen of contemporary atmosphere contains 55% of relic gas and 45% of gas of magmatic origin. Geologic evolution of the relative content of nitrogen in the atmosphere (under three different hypotheses of the origin of the dominant amount of N_2) is shown in Fig. 2. The most probable "intermediate" evolution of the nitrogen partial pressure in the atmosphere is presented by the curve 2 in Fig. 2.

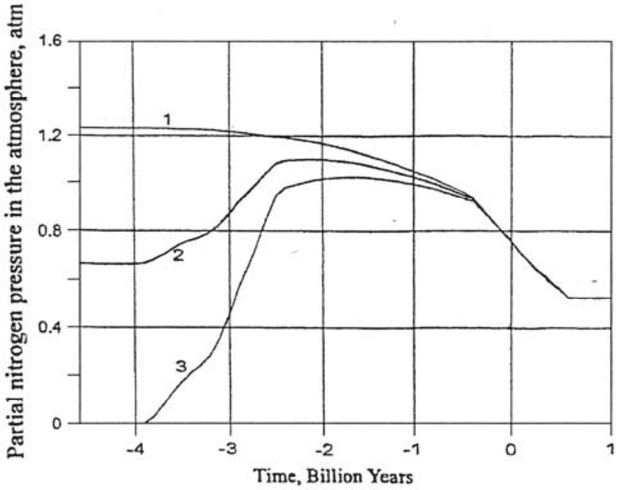

Figure 2. Evolution of the partial pressure of nitrogen in atmosphere. (1) Under hypothesis that the entire Earth's atmosphere nitrogen was of primordeal origin, (2) most probable intermediate scenario, and (3) assuming that the entire atmospheric nitrogen mass was degassed from the mantle. (Modified after Sorokhtin and Ushakov, 2002.)

Total mass of CO_2 degassed from the mantle throughout geologic history is estimated at 4.63×10^{23} g, and the CO_2 mass remaining in the mantle is estimated at 4.48×10^{23} g (Sorokhtin and Ushakov, 2002). Therefore, the total mass of CO_2 in the present-day Earth's system is about 9.11×10^{23} g (Sorokhtin and Ushakov, 2002; Sorokhtin et al. 2007). Accumulation of CO_2 in the upper geospheres (atmosphere, hydrosphere, and the Earth's crust) is shown in Fig. 3. Figure 4 illustrates the evolution of CO_2 partial pressure in the atmosphere.

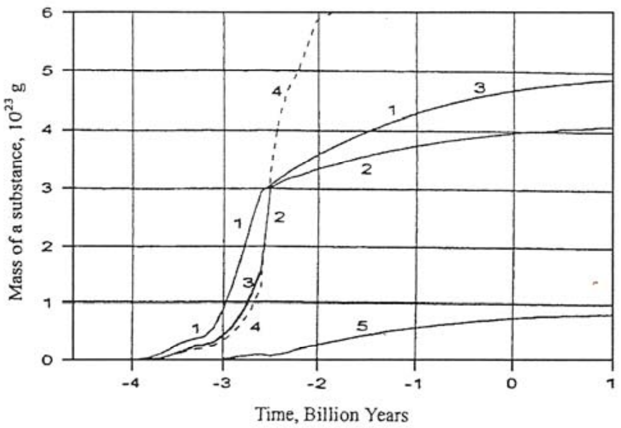

Figure 3. Mass of carbon dioxide in the Earth's crust. (1) Mass of the carbon dioxide degassed from mantle, (2) mass of the carbon dioxide accumulated in the carbonate rocks of the Earth's crust, (3) total mass of carbon dioxide fixed in carbonate rocks, (4) mass of water accumulated in the Earth's crust, and (5) mass of organic carbon present in rocks recalculated as carbon dioxide. (Modified after Sorokhtin and Sorokhtin, 2002.)

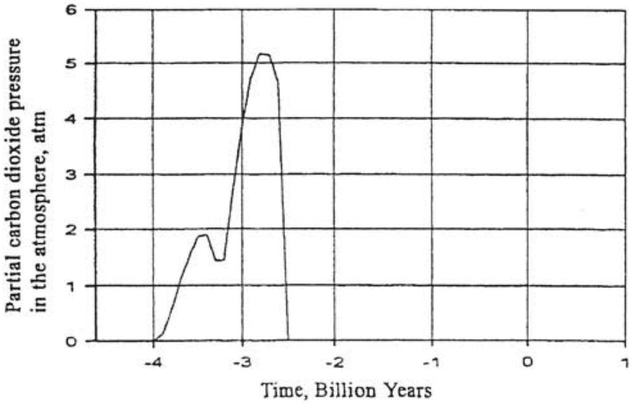

Figure 4. Evolution of the partial pressure of carbon dioxide in the atmosphere. (Modified after Sorokhtin and Sorokhtin, 2002.)

To estimate the amount of total anthropogenic CO_2 emission, one can use an excellent compendium of data on estimates of anthropogenic carbon dioxide emission from the Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, Tennessee (Marland et al., 2002). The estimates in this compendium are expressed in million metric tons of carbon. The data set comprises the annual releases of CO_2 from 1751 to 2002. They can be roughly sorted out into two groups: (1) before the year of 1900 and (2) after the year of 1900. The data of the first group exhibit linear growth of emission in 18th and 19th centuries, whereas the data from the second group show exponential growth of anthropogenic CO_2 emission in 20th Century. This observation allows one to use a piece-wise approximation for the data of compendium: a linear function for the first group and an exponential function for the second group.

Having constructed an appropriate approximation for the anthropogenic CO_2 data set, the authors obtained an estimate of 1.003×10^{18} g (Khilyuk and Chilingar, 2006). This amount constitutes less than 0.00022% of the total amount of CO_2 naturally degassed from the mantle. Comparing these figures, one can conclude that anthropogenic carbon dioxide emission is negligible in global long-term energy–matter transformation processes driving the Earth's climate.

Evaluation of the atmospheric oxygen content evolution throughout the geologic history encounters a great deal of uncertainty, because this process was affected considerably by many fuzzy factors, such as photosynthesis ability of ancient microorganisms. Nevertheless, even qualitative reconstructions based only on geochemical data present clear picture of continuously increasing oxygen content in the atmosphere. The reconstruction of accumulation of oxygen in sedimentary rocks and in the atmosphere (Sorokhtin and Ushakov, 2002; Sorokhtin et al., 2007) is presented in Fig. 5. Evolution of the atmospheric composition and pressure is shown in Fig. 6.

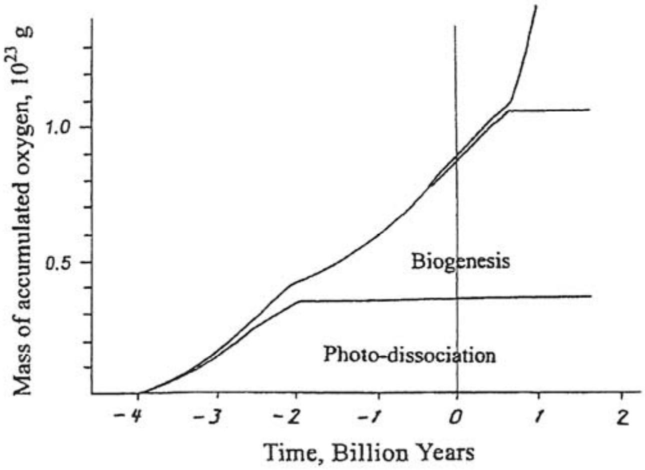

Figure 5. Accumulation of oxygen (and its origin) in the sedimentary rocks and in atmosphere. (Modified after Sorokhtin and Ushakov, 2002, p. 417.)

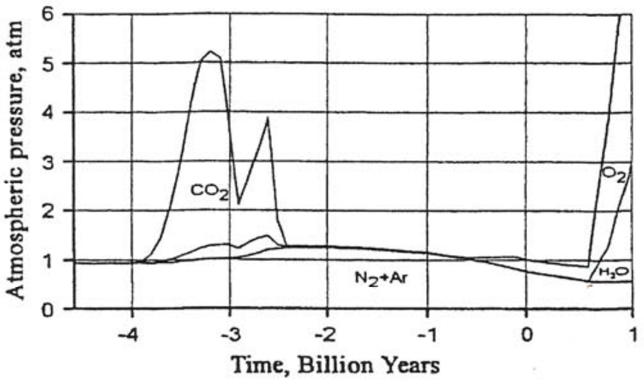

Figure 6. Evolution of composition and pressure of the Earth's atmosphere. (Modified after Sorokhtin and Ushakov, 2002.)

After reconstruction of the atmospheric pressure evolution, Sorokhtin (2001) used adiabatic model to compute the atmospheric temperature evolution throughout geologic history (Fig. 7).

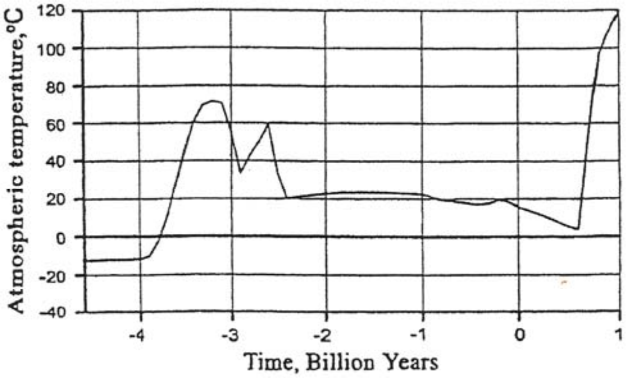

Figure 7. Temperature evolution of the Earth's atmosphere (average atmospheric temperature at sea level). (Modified after Sorokhtin and Ushakov, 2002.)

In the light of debates on global warming, one should notice the gradual reduction of atmospheric pressure (Fig. 6) and corresponding gradual cooling of atmosphere (Fig. 7) on the geologic time scale between approximately –0.3 BY and +0.5 BY (zero corresponds to the present time). This means that we live in the cooling geologic period and the global warming observed during the past 150 years is just a short episode in geologic history. According to Sorokhtin and Ushakov (2002), the cooling period will continue in the future due to life-activities of the nitrogen-consuming bacteria that transfer the atmospheric nitrogen into soils with subsequent burial in sediments.

Global cooling due to increase in CO_2 content

Increase in CO_2 content leads to global cooling of atmosphere. This, at first sight, paradoxical conclusion can be inferred from the adiabatic theory of heat transfer. To compare the temperature characteristics of a planet at various compositions of its atmosphere, one can use the following convenient form of atmospheric temperature equation (Sorokhtin et al., 2007):

$$T = b^{\alpha}\left\{\frac{S(1-A)}{8\sigma\pi^{-1}\times\left(\left(\frac{\pi}{2}-\psi\right)+\frac{\psi}{1+\cos\psi}\right)}\right\}^{1/4}\left(\frac{p}{p_0}\right)^{\alpha}$$

(6)

where S is the solar constant at the distance of Earth from Sun; σ is the Stefan-Boltzmann constant; A is the planet's albedo (for the Earth $A \approx 0.3$); ψ is the precession angle; p is the atmospheric pressure; p_0 is the atmospheric pressure at sea level; α is the adiabatic exponent and the coefficient b is defined by the following expression:

$$b = \frac{1}{(1-A)^{\frac{1}{4\alpha}}}$$

(for the Earth, $\alpha = 0.1905$).

For the present-day nitrogen–oxygen Earth's atmosphere, $b^{\alpha} = 1.093$. The value of b does not change if the composition of atmosphere changes, whereas the value of b^{α} changes with the value of adiabatic constant α if the composition of planet's atmosphere changes.

Equation 6 can be used for comparison of temperature characteristics of the same planet for various compositions of its atmosphere. Thus, if one assumes that the existing nitrogen–oxygen atmosphere of Earth is replaced entirely by an imaginary carbon dioxide atmosphere with the same pressure of 1 atm and adiabatic exponent $\alpha = 0.1428$, then the value of $b^{\alpha} = 1.597^{0.1428} = 1.069$ and the near-surface temperature would decline to 281.6 K, i.e., the atmosphere cools by 6.4 °C (instead of warming, as the traditional theory states) (Sorokhtin et al., 2007).

Constructing the distributions of temperature in the carbon dioxide atmosphere, one should take into consideration the fact that for the same pressure the corresponding elevation over sea level is lower than that for the nitrogen–oxygen atmosphere of Earth: $h(CO_2) = h(N_2+O_2)\times 29/44$, where h is the elevation, and 29 and 44 are the molar weights of nitrogen–oxygen and carbon dioxide atmospheres, respectively. Constructed in such a way temperature distributions are shown in Fig. 8. In this figure, the graph of temperature distribution for the carbon dioxide troposphere lies below the graph of distribution for the nitrogen–oxygen atmosphere. Correspondingly, the-near surface temperature for the carbon dioxide troposphere occurs 6.4 °C lower than that for the nitrogen–oxygen atmosphere (not considerably higher as some scientists continue to believe). Thus, the accumulation of carbon dioxide in great amounts in atmosphere should lead only to the cooling of climate, whereas insignificant changes in the partial pressure of CO_2 (few hundreds of ppm) would not practically influence the average temperature of troposphere and the Earth's surface (Khilyuk and Chilingar, 2003).

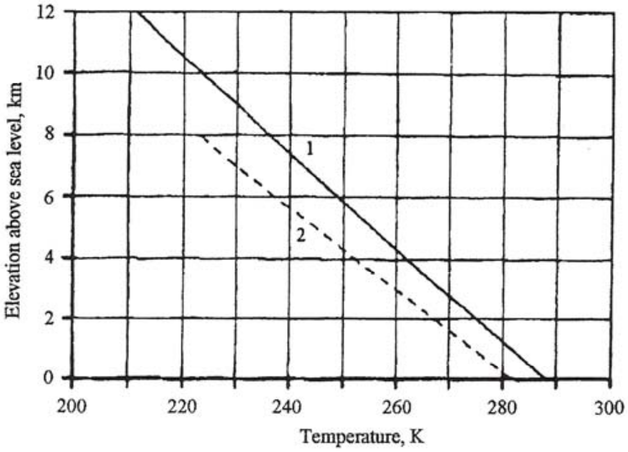

Figure 8. Averaged temperature distributions in the Earth's troposphere. (1) Present-day nitrogen–oxygen atmosphere and (2) hypothetical model of carbon dioxide atmosphere.

By analogy, if one assumes that the existing carbon dioxide atmosphere of Venus is entirely replaced by the nitrogen–oxygen atmosphere at the same pressure of 90.9 atm, then its surface temperature would increase from 735 to 796 K (from 462 to 523 °C). Thus, one can conclude that saturation with carbon dioxide (at the same other conditions) would result in cooling of the entire planet's atmosphere. The averaged temperature distributions for the existing carbon dioxide and hypothetical nitrogen–oxygen atmosphere are shown in Fig. 9.

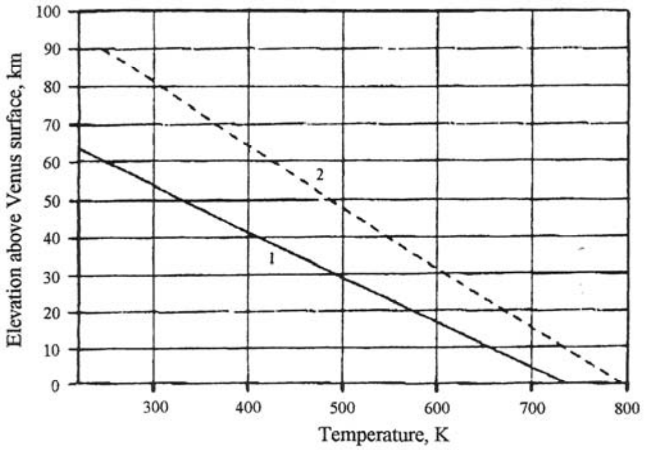

Figure 9. Averaged temperature distributions in the troposphere of Venus. (1) Present-day carbon dioxide troposphere and (2) hypothetical model of nitrogen–oxygen atmosphere at the same physical conditions.

Microbial activity at the Earth's surface

From all the live species, only bacteria can directly influence the mass and content of the gaseous mixture of the Earth's atmosphere. Considerable changes in contents of various gases composing air can alter the Earth's climate. Recent discoveries in microbiology revealed a broad proliferation of methane-generating and methane-consuming bacteria and also (which is even more important) abundance of denitrifying and nitrogen-consuming bacteria. Therefore, the interplay of these "microbial" forces should affect the Earth's climate considerably.

Methane gas entering the atmosphere from such natural sources as (1) wetlands, (2) rice paddies, (3) cattle digestion, (4) termite digestion, and (5) marine organisms is actually generated by bacteria. There were few studies on methane-generating bacteria in spite of the fact that life activity of these bacteria considerably contribute to the total balance of methane gas in atmosphere. Among important research works on methane-generating bacteria, one should mention the Cornell University study initiated in 2002 with the support of National Science Foundation (www.news.cornell.edu/Chr_onicle/02/2.14.02/microbial_observatory.html). The purpose of this study was to extract from the wetlands (dominant source of natural methane) and artificially grow the bacteria, and to determine the impact of environmental conditions on the life of bacterial colonies.

Recently, a team of researchers (from Penn State University and University of California, Los Angeles) discovered vastly proliferated methane-consuming archaeobacteria (Orphan et al., 2001, 2002). These bacteria consume most of the methane gas at the bottom of World Ocean, preventing the methane accumulation in atmosphere.

Microbial activities play an important role in the transit of nitrogen from the atmosphere to the Earth's surface and vice versa. Only bacteria are able to consume and accumulate nitrogen directly from atmosphere. They fix it to organic molecules, producing proteins (nitrogen fixation process). All other live species consume and accumulate nitrogen via food chain, from proteins produced by bacterial activity in the process of nitrogen fixation.

Bacteria living on the roots of some plants can fix nitrogen by producing proteins (www.starsandseas.com/SAS%20Ecology) Animals can get necessary nitrogen by eating plants. The remains of plants and animals can be buried in the oceanic sediments, transferring nitrogen into solid matter of Earth. It is not clear yet what is the scope of life activities of such bacteria.

Recently, microbiologists discovered new microbial species consuming nitrogen: spirochetes (corkscrew bacteria) living in termite guts and fresh and saline waters (Lillburn et al., 1999, 2001). Huge population and vast proliferation of termites worldwide make spirochetes, living in the guts of termites and generating proteins, a major supplier of nitrogen to the Earth's live matter.

Some soil bacteria, however, consume NO_3^- (nitrates) and convert them into nitrogen, returning the nitrogen gas into atmosphere. This process is called denitrification. Therefore, the increase or reduction of nitrogen content in atmosphere may be determined by the balance between bacterial activities in the processes of nitrogen fixation and denitrification.

Global warming or global cooling?

Do we live in the time of global warming or global cooling? The answer to this question depends on the time span of observed atmospheric changes. The latest 150 years were (and the near future will probably be) a period of global warming (Fig. 10). The major causes of currently-observed global warming are: rising solar irradiation and increasing tectonic activity. According to the NASA study, since 1978, the amount of solar irradiation, during the times of quiet sunspot activity, has been increasing by about .05 percent per decade (Wilson and Mordvinov, 2003). This is a persuasive explanation of the currently observed global warming. On the other hand, if one considers the last three millennia, then one can observe a clear cooling trend in the Earth's climate (Keigwin, 1996; Hoyt and Schatten, 1997; Sorokhtin and Sorokhtin, 2002; Sorokhtin and Ushakov, 2002; Gerhard 2004; Khilyuk and Chilingar, 2004, 2006; Sorokhtin et al. 2007). During that period, the natural global temperature deviations reached 3 °C with a clear trend of decreasing global temperature by about 2 °C (Fig. 11).

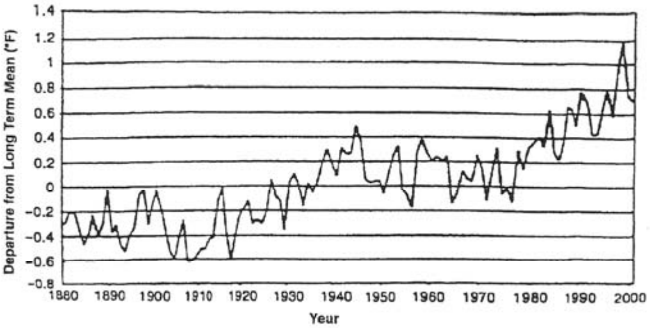

Figure 10. Global average temperature changes in 20th Century. (Modified after EPA Global warming site: Climate. U.S. National Climatic Data Center, 2001.)

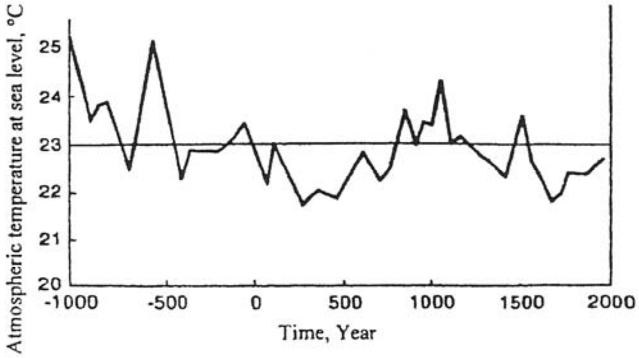

Figure 11. Surface temperature in the Sargasso Sea (with time resolution of about 50 years) as determined by isotope ratios of remains of marine organisms buried in the sediments of seafloor. Horizontal line represents the average temperature over a 3,000-year period. (Modified after Keigwin, 1996.)

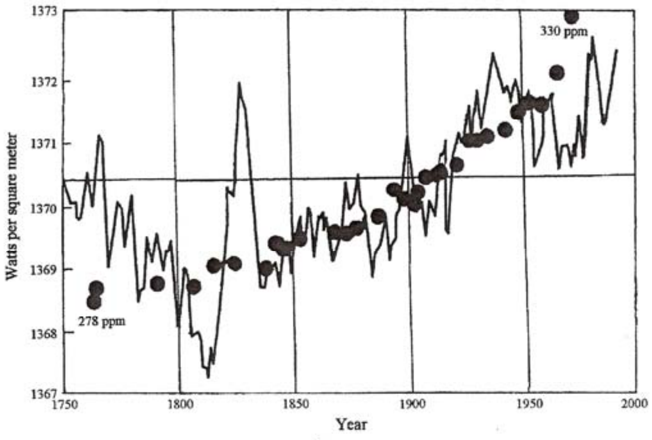

Figure 12. Solar irradiance (W/m^2) and CO$_2$ concentrations in atmosphere (ppmv) in Northern Hemisphere (solid dots). (Modified after Hoyt and Schatten, 1997.)

This trend started at least 7,000 years ago. Friedman (2005) studied the oxygen isotope composition of Gulf of Aqaba beachrock (carbonate cement). He showed that the temperature of ambient seawater decreased for approximately half of the Holocene. According to Friedman (2005), the average Red Sea water temperature decreased from 33 to 17 °C over an interval of approximately 4500 years – between the ages of 7.07 ± 0.38 and 2.65 ± 0.23 ka. Thus, the general tendency in the Red Sea area (and over the entire Earth's surface) has been toward global cooling. Combining the Friedman's findings with those of Keigwin (1996) (Fig. 11), one can conclude that the latest cooling geologic period comprises most of the Holocene. Inasmuch as the deduced temperature change occurred during the time of relatively stable concentration of carbon dioxide in the atmosphere, the changes in its content were not driving the Earth's global temperature (Jenkins, 2001). The cooling trend will probably last in the future (Fig. 7). This means that we live in the *cooling geologic time* and the global warming observed during the last approximately 150 years is just a short episode in the geologic history.

Conclusions

The writers identified and described the global forces of nature driving the Earth's climate: (1) solar irradiation as a dominant energy supplier to the atmosphere (and hydrosphere); (2) outgassing as a dominant gaseous matter supplier to the atmosphere; and (3) microbial activities at the interface of lithosphere and atmosphere. The scope and extent of these natural processes are at least 4 orders of magnitude greater than the corresponding anthropogenic impacts (such as emission of the greenhouse gases) on Earth's climate.

The anthropogenic impact on the global atmospheric temperature is negligible (Sorokhtin, 2001; Khilyuk and Chilingar, 2003, 2004, 2006; Sorokhtin et al., 2007)). Considering relationship between the carbon dioxide concentration and global atmospheric temperature, one should understand that (according to the adiabatic theory) the saturation of atmosphere with CO_2 could lead only to its cooling (but not to warming). One should also keep in mind the fact that peaks in the Sun irradiation always precede the peaks of CO_2 concentration in the atmosphere (Fig. 12), which supports the hypothesis that temperature changes cause the corresponding changes in CO_2 concentration in the atmosphere (Sorokhtin, 2001; Khilyuk and Chilingar, 2003).

The global natural processes drive the Earth's climate: "Climate will change, either warmer or colder, over many scales of time, with or without human interference" (Gerhard, 2004). Any attempts to mitigate undesirable climatic changes using restrictive regulations are condemned to failure, because the global natural forces are at least 4 orders of magnitude greater than the available human controls. In addition, application of these controls will lead to catastrophic economic consequences. Estimates show that since its inception in February 2005, the Kyoto Protocol has cost about $10 billion a month, supposedly averting about 0.0005 °C of warming by the year 2050. Thus, the attempts to alter the occurring global climatic changes using restrictive regulations have to be abandoned as meaningless and harmful. Instead, moral and professional obligation of all responsible scientists and politicians is to minimize potential human misery resulting from oncoming natural global climatic changes.

References

Arrhenius, S.: "*On Influence of Carbonic Acid in the Air upon the Temperature of the Ground*", *Phil. Mag.* (1896) **41** 237.

Bachinskiy, A.I. et al.: "*Handbook of Physics*", Uchpedgiz, Moscow (1951) 380.

Baliunas, S.L.: "*The Kyoto Protocol and Global Warming*", *Imprimis* (2002) **31(3)** 1.

Baliunas, S.L. and Soon, W.: *"The Sun–Climate Connection", Sky and Telescope* (1996) **12** 38.

Barron, E.J.: "*Climatic Variations in Earth History. Understanding Global Climate Change*", Earth Science and Human Impact, Global Change Instruction Program #108, USAR (1994) 23.

Bluemle, J.P. et al.: *"Rate and Magnitude of Past Global Climate Changes"*, In: Gerhard, L.C., Harrison, W.E. and Hanson B.M. (Eds.), Geological Perspective of Global Climate Change. AAPG Studies in Geology (2001) **47** 193.

Caldeira, K. and Wickett, M.: "*Anthropogenic CO_2 and Ocean pH", Nature* (2003) **425 (6956)** 365.

Friedman, G.M.: *"Climate Significance of Holocene Benchrock Sites Along Shorelines of the Red Sea", Am. Assoc. Petrol. Geol. Bull.* (2005) **89(7)** 849.

Gerhard, L.C.: *"Climate Change: Conflict of Observational Science, Theory, and Politics", Am. Assoc. Petrol. Geol. Bull.* (2004) **88(9)** 1211.

Gribbin, J.: "*Blinded by the Light, the Secret Life of the Sun*", Harmony Books, New York (1991) 275.

Holland, H.D.: "*The Chemical Evolution of the Atmosphere and Oceans"*, Princeton Univ. Press, Princeton (1984) 552.

Horrell, M.A.: *"Finding the Solar Constant and Average Temperature of a Planet"*, (2003) http://www.imsa.edu/edu/geophysics/atmosphere/energy/blackbody2.html.

Hoyt, D.V. and Schatten, K.H.: "*The Role of the Sun in Climate Changes"*, Oxford University Press, New York (1997) 279.

Jenkins, D.A.L.: *"Potential Impact and Effect of Climatic Changes"*, In: Gerhard, L.C., Harrison, W.E. and Hanson, B.M. (Eds). Geological Perspective of Global Climate Change. AAPG Studies in Geology (2001) **47** 333.

Keigwin, L.D.: *"The Little Ice Age and Medieval Warm Period in the Sargasso Sea", Science* (1996) **274** 1504.

Khilyuk, L.F., Chilingar, G.V., Endres, B., and Robertson, J.: "*Gas Migration"*, Gulf Publishing Company, Houston (2000) 389.

Khilyuk, L.F., and Chilingar, G.V.: *"Global Warming: Are We Confusing Cause and Effect?", Energy Sources* (2003) **25** 357.

Khilyuk, L.F., and Chilingar, G.V.: *"Global Warming and Long-term Climatic Changes: A Progress Report", Environ. Geol.* (2004) **46** 970.

Khilyuk, L. F., and Chilingar, G.V.: *"On Global Forces of Nature Driving the Earth's Climate. Are Humans Involved?", Environ. Geol.* (2006) **50** 899.

Kondratiev, K.Ya.: "*Global Climate"*, Nauka, Moscow (1992) 359.

Lillburn, T.G. et al.: *"Philogenetic Diversity of Termite Gut Spirochetes", Environ Microbiol.* (1999) **1(4)** 331.

Lillburn, et al.: *"Nitrogen Fixation by Symbiotic and Free-living Spirochetes"*, *Science* (2001) **292(5526)** 2495.

Marland, G. et al.: "*Global CO_2 Emission from Fossil-fuel Burning, Cement Manufacture, and Gas Flaring, 1751 – 2002*", Information Analysis Center, Oak Ridge National Laboratory, Tennessee (2002); http://cdiac.ornl.gov/ftp/ndp030/global.1751 2002.ems.

Marov., M.Ya.,: "*Planets of Solar System"*, Nauka, Moscow (1986) 320.

Milankovitch, M.: "*Astronomische Theorie der Klimaschwankungen ihr Werdegang und Widerhall"*, Serbian Academy of Science, Monograph 280 (1957) 58.

Orphan, V.J. et al.: *"Multiple Archaeal Groups Mediate Methane Oxidation in Anoxic Cold Seep Sediments", Proc. Nat. Acad. Sci. USA* (2002) **99(11)** 7663.

Orphan, V.J. et al.: *"Methane-Consuming Archaea Revealed by Directly Coupled Isotopic and Phylogenetic Analysis", Science* (2001) **293** 484.

Patterson, R.T. et al.: *"Late Holocene Sedimentary Response to Solar and Cosmic Ray Activity Influenced Climate Variability in the NE Pacific", Sedimentary Geology* (2004) **172** 67.

Robinson, A.B. et al.: *"Environmental Effects of Increased Atmospheric Carbon Dioxide"*, [info@oism.org; info@marshall.org] (1998) 8.

Sorokhtin, O.G.: *"The Greenhouse Effect of Atmosphere in Geologic History of Earth", Doklady AN SSSR* (1990) **315(3)** 587.

Sorokhtin, O.G.: *"Greenhouse Effect: Myth and Reality", Herald Russian Academy of Natural Sciences* (2001) **1(1)** 8.

Sorokhtin, O.G.: *"Temperature Distribution in the Earth", Izvestiya RAN, Physics of Earth* (2001) **3** 71.

Sorokhtin, O.G., Chilingar, G.V., and Khilyuk, L.F., "*Global Warming and Global Cooling: Evolution of Climate on Earth*", Elsevier, Amsterdam (2007) 313.

Sorokhtin, O.G. et al.: *"Evolution of the Earth's Global Climate*", Energy Sources (2007) **29(1)** 1.

Sorokhtin, O.G. and Sorokhtin, N.O.: *"Origin and Evolution of the Earth's Atmosphere", Herald Russian Academy of Natural of Sciences* (2002) **2(3)** 6-18.

Sorokhtin, O.G. and Ushakov, S.A.: "*Development of Earth*", Moscow University, Moscow (2002) 559.

Soon, W. et al.: "*Global Warming – a Guide to the Science",* Risk Controversy Series 1, The Fraser Institute, Vancouver (2001) 62.

Vinogradov, A.P.: “*Introduction to Geochemistry of Ocean*”, Nauka, Moscow (1967) 215.

Voitkevitch, G.V., Kokin, A.V., Miroshnikov, A.E, and Prokhorov, V.G.: “*Handbook of Geochemistry*”, Nedra, Moscow (1990) 480.

Wilson, R.C. and Mordvinov, A.V.: *“Secular Total Solar Irradiance Trend During Solar Cycles 21-23”, Geophys. Res. Lett.* (2003) **30(5)** 1199.

Yasamanov, N.A.: *“Modern Global Warming: Causes and Ecological Consequences”, Bull. Dubna International University of Nature, Society, and Man* (2003) **1(8)** 12.