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Why Carbon Dioxide Emissions Should Not Be Limited[1]

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Abstract—The sensitivity of the global climate to the main factors that form the climate, that is, the anthropogenic, solar, volcanic, oceanic, and orbital factors, is analyzed. It is established that the sensitivity of the global climate to a twofold increase in the concentration of CO_2 does not exceed 2°C. As a result of interference of the anthropogenic and the natural factors, the mean global temperature will probably rise by about 1°C in the forthcoming century. A study of the consequences of realizing various scenarios for energy development in the world led us to the conclusion that it is redundant to require limitation of CO_2 emissions; the latter should be done on a voluntary basis.

In March 1994, the Framework Convention of the United Nations on a Change in the Climate (henceforth referred to as the Convention) proposed that all the 155 countries that subscribed to it at the World Conference on the Environment and on Development held in June 1992 in Rio de Janeiro should limit carbon dioxide emissions in the forthcoming ten-year period to the 1990 level. In March and April of 1995, the 116 countries that attended the Convention, and also the European Union, adopted the Berlin Mandate that already calls for a reduction of emissions of greenhouse gases after the year 2000 in accordance with a clearly established schedule that will be worked out before the next conference is held in 1997 in Paris. The inconceivable haste with which such an important decision was taken is due to the catastrophical forecasts of warming of the climate, which were based on an incorrect extrapolation of historical trends in energy consumption, on underestimating the adaptive capabilities of the biosphere, and on complete disregard of what is called the natural course of the climate. Significantly, ferverish international activities for combatting emissions of greenhouse gases are being unleashed in parallel and independently of the exceptionally important events of the last five years, among which are the following:

(1) The per capita energy consumption e in the world is evidencing a clear trend toward stabilization. Note that this process began already 20 years ago, that is, long before the conference in Rio and present-day speculation about global warming of the climate (Fig. 1). Such a phenomenon was observed in peacetime for the first time in the industrial age, and is due to the mass transition of countries to the new, post-industrial stage of their development, in which per capita energy consumption remains constant [1].

This fact is of very great importance, because, as a result, the total energy consumption of the world E will

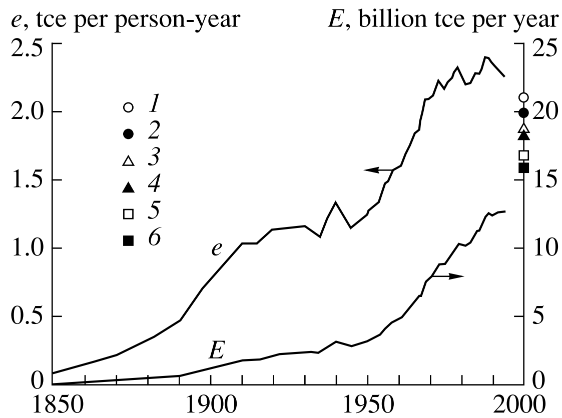

Fig. 1. The evolution of energy consumption in the world from the middle of the 19th century, and several recent forecasts on energy consumption in the year 2000; the year of publication is given. (*1*) Atomic Energy Institute (AEI), 1987; (*2*) International Institute of Applied Systems Analysis (IIASA), 1981; (*3*) International Atomic Energy Agency (IAEA), 1984; (*4*) Oak Ridge National Laboratory, 1985; (*5*) World Energy Conference (WEC), 1984; (*6*) International Commission on Climatic Changes (IPCC), 1992.

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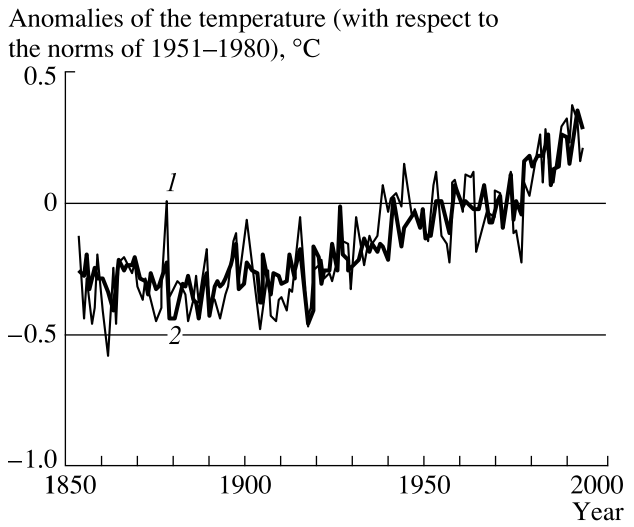

Fig. 2. A comparison of measurements [4] of the mean global temperature (*1*) with the results of calculations using the regressional-analytical model (*2*).

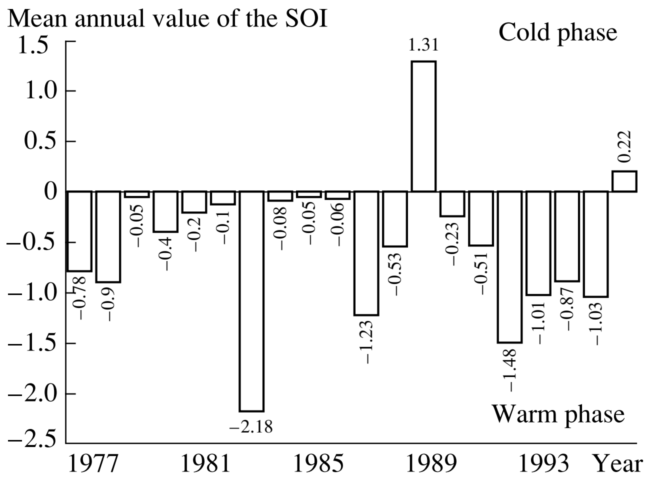

Fig. 3. Mean annual value of the Southern Oscillation Index in 1977–1996.

increase at a much slower rate. We can assert that the serious slowdown of the rate of growth of energy consumption came as a complete surprise to the forecasters, who only recently predicted a value for annual energy consumption in the range from 16 to 21 billion tce by the year 2000, if present-day trends will be sustained (Fig. 1). Actually, this value will bandly exceed 14 billion tce in the year 2000, if present-day trends will continue.

(2) The rates of growth of the concentration of all the main greenhouse components of the atmosphere (carbon dioxide, methane, the freons) sharply decreased; moreover, for the most important gases (CO_2 and CH_4), this occurred at a time when their emissions increased [2].

(3) The rates of growth of the population of the world decreased faster than was expected: in the first half of the 1990s, they reached the lowest level in all of the post-war period (1.57% annually) [3]. We may expect that further development of this process will lead to an even more noticeable decline in the rates of growth of emissions of the greenhouse gases, which form as a result of the anthropogenic activities of human beings.

(4) For four years in succession (1991–1994), the mean global temperature was quite a bit lower than the record level of 1990 for reasons that have nothing whatsoever to do with the activities of human beings. This was the result, primarily, of powerful eruptions of the volcanos Redoubt (in 1990), Pinatubo (in 1991), and Mount Hudson (in 1991), and also because of the approaching minimum of solar activity (1996). Only in 1995 was the previously lost trend for warming of the climate recovered: the climate in 1995 was several hundredths of a degree warmer than in 1990. Surprisingly, the year 1996 turned out to be one of the coldest in the past ten years.

Thus, we have no grounds to speak of an unceasing “avalanche-like” warming of the climate.

(5) A large part of the noticeable warming during the last 20 years (Fig. 2) was due to the exceptionally warm phase of the phenomenon ENSO (El Niño/Southern Oscillation), which is a typical atmospheric phenomenon that is determined by inherent properties, as well as extraterrestrial relationships of the global climatic system (Fig. 3). From Fig. 3 we see that in 18 of the last 20 years, the Southern Oscillation Index (SOI) was negative.[2] This corresponds to the warm phase of the phenomenon ENSO. This phenomenon was recorded for the first time in all the time that sufficiently detailed meteorological observations have been made in the Pacific Ocean basin, that is, in 145 years.

As is the case with every complex geophysical phenomenon, a change in the climate has many causes, of which the anthropogenic activities of human beings is only one factor, notwithstanding its rather great importance in present times.

In our study, on the basis of data from present-day instrumental observations of changes in the temperature (1854–1993) and most complete information from the archives on the main anthropogenic factors (greenhouse gases, the tropospheric sulfate aerosol) and natural factors (solar and volcanic activity, the ENSO phenomenon, parameters of the heliocentric orbit of the Earth) that determine the climate, we found the sensi-

[2] The Southern Oscillation Index is the normalized difference in atmospheric pressure at the meteorological stations on the Island of Tahiti (in French Polynesia) and in Darwin (Australia). When the atmospheric pressure in Darwin is higher (with a negative SOI), an enormous zone of positive sea-water temperature anomalities (a warm phase) is formed in the Pacific Ocean, and this zone appreciably affects the mean global temperature.

Coefficients of the sensitivity of global temperature to different climatic factors

Volcanic parameter	Climatic factor				
	ENSO	Volcanos	The Sun	Greenhouse gases and tropospheric aerosols*	Parameters of the heliocentric orbit of the Earth
NORTHERN HEMISPHERE					
Acidity index	–0.088	–0.0017	0.0024	0.53 (2.32°C)	
Smithsonian index	–0.083	–0.0011	0.0025	0.52 (2.27°C)	
SOUTHERN HEMISPHERE					
Acidity index	–0.078	–0.0006	0.0002	0.36 (1.57°C)	
Smithsonian index	–0.083	–0.0006	0.0002	0.36 (1.57°C)	
THE GLOBE					
Acidity index	–0.083	–0.0011	0.0013	0.45 (1.97°C)	
Smithsonian index	–0.081	–0.0008	0.0014	0.44 (1.92°C)	
The temperature signal in 1500–1996 (the difference between the maximal and minimal values of the mean global temperature for a change in the given climatic factor), °C	0.34	0.36	0.27	0.70	0.21

* Temperature rises when doubling the carbon dioxide concentration in the atmosphere are given in brackets.

tivity of the climate to all of the above factors. The following quantitative parameters that describe changes in one or another factor were used:

Concentrations of the greenhouse gases and the tropospheric sulfate aerosol	radiative forcing
Solar activity	Wolf Numbers
Volcanic activity	the acidity index of the Greenland [5] and Antarctic [6] ice sheets or the modified Smithsonian Index [7]
The ENSO phenomenon	the Southern Oscillation Index
Parameters of the heliocentric orbit of the Earth	the linear trend of a long-term change in the temperature of the late Holocene (the last 5000 years).

The regressional-analytical model of the Nuclear Safety Institute and the Moscow Power Institute was used for calculations based on methods of regressional multi-factorial analysis. Several results of these calculations are given in the table. A comparison of data from calculations on the model with the real history of the climate for the last 140 years is given in Fig. 2.

Analyzing the results in the table, we can conclude that they do not contradict our understanding of the effect that the above factors have on the climate; this understanding was acquired as a result of studies of problems in special branches of science (the physics of the atmosphere, solar physics, volcanology, oceanology, paleoclimatology, and others). For example, our calculations show that the maximal temperature effect of the ENSO phenomenon amounted to 0.34°C (0.28°C according to the data in [8]), and the maximal decrease in the temperature of the Northern Hemisphere after the most powerful eruptions of volcanos (such as the one in Tambor in 1815) amounted to 0.5°C (0.5–0.7°C, according to several other sources [9, 10]). Calculations clearly show that, in the course of the last five centuries, no one main factor of the climate has ever been dominant with respect to the others. This signifies that the extent of warming in the future (we believe that a certain amount of warming is inevitable) will be determined by a complex superposition of the anthropogenic and the natural factors. We should also emphasize that our model with invariable coefficients established for the period of most reliable instrumental observations (1854–1993) excellently reconstructs all the main climatic events of earlier ages, right up to the beginning of our present era (the Little Glacial Period, the Optimum of the Middle Ages, the Pessimum of the Epoch of the Great Migration of Peoples, the Optimum of Roman Times) and displays a quantitative agreement with four independent temperature archives [11–14] for this period of time. Therefore, we hope that our forecast for changes in the climate will be very reliable.

The concept about the deterministic nature of changes in the climate reduces the problem to forecasting the prediction of the behavior of climate-forming factors. We have shown [15] that all the natural factors of the climate will act in the course of the forthcoming century to create colder weather, and thereby to reduce considerably the extent of warming due to anthropogenic factors. The results of calculations of the mean global temperature in accordance with our base forecast are shown in Fig. 4 (curve *1*). The basis of this forecast is, in particular, the genetic scenario of energy development that proceeds from historical laws of energy development [16], without any special measures taken to limit CO_2 emissions. From Fig. 4 we see that the mean global temperature will not rise for an infi-

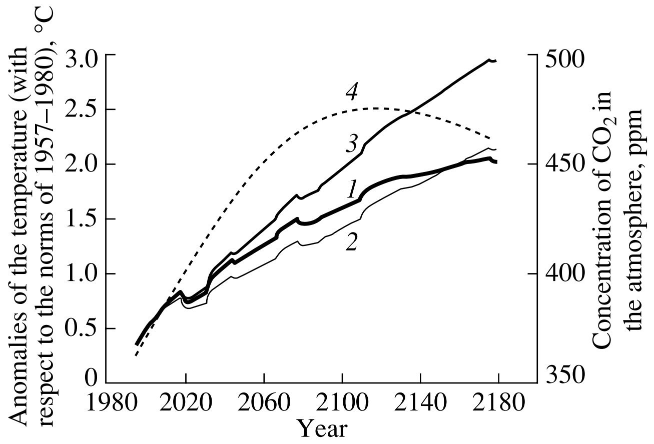

Fig. 4. Forecasts for changes in the mean global temperature (*1–3*) and concentrations of carbon dioxide in the atmosphere (*4*) until the year 2180: (*1*) according to my base forecast; (*2*) with constant emissions of CO_2 at their 1990 level (6.1 billion tons of C annually); (*3*) with constant per capita emissions of CO_2 at their 1971–1995 level (1.14 tons of C per person annually); (*4*) according to my base forecast.

nitely long time. This temperature will have already reached its maximum at a level of about 2°C with respect to the norms of 1951–1980 by the middle of the XXII century. In this figure, we also find the corresponding forecast for the atmospheric concentration of CO_2 that accounts for the reaction of the biosphere and the ocean on the forthcoming rise in the temperature and the carbon dioxide content. In particular, this forecast shows that, as a result of interaction between many natural and anthropogenic factors (an increase in the amount of carbon that is captured by the continental biota, the more intensive run-off of carbon into the ocean, the decrease in the amount of fossil fuels that will be burned), the rates of growth of the CO_2 content should decrease from the present-day level of 0.4% to 0.07% annually by the end of the next century. In the middle of the XXII century, the increase in the concentration of CO_2 will give way to a slow decrease in concentration.

Figure 4 also shows the results of two alternative scenarios for energy development and carbon dioxide emissions into the atmosphere.

The alternative with constant carbon (C) emissions at their 1990 level (6.1 billion tons of carbon annually) projects rather strict limitations on emissions for the industrially advanced countries in accordance with the recommendations of the Conference in Rio de Janeiro (in 1992), and calls for gradual introduction of similar practices in other countries of the world.

The alternative with constant per capita emissions at their 1971–1995 level (1.14 tons C per person annually) corresponds to the status quo that arose historically in the last quarter of a century, when the decrease in CO_2 emissions in the industrially advanced countries was compensated by their increase in the newly developed countries of the world (Korea, Thailand, Malaysia) and in several of the developing countries (China, India, Indonesia).

Figure 4 shows that in the alternative with strict control of emissions, with present-day trends retained for an entire century, the temperature will only deviate from the base forecast with unlimited emissions by at most ±0.3°C, which lies within the bounds of climatic variability from year to year.[3]

The main conclusions and some observations are as follow:

(1) An analysis of changes in the climate for the period of most reliable geophysical and instrumental meteorological observations (1854–1993) indicates with great certainty that the sensitivity of the climatic system to a two-fold increase in the concentration of CO_2 is about 2°C (see the table); this is at the low end of the range 1.5–5.5°C that was predicted by models for general circulation of the atmosphere and the ocean.

(2) Correct extrapolation of historical trends in fossil fuel energy use and a corresponding evaluation of carbon emissions into the atmosphere allow us to conclude that doubling the pre-industrial concentration of CO_2 (277 ppm) will not be possible in the XXI and also the XXII centuries.

(3) The real influence of burning fossil fuels and of anthropogenic activities, in general, on the climate is not as great as presently believed. Moreover, the rise in temperature due to anthropogenic causes takes place on the background of a clearly delineated trend of the natural climate to become colder (Fig. 5). As a result, the maximal temperature rise due to anthropogenic activities, which will take place in the middle of the XXII century, should not exceed 1.5°C with respect to the 1990 level. This is much like the range of natural secular variability of the climate. For example, the maximal difference in temperature between the warmest year (1995) and the coldest year (1862) ever recorded during instrumental observations was 1.0°C.

An increase in the temperature in the range from 1.0 to 1.5°C will mean a recovery of climatic conditions that correspond to one of the most favorable periods of the present post-glacial era (the Golocene), that is, to the Great Atlantic Optimum, which occurred five or six thousand years ago (Fig. 5). A rise in temperature of 4 to 8°C and a return to the temperature conditions of the Pliocene (two to nine million years ago) and, even more so, to the Cretaceous period (more than 67 million years ago), undoubtedly will not endanger humanity. More likely, such forecasts, indicate that the people who proposed them lack good sense.

(4) Various real scenarios of CO_2 emissions very weakly affect the level of the temperature rise by the year 2100. Here, we mean the scenarios with constant emissions at their 1990 level, with constant per capita

[3] The difference in the temperatures for two years in succession is the measure of variability from year to year. The greatest difference in temperatures during the entire period of instrumental observations was recorded in 1878/1879, when it was 0.37°C [4].

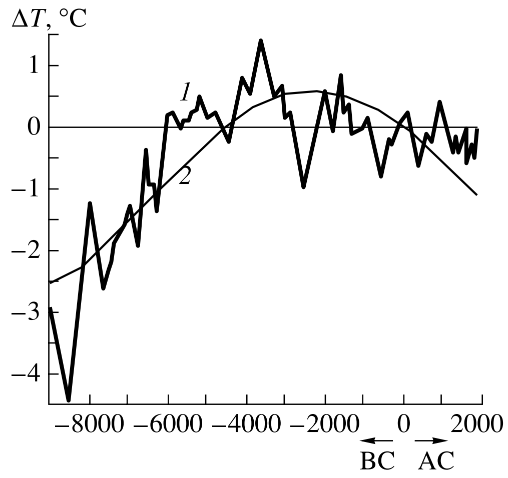

Fig. 5. The history of the temperature of the Northern Hemisphere for the past 11000 years (*1*) [14] with a long-period trend (*2*).

emissions at their 1971–1995 level, and the base forecast. The effect lies within ±0.3°C, which is at the level of climatic variability from year to year. This is a consequence of the fact that human beings can substantially influence only one important factor forming the climate, namely, the concentration of greenhouse gases. Even this influence is damped out by the biosphere and the ocean, in accordance with the fundamental principle of Le Shatelet–Brown.

(5) If the trend of energy development is correctly extrapolated into the future, we should not discover any signs of catastrophical warming of the climate in the forthcoming centuries. An opposite result may be obtained only if an unfounded extrapolation is made of present-day standards of energy consumption in several of the most spendthrift industrially advanced countries for the future situation in all of the presently developing countries, and simultaneous use is made of unfounded overestimations (3–5°C) for the sensitivity of the global climatic system.

(6) Mandatory reduction of CO_2 emissions at the expense of energy sources, in order to avert a global climatic catastrophe, is a redundant measure that should be taken voluntarily.

It seems no one doubts that every country has the right to pursue its own interests and may count on equivalent compensation if the latter must be abandoned. Russia is undoubtedly interested in warming of the climate and in overcoming its enormous deficit in energy consumption, in other words, in increasing CO_2 emissions. The extent to which this is accomplished should be commensurate with the role Russia intends to play in the world. We should be clearly aware of the fact that, by continuing to meet the obligations associated with the Convention on changes in the climate, Russia will soon find itself in the paradoxical situation of a country that is ready to pay an ever-increasing price for the right to inflict maximal damage to its economy and environment.

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