THE SUN DEFINES THE CLIMATE

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(translated from Russian by Lucy Hancock)

Experts of the United Nations in regular reports publish data said to show that the Earth is approaching a catastrophic global warming, caused by increasing emissions of carbon dioxide to the atmosphere. However, observations of the Sun show that as for the increase in temperature, carbon dioxide is "not guilty" and as for what lies ahead in the upcoming decades, it is not catastrophic warming, but a global, and very prolonged, temperature drop.

Life on earth completely depends on solar radiation, the ultimate source of energy for natural processes. For a long time it was thought that the luminosity of the Sun never changes, and for this reason the quantity of solar energy received per second over one square meter above the atmosphere at the distance of the Earth from the Sun (149 597 892 km), was named the solar constant.

Until 1978, precise measurements of the value of the total solar irradiance (TSI) were not available. But according to indirect data, namely the established major climate variations of the Earth in recent millennia, one must doubt the invariance of its value.

In the middle of the nineteenth century, German and Swiss astronomers Heinrich Schwabe and Rudolf Wolf established that the number of spots on the surface of the Sun periodically changes, diminishing from a maximum to a minimum, and then growing again, over a time frame on the order of 11 years. Wolf introduced an index ("W") of the relative number of sunspots, computed as the sum of 10 times number of sunspot groups plus the total number of spots in all groups. This number has been regularly measured since 1849. Drawing on the work of professional astronomers and the observations of amateurs (which are of uncertain reliability) Wolf worked out a reconstruction of monthly values from 1749 as well as annual values from 1700. Today, the reconstruction of this time series stretches back to 1611. It has an eleven-year cycle of recurrence as well as other cycles related to onset and development of individual sunspot groups: changes in the fraction of the solar surface occupied by faculae, the frequency of prominences, and other phenomena in the solar chromosphere and corona.

Analyzing the long record of sunspot numbers, the English astronomer Walter Maunder in 1893 came to the conclusion that from 1645 to 1715 sunspots had been generally absent. Over the thirty-year period of the Maunder Minimum, astronomers of the time counted only about 50 spots. Usually, over that length of time, about 50,000 sunspots would appear. Today, it has been established that such minima have repeatedly occurred in the past. It is also known that the Maunder Minimum accompanied the coldest phase of a global temperature dip, physically measured in Europe and other regions, the most severe such dip for several millennia, which stretched from the fourteenth to the nineteenth centuries (now known as the Little Ice Age).

The search for a relationship between large climate variations and phenomena observed in the Sun led to an interest in finding a connection between periods of change in the terrestrial climate and corresponding significant changes in the level of observed solar activity, because the sunspot number is the only index that has been measured over a long period of time.

Variations in solar activity and climate

Analyzing data on solar activity, the American astrophysicist John Eddy in 1976 noted a correlation between periods of significant change in the number of spots in the past millennium and large changes in the climate of the Earth, changes that have profoundly influenced the life of peoples and states, initiating economic and demographic crises. Later, St. Petersburg geophysicist Eugene Borisenkov showed (1988) that in each of 18 deep minima of solar activity of the Maunder Minimum type, minima which have occurred about every 200 years for the last 7500 years, there have been periods of deep temperature decline, while in the periods of high sunspot maxima, there have been periods of global warming. Such changes in the climate of the Earth could be caused only by lasting and significant changes in the Sun, because there was absolutely no industrial effect on nature in those times. This supports the idea that in the bicentennial periods of maximum levels of solar activity, the TSI has always substantially increased, and it has noticeably decreased in periods of minima.

Thus, not 11-year, but bicentennial cycles of solar variation are the dominant factor in climate variations that last for decades: temperatures in the ocean-atmosphere system, the physical parameters of the earth's surface and its albedo, concentrations of greenhouse gases (primarily water vapor and carbon dioxide) in the atmosphere. Also, a quite important influence on climate is exerted by the world ocean, which possesses large thermal inertia and serves as the principal receiver and storage of solar energy.

Inconstancy of the TSI

At present there is a continuous sequence of observations of values of the TSI $S_{\odot}$ from 1978 (heavy line in Fig. 1), directly measured by space instruments. The largest value was observed in solar cycle 22 (of the "short" 11-year cycles), which fell in the maximum of the bicentennial cycle. This value was 1365.98 ± 0.02 W/m^2. In solar cycle 23, the maximum was substantially less: 1365.79 W/m^2. The values of the TSI measured in the minima of solar cycles 21, 22 and 23 were 1365.57, 1365.50 and 1365.17 W/m^2 respectively. Finally, from 1 July through September 2008 the constant was 1365.10 W/m^2. The amplitude of the 11-year oscillations of the TSI during the maximum of the bicentennial cycle was approximately 1.0 W/m^2, or 0.07%; from the beginning of the 1990s it began to decline gradually. The level relative to which these oscillations occur is the bicentennial component of variation in the TSI, revealed by us in 2005 (dotted line in Fig. 1).

Comparison of trends in variation of the TSI with sunspot number shows that the Sun emits more energy per month at its minimum, namely when the number of sunspots is a maximum (Fig. 2). But, unfortunately, even in textbooks on the climatology the opposite is said about the TSI and there is no reference at all to its bicentennial component.

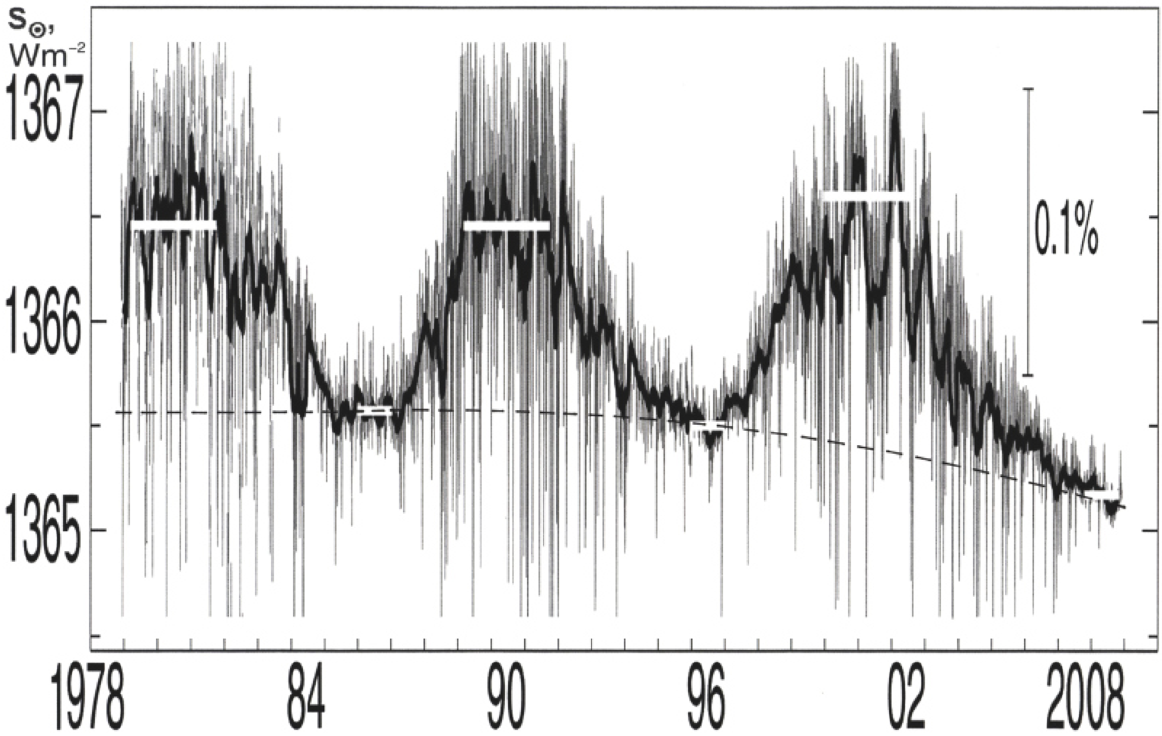

Fig. 1. Variation in the TSI during the period 1978 to 2008 (heavy line) and its bicentennial component (dash line), revealed by us. Distinct short-term upward excursions are caused by the passage of faculae on the solar disk, and downward excursions by the passage of sunspot groups. (Graph is taken from the site www.pmodwrc.ch/pmod.php?topic=tsi/composite/SolarConstant)

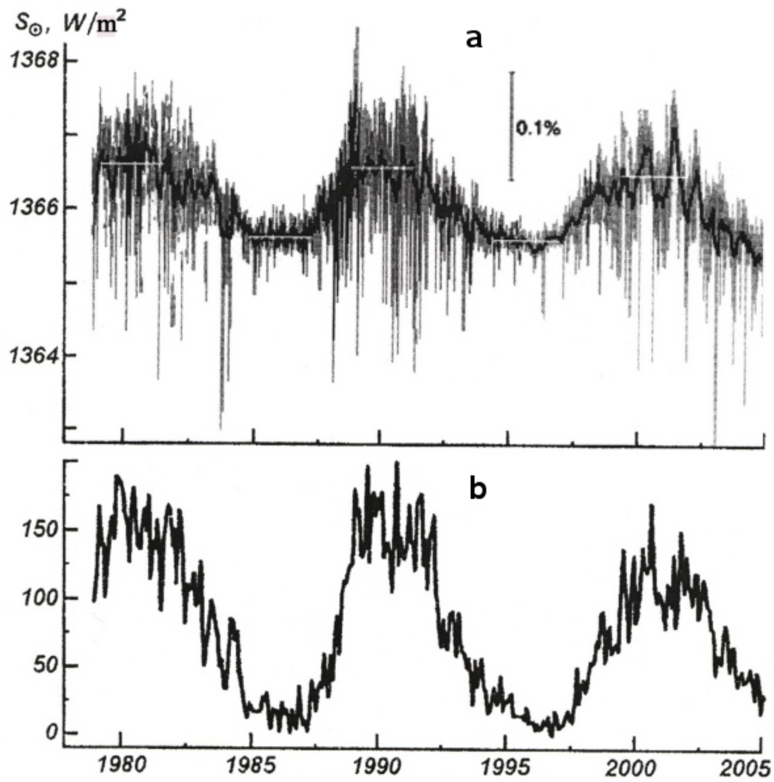

Fig. 2. Variation of the TSI (a);
of the average monthly values of sunspot number W (b) since 1978.

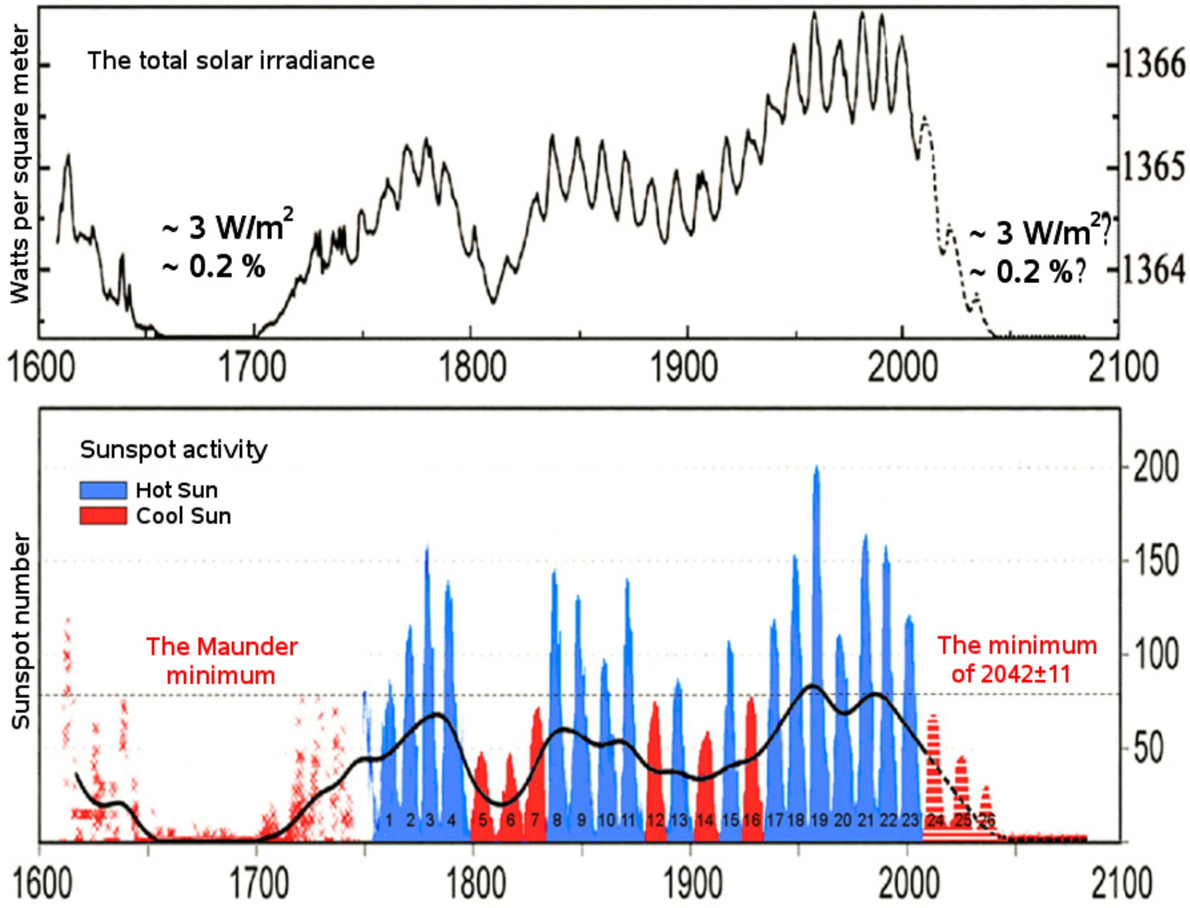

Fig. 3. Variation in the TSI drawing on the data reconstruction of Lean, J.L (2000) and Wang Y. - M., Lean J.L., Sheeley N.R. (2005) up to 1978, sunspot activity of the Sun from 1611, and changes forecast by us after 2008 (dotted lines).

The bicentennial component of the variation in the TSI has decreased serially at a rate that has been accelerating from the 21st solar cycle to the 22nd and 23rd (dotted line in Fig. 1). A comparable drop within the same period, as expected, is observed in the fluctuations of the number of spots (heavy line in Fig. 3). It is tentatively appropriate to assume: if in the maximum of 11-year “short” cycle the relative number of spots is less than 80, then the Sun is cold (intensity of radiated energy is lower than average), while if the sunspot number is greater than 80, the Sun is hotter than average. The presently-observed simultaneous drop in the bicentennial components of both the value of TSI and the level of solar activity, a drop which is accelerating, indicates the beginning of the actively-decreasing phase of a “long” (200-year) solar cycle.

Variations in the TSI – the result of changing the radius

Oscillation in the intensity of solar radiation follows from changes in the radius of the Sun. When the radiating surface increases, luminosity grows. The TSI is determined by the relationship:

$$S_\odot = \frac{\sigma R_\odot^2 T_{эф}^4}{A^2},$$

where is the Stephan-Boltzmann constant, A the average distance from Sun to earth (the astronomical unit); $R_\odot$ = 695 900 ± 70 km the radius of the Sun; and T_{eff} = 5776 K the Sun’s effective temperature. A differential change in the TSI is expressed thus:

$$\frac{\Delta S_{\odot}}{S_{\odot}} = 2\frac{\Delta R_{\odot}}{R_{\odot}} + 4\frac{\Delta T_{эф}}{T_{эф}}.$$

Such a change occurs as a result of the flow of complex processes in the interior of the Sun. Even a smooth change in the temperature of surface layer, no more than 10^{-3} °K in a 24-hour period, leads to disruption of hydrostatic equilibrium (the balance between internal pressure and gravity). Restoration of thermodynamic equilibrium can be achieved through a change in the size of the Sun to that value which restores balance; specifically, restores the temperature of the surface to the previous level, such that $\Delta T_{eff} = 0$, thus the relationship:

$$\frac{\Delta S_{\odot}}{S_{\odot}} \approx 2\frac{\Delta R_{\odot}}{R_{\odot}}.$$

In that case, alternations in the TSI occur as a result of fluctuations in the radius of the Sun with an amplitude of up to 250 km in the 11-year cycle, and 700-800 km in the bicentennial cycle (Fig. 3). The precise value of these fluctuations serves as the most important indicator of both the TSI and the level of solar activity. Therefore, long-term, high-precision measurements of the solar radius would facilitate a more-reliable estimate of the value of the TSI and its fluctuations.

The bicentennial or “long” cycle of solar activity plays the predominant role in laws governing the development of the daughter or “short” 11-year cycles, since the latter’s duration sequentially increases during the increasing phase of the long cycle, until the maximum of the “long” cycle occurs and its decrease sets in (Fig. 4). The duration of the current solar cycle 23 (12 years) is not an exception to this rule and on the whole it supports the hypothesis of dependence. This cycle’s uniqueness consists in the fact that it has become the most prolonged among all the reliably observed cycles in more than 150 years of observations. This further confirms the initiation of the actively-decreasing phase of the bicentennial cycle.

The existence of cycles of solar activity in which solar activity, luminosity and diameter vary in synchrony is reliably established. Strictly speaking, the Sun is never found in a steady state of energetic and mechanical equilibrium. The Sun is a variable star, which changes its parameters under “short” and “long” cycles, and its behavior cannot be precisely predicted. Studies of cyclic variation in the behavior of the Sun and of the processes that occur in its interior have great value for astrophysics; the theory of stars was conceived and later substantiated through solar research. Unfortunately, direct observation of comparable fluctuations of the intensity of emission and radius of other stars cannot be undertaken in the near future.

Still, cyclic variations in the level of solar activity/sunspot number, though they occur in parallel with fluctuations of the solar radius and TSI, themselves have virtually no effect on the terrestrial climate.

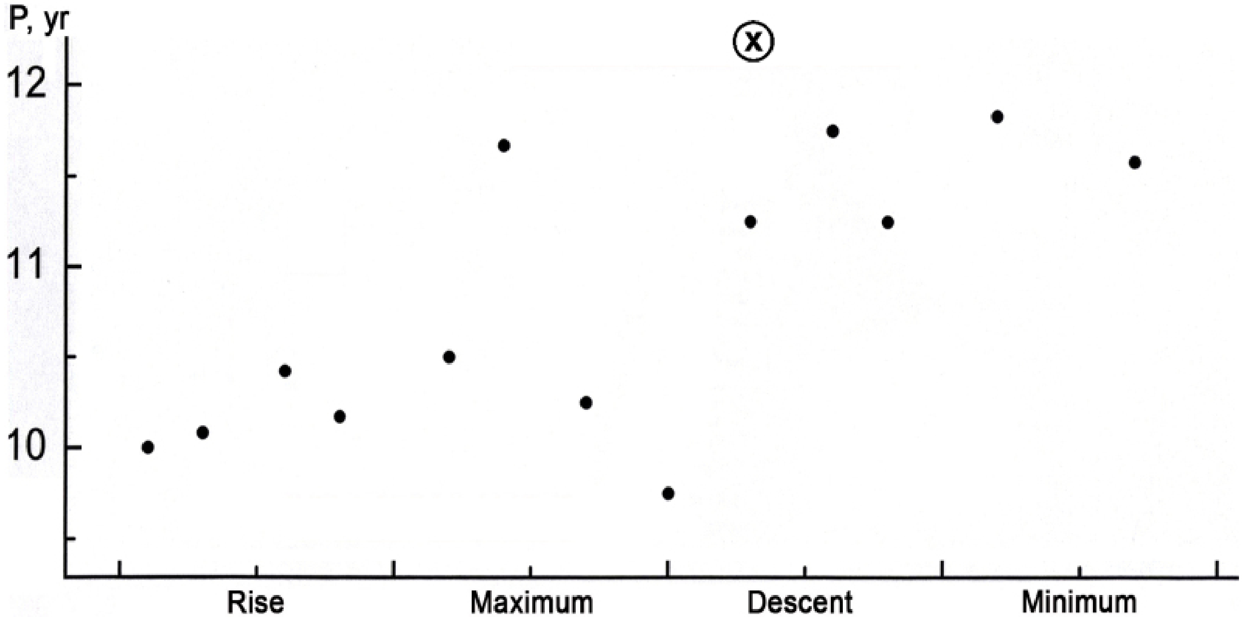

Fig. 4. Dependence of the duration of the 11-year cycles of the sunspot activity (R) on the phase of bicentennial cycle (X - 23rd cycle). Plotted on the Y-axis is the duration “short” cycles; plotted on the X-axis - phase of bicentennial cycle.

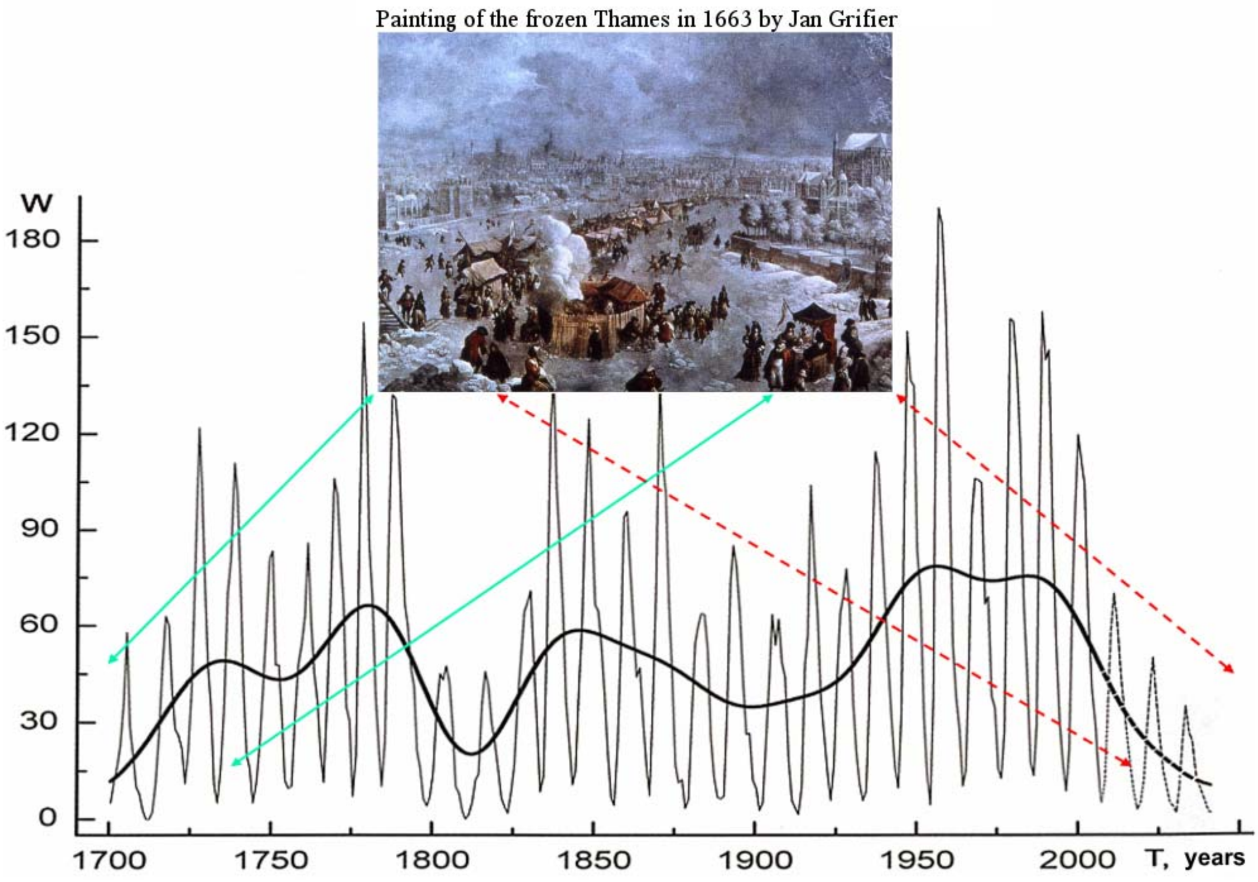

Fig. 5. Observed variations in the 11-year sunspot activity (continuous thin line) and the bicentennial activity of the Sun (continuous heavy line) 1700-2008, and our forecast of variations in these values for the period of 2009-2042 (dotted lines).

Variation in the temperature in the interior of the Sun

Changes in the temperature of the Sun's core result in corresponding changes of pressure; equilibrium is disrupted. Fluctuations of the energy of thermonuclear fusion in the solar core may be the cause of the transience of the thermodynamic state of the Sun. Long-period radial motions of plasma, cyclically reversing direction depending on changes in the temperature, must be taking place within the Sun. These radial motions of plasma in turn may catalyze change in the number of sunspots and the TSI. The additional energy released in solar core may be the source of energy for these motions.

The amplitude of fluctuations of the temperature of the solar core, and in turn of the radius of the Sun, would determine the power of the solar cycle. Small amplitudes may initiate weak cycles (i.e., where the increase in the level of activity and the value of TSI are small), and large amplitudes initiate powerful cycles. A missing change, or very small one, in the temperature of the solar core at its minimum could lead to deep "downfall" similar to the Maunder minimum.

Consequently, the precise value of the radius of the Sun and its relative changes serve as parameters of the first importance and are among basic indicators of the value of the TSI and the level of activity of sunspot formation.

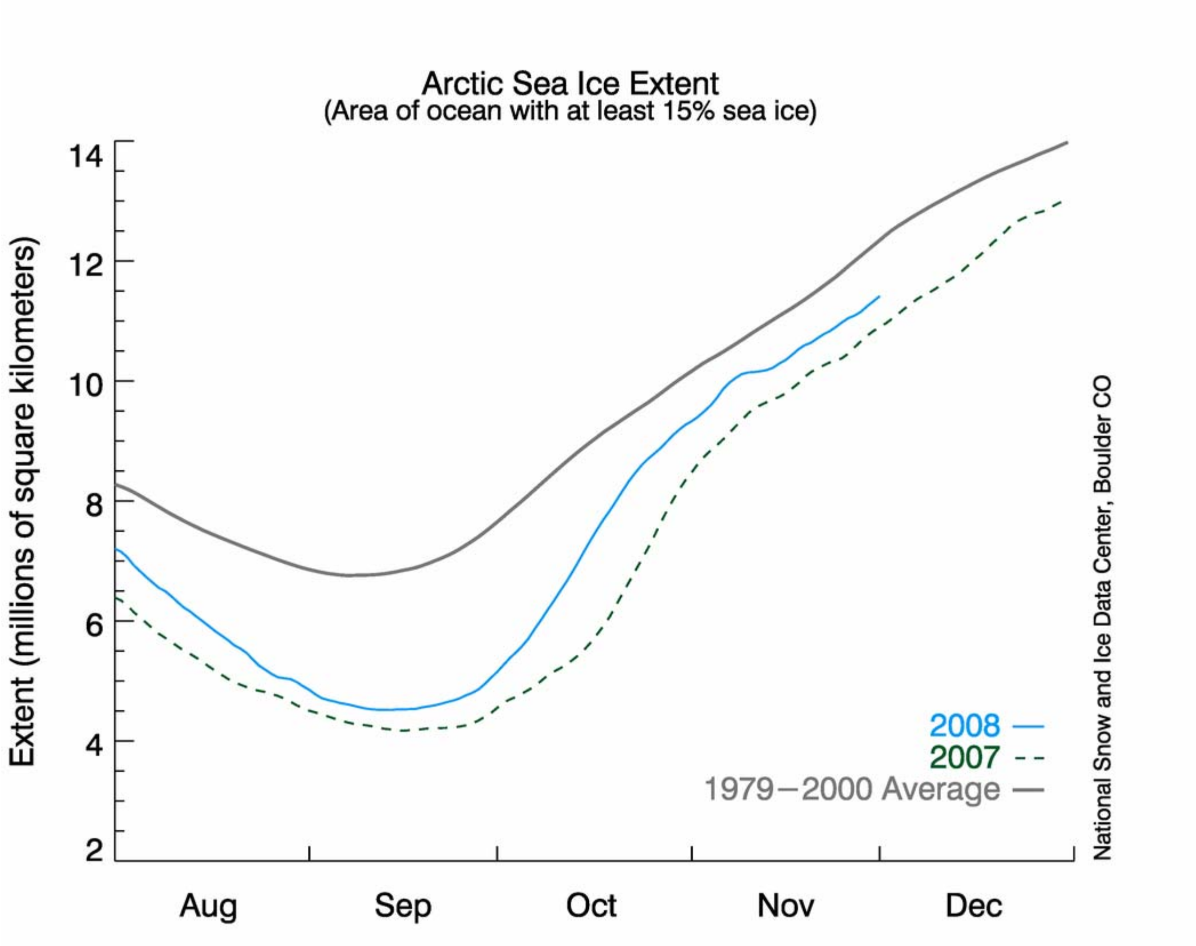

Fig. 6. Increase of the ice cover in the Arctic in 2008.

Prediction of variations in solar cycles 24 to 27

The changing gradient of the bicentennial component of variation in the TSI observed over three consecutive “short” cycles (Fig. 1) delineates further dynamics in the value of the TSI and the level of solar activity, not only of these cycles but also subsequent cycles although with somewhat smaller accuracy. From this consideration, the most probable maximum in the next, the 24th, solar cycle, will be at sunspot number 65 ± 15. But in the subsequent cycles 25-26, falling in the present bicentennial cycle’s phase of active decrease, the trend toward reduction in the absolute value of the TSI will persist, together with decrease in the level of corresponding maxima in solar activity to 45 ± 20 and sunspot number to 30 ± 20 (Fig. 3, 5). Therefore we would expect the onset of the phase of deep minimum in the present 200-year cycle of cyclic activity of the Sun to occur at the beginning of solar cycle 27; i.e., tentatively in the year 2042 plus or minus 11 years, and potentially lasting 45-65 years.

Reduction in the TSI and the future temperature drop

The most significant solar event in the 20th century was the extraordinarily high level and the prolonged (virtually over the entire century) increase in the intensity of the energy radiated by the Sun (Fig. 3). A similar rise in solar radiation has not been observed in at least 700 years. However, its consequence - the global warming of climate - that followed, was not an anomalous event in the life of the Earth. Climate on the Earth has periodically changed, and our planet during the course of the well-studied, most recent millennia has repeatedly survived global warming, comparable to that of the current period, after each of which episodes the temperature has dropped deeply, in a bicentennial cycle. Neither temperature drop nor warming lasts longer than the 200-year fluctuations of size and luminosity of the Sun.

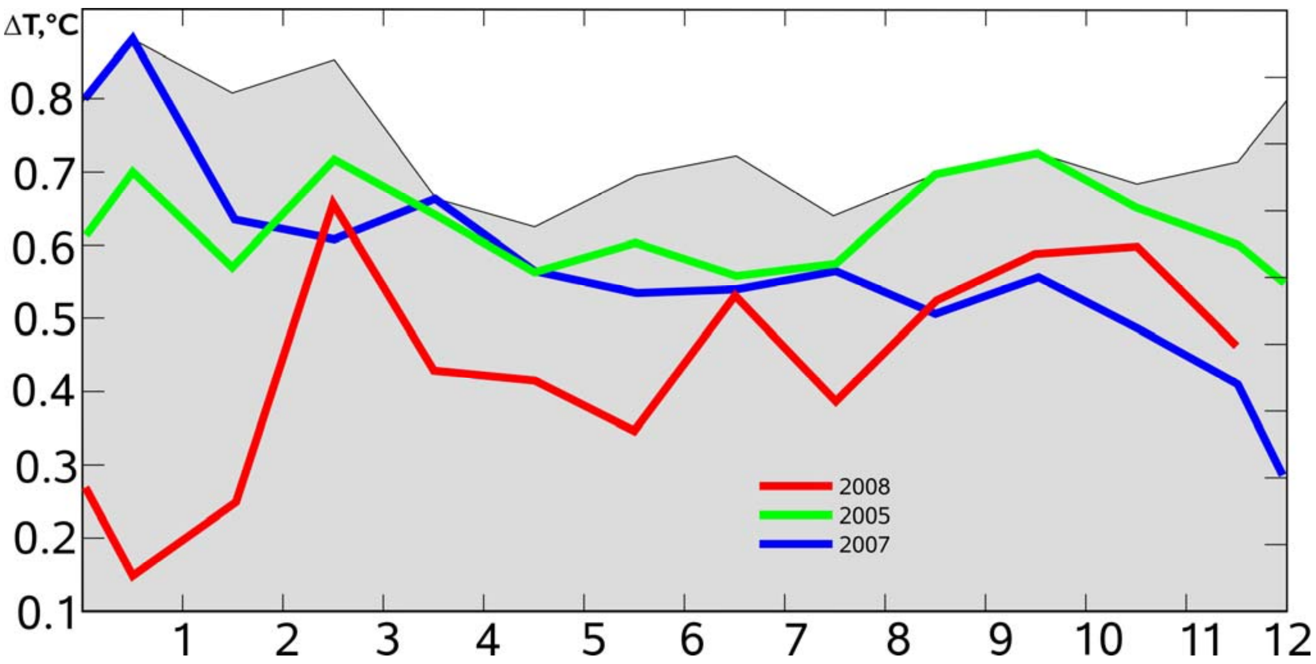

Fig. 7. Observed trend toward temperature decrease. Figure from the site http://data.giss.nasa.gov/gistemp/graphs/

The observed prolonged high maximum of solar activity that occurred during the 11th to 12th centuries' warming period (the Minor Climate Optimum), which was comparable to contemporary warming or even greater, caused serious climate changes. In Scotland vineyards were cultivated; Greenland completely justified its name of "green land" and was settled by Normans at the end of the tenth and beginning of the eleventh century. But a subsequent deep fall in the temperature (the Maunder minimum, the coldest phase of the Little Ice Age) froze all the channels in Holland, in London froze the Thames, in Paris froze the Seine, and in Greenland caused the glaciers to grow, forcing people to leave its centuries-old settlements.

The intense solar energy flow radiated since the beginning of the 1990's is slowly decreasing and, in spite of conventional opinion, there is now an unavoidable advance toward a global temperature decrease, a deep temperature drop comparable to the Maunder minimum (Fig. 5). By the middle of this century the shortage of solar energy received may be on the order of 0.2% of its maximum average level in the 1980's; thus, about 3 W/m^2. Although the change in the TSI would be at a level of about 0.07% in the "short" cycle, its influence on the climate would be smoothed out by the thermal inertia of the world ocean. However, if a similar shortage persists over two cycles, the climate will unavoidably change, with a time delay of 17 ± 5 years because of the thermal inertia just noted.

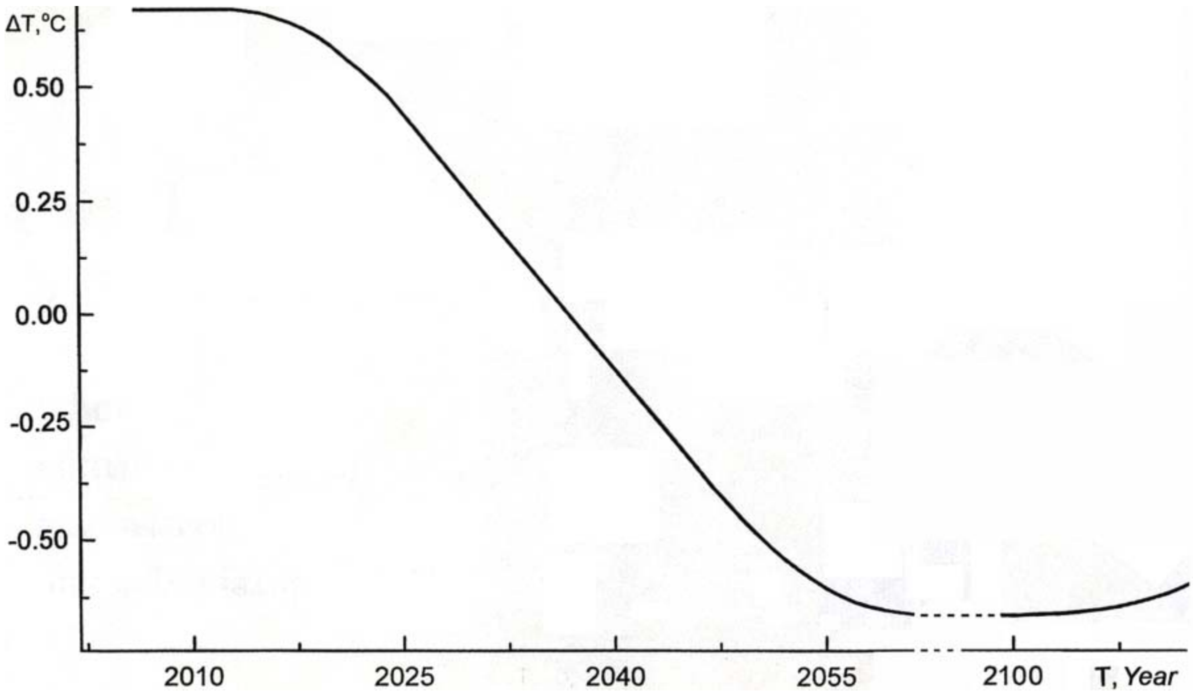

Fig. 8. Forecast of the scenario of a deep temperature drop of climate in the middle of the 21st Century.

At present, in the 23rd "short" solar cycle, which has extended to 12 years, the upper atmosphere receives in average 0.19 W/m^2 less solar energy than it did in the 22nd solar cycle. Annually, the shortage is 6 x 10^6 joules/m^2, while over an entire cycle, the hemisphere of the earth turned to the Sun – an area of 127.5 x 10^6 km^2 – will receive 24 million megajoules less energy than before. The Sun no longer heats the Earth as before. Our planet experiences a shortage of energy comparable with the summed power of 21 million nuclear power plants; it is living under the conditions of a cooling

Sun. Consequently, we should expect not the catastrophic melting of ice, but, on the contrary, the gradual growth of ice caps at the poles. It has already begun: the area of ice cover in the Arctic in September 2008 (4.52 mln. km^2), in spite of all forecasts, rose by 390 thousand km^2 above that of a year ago (when it was 4.13 mln. km^2) and in the subsequent four months it grew substantially further (Fig. 6).

British researchers assert that the current temperature drop is due to the La Niña phenomenon (this name is a translation from the Spanish “la niña” meaning “a girl”) in the Pacific Ocean, on the coasts of Ecuador, Peru and Columbia. This phenomenon is characterized by an anomalous decrease in the temperature of the surface of ocean averaging 0.5-1 degrees. This directly distinguishes the phenomenon from another widely known phenomenon – the El Niño (El Niño - “a boy”), which is characterized by an anomalous increase in the temperature of the surface of ocean. The two phenomena are equally complex to forecast and to understand. American geophysicists, who have studied them, assume that they can only be short-term fluctuations in a longer natural cycle, the “super-Niño”. We consider that all these phenomena (El Niño, La Niña, and “super-Niño”) are generated by the 11-year and bicentennial fluctuations of the intensity of solar energy radiation. The presence of correlation among them indicates this.

The tendency toward a decline in global temperature observed in 2006-2008 (Fig. 7) will stop temporarily in 2010-2012. Then an increase in the TSI is expected, as solar cycle 24 (a “short” cycle) will temporarily compensate for the declining bicentennial component. But if solar activity in the “short” cycle does not rise sufficiently, the cooling of planet will begin to the deep temperature drop in 2055-2060 ± 11 years, when temperature will be lower by 1.0 – 1.5 degrees. The following climate minimum will last 45-65 years, after which warming will necessarily begin, but only at the beginning of the 22nd century (Fig. 8).

Measurements on the board of the Russian segment of the International Space Station

More-precise determination of the date of the onset of the upcoming deep temperature drop and the depth of the decrease in the global temperature of the Earth may be achievable in eight years. For this it will be necessary to conduct precise (with an error no greater than ± 3-5 km) measurements of the form and diameter of the Sun, from the Russian segment of the International Space Station, and within the framework of the Russian - Ukrainian project Astrometria. In the Pulkovo Observatory within the project framework more than ten years of active work has been conducted on development of an unique instrument, the solar limbograph SL -200, whose delivery to the space station is planned for the beginning of 2011 (Fig. 9). The data on changing solar intensity that we will collect over about six years will enable an extrapolation to past and future periods and development of a more precise scenario of future climate change. It is precisely for this that the project is viewed as one of high applied significance.

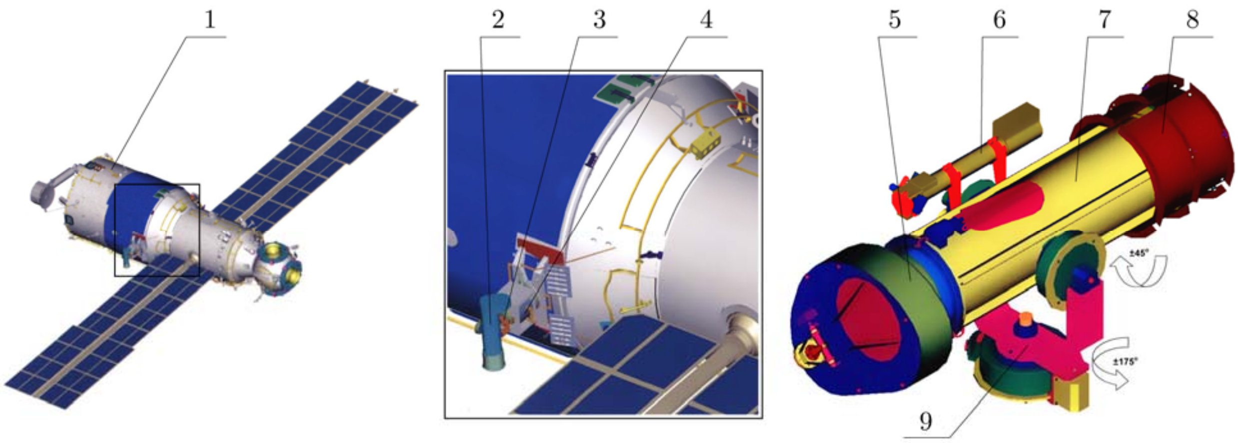

Fig. 9. Integration of the components of instrumental complex of the solar limbograph SL-200 of the Astrometria project on the external surface of the Russian segment of the ISS: 1 – Service module; 2 – Block of optics and mechanics (BOM) of the SL-200; 3 and 9 – Dedicated fine tracking platform; 4 – Universal work site (UWS-D); 5 – Block of mirror light filter of the BOM; 6 – Photoguide; 7 – Tube of the SL-200; 8 – Block of the heliophotomicrometer of the BOM.

Distant past of the terrestrial climate

In experiments on ice from the boreholes of Greenland and Antarctica (near the station "Vostok") at a depth of more than three kilometers are found bubbles of air from the epochs when the snow was stored. In these bubbles, using modern methods of high accuracy, researchers establish the CO_2 content, oxygen, and other components of the relict atmosphere, and also the temperature at which the snow fell. It has been seen that substantial increases in the concentration of carbon dioxide in the atmosphere and global climate warming have occurred cyclically, even when there was as yet no industrial action on nature. It has also been established that periodic, very substantial increases in the carbon dioxide content in the atmosphere for a period of 420 thousand years never preceded warming, but, on the contrary, always followed an increase in the temperature with a delay of 200-800 years, i.e., they were its consequence (Fig. 10). But the concentration of carbon dioxide in the atmosphere during the glacial periods of Earth history was always about half that of the present.

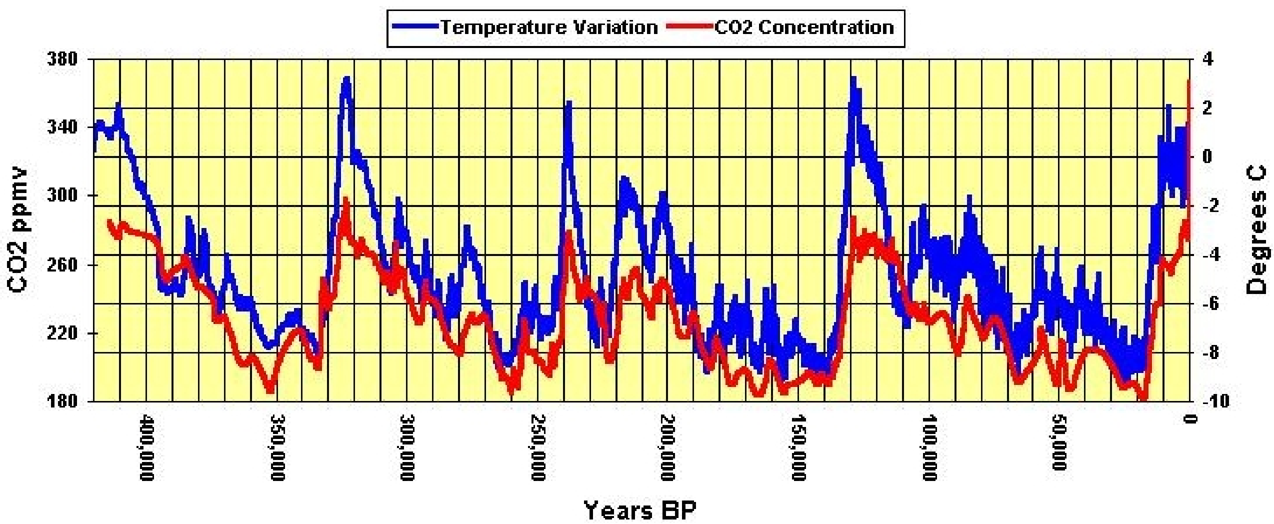

Fig. 10. Change in the temperature on the Earth and the concentration of carbon dioxide in its atmosphere for the last 420,000 years. Figure from the site http://www.daviesand.com/Choices/Precautionary_Planning/New_Data/

Increase in the concentration of greenhouse gases is not the reason for global warming, but on the contrary, the natural consequence of an increase in the temperature. The increase of greenhouse gases occurs with a delay, the period necessary for the warming of the world ocean and melting of icebergs (200-800 years). The ocean serves as the basic depository of CO_2, and since the solubility of gas in the water decreases with an increase in the temperature, the warming of the ocean leads to the emission of this large volume into the atmosphere. A further source of CO_2 entering the atmosphere was revealed several years ago by the Far-Eastern Department of the Russian Academy of Sciences: the huge amount of algae frozen into the icebergs that drift in the Arctic and near the Antarctic coasts. Falling into warm water after the melting of ice, they rot, giving out carbon dioxide. Consequently, the widespread point of view of the determining role of industrial human activity on the global warming of climate is the result of substituting cause for effect.

Thus, the observed global warming of the climate of the Earth is caused not by the anthropogenic emissions of greenhouse gases, but primarily by extraordinarily high solar intensity that extended over virtually the entire past century. Future decrease in global temperature will occur even if anthropogenic ejection of carbon dioxide into the atmosphere rises to record levels.

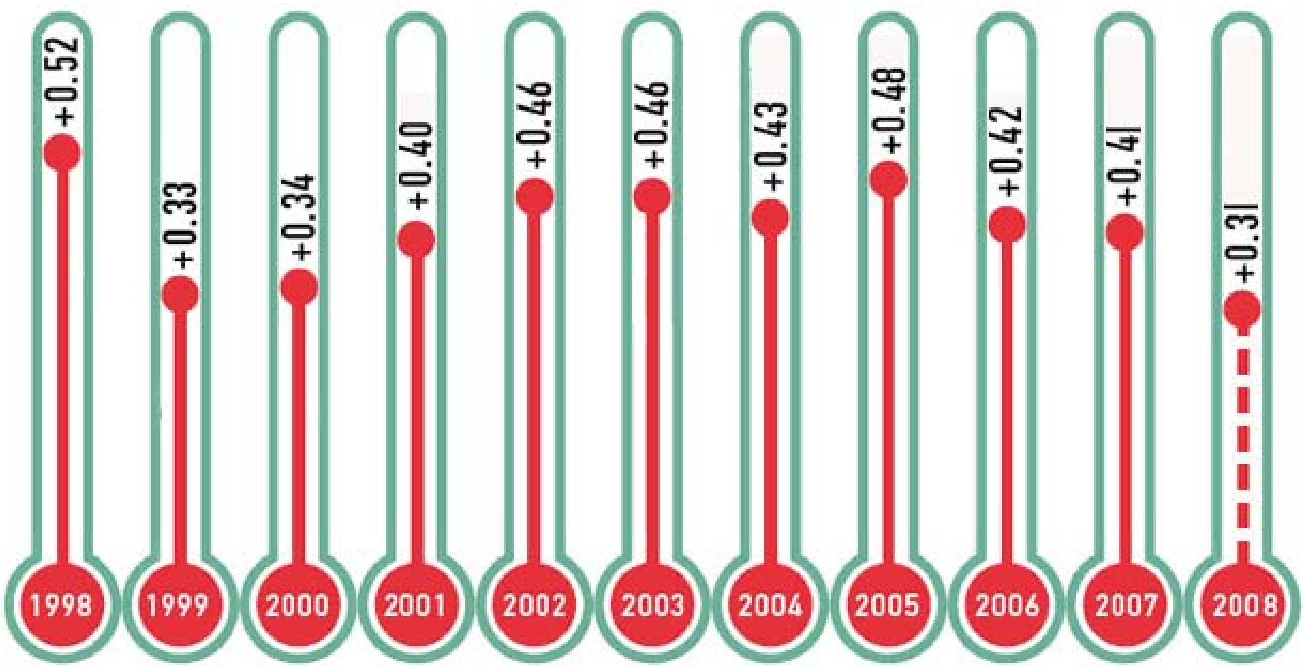

Fig. 11. Observed stabilization of temperature for the last ten years and its tendency to drop in 2006-2008.

Warming on Mars and other planets

A global increase in temperature has also occurred on Mars. NASA researchers, after tracing changes on its surface from 1999 until 2005, discovered melting ice at Mars' south pole and warming of the Martian climate, a natural event that occurred without any contribution by Martians or greenhouse effect driven by Martians. Analogous processes have also been observed on Jupiter, Neptune, Triton, Pluto and other planets of the solar system. These can only be the direct consequences of the action of one and the same factor - the prolonged and extraordinarily high level of the energy radiated by the Sun.

Warming on Mars did not occur as a result of change in the shape of its orbit and inclination of its axis of rotation, as is frequently asserted: these processes occur on time frames of tens of thousands of years, and therefore in this negligible time frame (six years!) in no way could they affect the climate. The recently-observed dust storms on Mars could arise as a result of uneven heating of various regions on the surface of planet by anomalously intensive solar radiation. Warming in turn led to change in the surfaces of planets so that they absorb more solar energy, and the physical properties of planetary atmospheres changed. These indirect results of the influence of the Sun caused increase in temperature additional to that directly caused by the bicentennial increase in the TSI.

According to the calculations carried out both in our laboratory and by foreign colleagues, the direct influence of a bicentennial variation in the TSI accounts for only about half of the amplitude of change in the global temperature of the Earth and only at first. The other half is an indirect impact: with a change in the temperature comes a change in the reflectivity of the earth's surface and change in the concentration of water vapor, carbon dioxide and other greenhouse gases in the atmosphere, each of which additionally and sharply accelerates further change in temperature.

There is no ocean on Mars; therefore its thermal inertia is much lower, and cooling begins much faster than the Earth. A drop in its temperature is a harbinger of temperature drop on Earth.

Influence of water vapor and carbon dioxide

Calculations carried out in our laboratory have showed that the energy absorbed by CO_2 (in the absorption bands 2.2-3 μm; 3.6-4.7 μm; 12.8-17.3 μm) and water vapour H_2O (4.4-8.8 μm; 5.5-7.5 μm; 15-30 μm and more than 20 μm), constitute approximately 63% of the entire thermal radiation of the Earth. About 51% is absorbed by water vapor and only about 12% by carbon dioxide. The Earth's atmosphere transmits about 10% of its own thermal emission into space, and the remaining 27% is absorbed by clouds and molecules of other greenhouse gases, primarily methane. Thus, water vapor absorbs more than half of all the radiated heat, and carbon dioxide takes only second place.

If it were possible to withdraw carbon dioxide from the atmosphere, its absorption would decrease from 63 to 51%. However, an increase in the concentration of carbon dioxide will cause virtually no increase in absorption. This is explained by the fact that in the wavelength range 4.7-12.8 µm (infrared radiation) carbon dioxide virtually does not absorb. The basic atmospheric window is located in the wavelength range 9-12 µm, while the maximum of the earth's blackbody radiation is about 10 µm. Outside the transmission window radiation does not pass into space, even with the present level of the concentration of carbon dioxide.

A basic effect on the thermal condition of the Earth has precisely a variation in the TSI. With its decrease by 1.0 W/m^2 the temperature of the Earth may decline up to 0.2 degrees, and the mean albedo of surface increase approximately to 0.003 (according to calculations, an increase in the albedo of 0.01 leads to a decrease in average annual temperature of approximately 0.7 degrees).

Determinative role of the Sun in variations in the climate of the Earth

The Earth, after receiving and storing over the twentieth century an anomalously large amount of heat energy, from the 1990's began to return it gradually. The upper layers of the world ocean, completely unexpectedly to climatologists, began to cool in 2003. The heat accumulated by them unfortunately now is running out.

Over the past decade, global temperature on the Earth has not increased; global warming has ceased, and already there are signs of the future deep temperature drop (Fig. 7, 11). Meantime the concentration of carbon dioxide in the atmosphere over these years has grown by more than 4%, and in 2006 many meteorologists predicted that 2007 would be the hottest of the last decade. This did not occur, although the global temperature of the Earth would have increased at least 0.1 degree if it depended on the concentration of carbon dioxide. It follows that warming had a natural origin, the contribution of CO_2 to it was insignificant, anthropogenic increase in the concentration of carbon dioxide does not serve as an explanation for it, and in the foreseeable future CO_2 will not be able to cause catastrophic warming. The so-called greenhouse effect will not avert the onset of the next deep temperature drop, the 19th in the last 7500 years, which without fail follows after natural warming.

The earth is no longer threatened by the catastrophic global warming forecast by some scientists; warming passed its peak in 1998-2005, while the value of the TSI by July - September of last year had already declined by 0.47 W/m^2 (Fig. 1).

For several years until the beginning in 2013 of a steady temperature drop, in a phase of instability, temperature will oscillate around the maximum that has been reached, without further substantial rise. Changes in climatic conditions will occur unevenly, depending on latitude. A temperature decrease in the smallest degree would affect the equatorial regions and strongly influence the temperate climate zones. The changes will have very serious consequences, and it is necessary to begin preparations even now, since there is practically no time in reserve. The global temperature of the Earth has begun its decrease without limitations on the volume of greenhouse gas emissions by industrially developed countries; therefore the implementation of the Kyoto protocol aimed to rescue the planet from the greenhouse effect should be put off at least 150 years.

Consequently, we should fear a deep temperature drop, but not catastrophic global warming. Humanity must survive the serious economic, social, demographic and political consequences of a global temperature drop, which will directly affect the national interests of almost all countries and more than 80% of the population of the Earth. A deep temperature drop is a considerably greater threat to humanity than warming. However, a reliable forecast of the time of the onset and of the depth of the global temperature drop will make it possible to adjust in advance the economic activity of humanity, to considerably weaken the crisis.

REFERENCES

1. Borisenkov E.P. **Climate variations during the last millennium.** – Leningrad, 1988.
2. Abdussamatov H.I. **On the decrease of the flow of solar radiation and a decrease in the global temperature of the Earth to the state of deep temperature drop in the middle of the 21st Century** // Proceedings of KrAO, 2007, Vol. 103, № 4, p. 292 - 298.
3. Abdussamatov H.I. et al. **Project Astrometria on the measurement of the time variations in form and diameter of the Sun on the service module of the Russian segment of the ISS** // Proceedings of RAS, physical section, 2007, Vol. 71, № 4, p. 611 - 616.
4. Scafetta N. and West B. J. **Is Climate Sensitive to Solar Variability?** // Physics Today, 2008, #3, Vol. 61.

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