ARTICLE
Reasons for Modern Warming: Hypotheses and Facts

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ARTICLE INFO	ABSTRACT
	Two hypotheses of modern warming are considered: natural and anthropogenic. The probabilities of each of them are compared. It is proved that the hypothesis of natural warming is much more likely than the hypothesis of anthropogenic warming. It is shown that the displacement of the Sun from the center of mass of the solar system directly affects the temperature of the surface atmosphere in the synoptic regions of Eurasia. This result corresponds to the model of E. P. Borysenkov with variations of the solar constant or, equivalently, with variations of the Bond albedo.

1. Introduction

The World Climate Change Conference held in Moscow in 2003 [1] was mainly devoted to finding the causes of significant changes in the Earth's geospheres in recent decades. Both natural and anthropogenic factors were considered, but the problem of their interrelation in the ongoing processes has not been resolved. The discussions revealed a whole spectrum of opinions on this subject: only anthropogenic factors affect the climate, only natural ones, anthropogenic factors prevail, and natural ones prevail.

The problem of modern warming of the lower atmosphere is the main issue of climatology in recent decades. There are two points of view: either warming is caused by mainly natural factors, or by anthropogenic.

The IPCC reports take a standpoint of the anthropogenic type of modern warming, for example [2].

Not all researchers agree with this: for example, a well-reasoned and complete review [3] provides a detailed criticism of the position of anthropogenic warming. Let's add here the works [4-6]. That is, the problem has not been resolved and is under discussion.

The article discusses both hypotheses. Based on the

published facts, the probabilities of both the natural hypothesis and the anthropogenic one are estimated.

2. Methods and Materials

The NCEP/NCAR Reanalysis datasets for the period 1972-2012 was used in the study. Two parameters were taken: outgoing longwave radiation (OLR) and the monthly average temperature of the near-surface atmosphere.

The calculation of the Sun displacement from the common center of mass of the Solar system was carried out according to the algorithm described in the article [7].

Standard statistical methods of data processing were used.

3. Results

Let us put the question this way: which of the two hypotheses of modern warming is more probable?

H1: outgoing shortwave radiation (OSR),

H2: outgoing longwave radiation (OLR).

Let's start our analysis by considering H2 hypothesis. If the hypothesis is correct, then modern warming is due to human activity, that is, to an increase in CO_2 emissions, which increase the greenhouse effect, holding back the flux of outgoing longwave radiation, and due to this, the temperature of the surface atmosphere is raised. Therefore, there should be a trend towards a decrease in the OLR.

Figure 1 shows a graph of changes in the OLR anomalies with an assessment of its trend (the average value in the period 1975-2012 was taken as the norm). The graph is built according to NCEP/NCAR Reanalysis data on a 2.5x2.5 degree grid, taking into account the latitude of the grid points. Since there are 144 grid points in each latitudinal band, then each grid point at a distance between equatorial and polar regions has various areas.

This effect can be taken into account in two ways: either to introduce correction factors for each latitudinal band, taking into account its contribution to the OLR, or to thin out latitudinal bands so that one grid point has an approximately equal area. The second option was implemented.

It can be seen from the figure that there is no trend for a decrease in the OLR in both hemispheres. Moreover, in the Northern Hemisphere, there is a trend towards an increase in the OLR by almost 2 W/m². This fact is confirmed by the result of the analysis for the tropical zone, published in the article [8]: their trend reached 7 W/m².

So, due to the inconsistency with the data, the probability of the H2 hypothesis validity is very small.

Consider the H1 hypothesis. The main conclusion of the Fourth IPCC Report comes down to the statement that it is impossible to explain modern warming only by natural causes [9]. It is pointed out that it is absolutely true that changes in the incoming solar radiation flux have fluctuations of order 0.1% and are not able to cause changes in the temperature of the surface atmosphere by 1.0° C.

At the same time, for some unknown reason, changes in outgoing shortwave radiation greater by an order of magnitude are ignored [10]: a decrease in the mean annual Bond albedo by 0.01 from 1985 to 2000 (Figure 2).
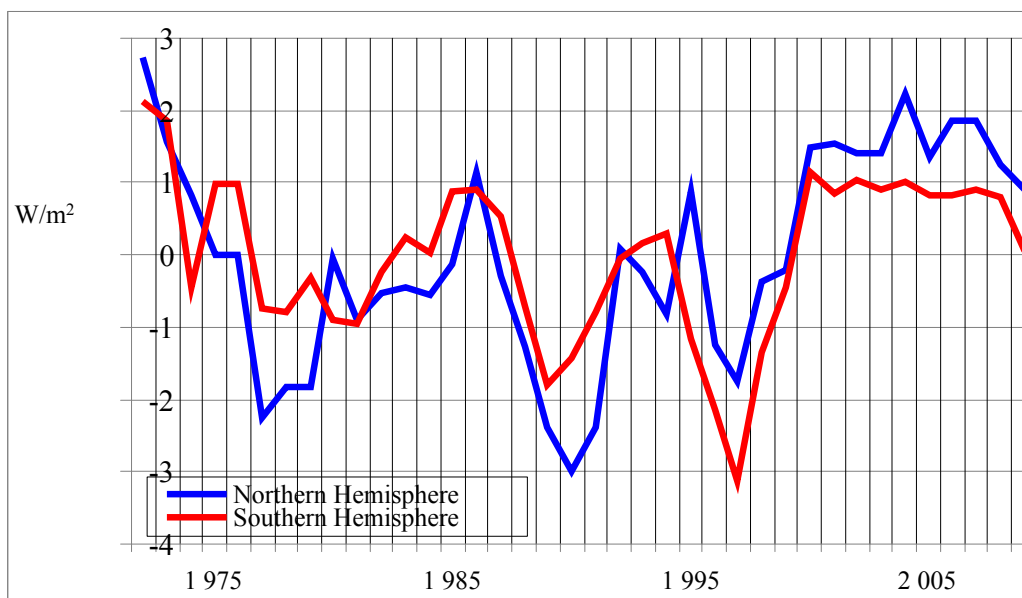

Figure 1. Interannual changes in the outgoing longwave radiation of the Earth
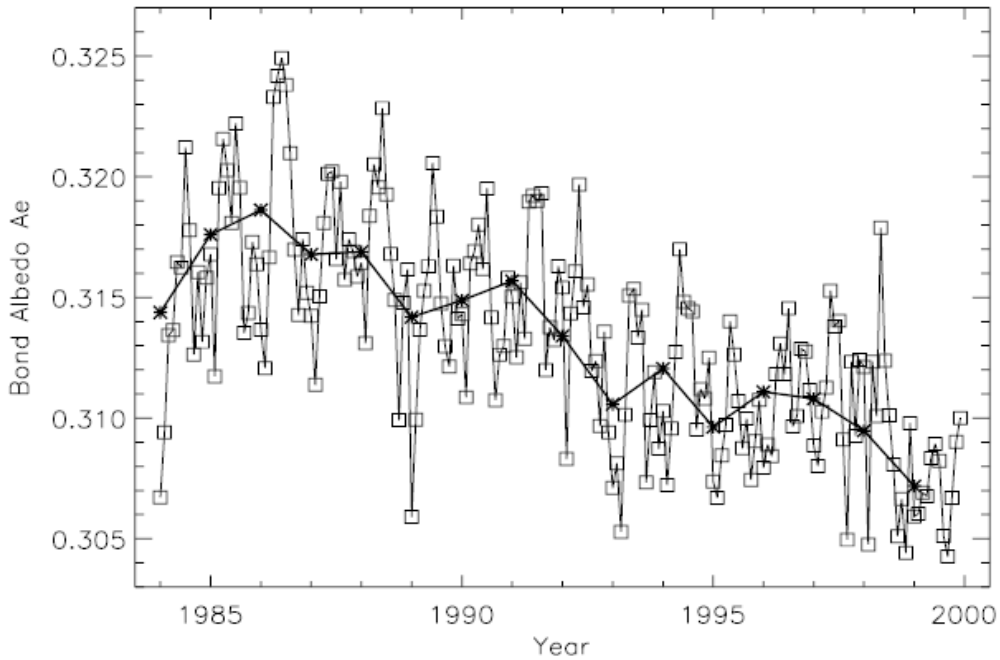
Figure 2. Mean monthly (grey) and mean annual (black) dynamics of the Bond albedo [10].

The figure shows that over a 15-year period, the annual albedo decreased by 0.011 (0.318-0.307). Note that such a decrease in albedo corresponds to an increase in the solar radiation flux by 3.4 W/m². This value is sufficient to cause a modern increase in the temperature of the lower atmosphere: data from the article [11] showed that an abrupt change in albedo by 0.01 will lead to an increase in the temperature of the surface atmosphere by 1.1° C, with a delay caused by the thermal inertia of the hydrosphere.

Consequently, the H1 hypothesis explains modern warming and is therefore more likely than the H2 hypothesis.

The series in Figure 1, 2 were continued in the articles [12,13]. In the article [12] the Bond albedo anomalies are estimated by the reflected light of the Moon, which, according to the authors, does not exceed 0.5 W/m2 for the period 2001-2018. This is 6 times less than estimate of albedo anomalies for the period 1984-2000, presented in Figure 2. An anological estimate of Bond's albedo is given by the authors of [13] by the CERES method in the interval 2001-2020, in their opinion, the albedo anomalies fit into 1.5 W/m2, but in the interval 2001-2014, the albedo anomalies are kept within 0.5 W/m2 and only after 2014 go beyond this limit.

Authors [12] are sure that solar activity, measured by Wolf numbers, cannot be the cause of changes in Bond's albedo. What is the reason then? Let's consider this issue in the discussion.

To understand the processes under study, we need to consider such a parameter as the displacement of the Sun relative to the center of mass of the Solar System. For the first time, the offset was introduced in the article [7] and calculated by the formula (1):

$$\mathbf{R}M + \Sigma \mathbf{r}_k m_k = 0 \tag{1}$$

Here $\mathbf{R}$ is the displacement vector of the Sun, M is the mass of the Sun, m_k is the mass of planets from Mercury to Pluto, $\mathbf{r}_k$ is the radius vector of the k-th planet. Figure 3 shows a graph of the displacement of the Sun, calculated by the formula (1). The displacement was maximum and equal to $|\mathbf{R}|=1.4$ million km in May 1982 and was practically zero in 1990.
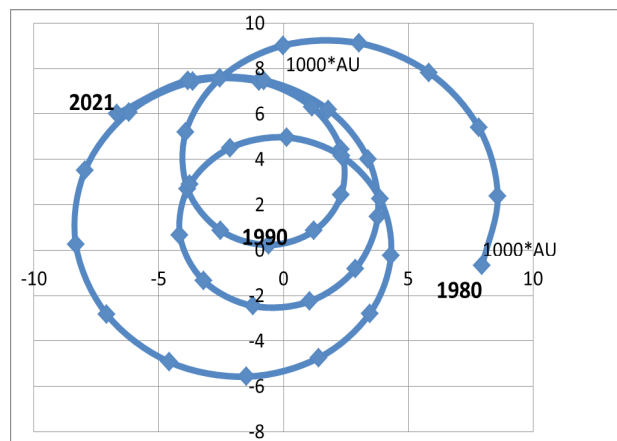

Figure 3. The displacement of the Sun from the center of mass of the Solar system in the plane of the ecliptic for the period 1980-2021.

Let us assume that the albedo changes insignificantly during the year. Then the question is, in which months of the year will the effect of albedo change be maximal? Since the perigee of the Earth's orbit falls on the beginning of January (the difference in the incoming solar radiation reaches 7% compared to the apogee) and, given that 80% of the surface in the Southern Hemisphere is covered with water, and only 60% of that in the Northern, while the hydrosphere is the main heat accumulator, then we can expect that the effect will be maximum in January. And, taking into account the thermal inertia of the World Ocean, the neighboring months, December, February and March, should be added to this period.

Figure 4 from [14] shows the monthly mean anomalies of the surface air temperature in the south of Western Siberia for the periods 1960-1980 and 1981-2002. The figure shows that after the Earth passes the perigee, the effect of the thermal inertia of the World Ocean is observed up to March.

4. Discussion

The question arises as to the reason for the albedo change shown in Figure 2. Factors such as deforestation or volcanic eruptions cannot be the primary cause of warming, because they have time scale differing from that of modern warming: hundreds of years vs. years.

What about the effect of greenhouse gases on albedo? Yes, it exists, but the first factor here is not CO_2, but water vapor, which takes on 2/3 of the greenhouse effect.

Moreover, water vapor plays a double role: it reduces the inflow of solar radiation and, at the same time, holds the OLR steady, increasing the near-surface temperature of the atmosphere. And which process will be more significant, and at what time, is not yet very clear.

What can change the albedo?

How does the displacement of the Sun from the center of mass of the Solar system effect on albedo and, accordingly, on temperature of the surface atmosphere? To answer this question, let us take the data archives on anomalies of the mean monthly temperature of the near-surface atmosphere for the period 1881-1977 [15,16] and select here those weather stations that have observational data for a period of at least 30 years. Further, for each of these 810 stations, we calculate the difference in the anomalies of the mean monthly air temperatures at the Sun displacement of less than -0.5 million km and more than 0.5 million km.

It turned out that the greatest effect in terms of intensity is observed in the winter season. Because at the beginning of January, the influx of solar energy is almost 7% higher than at the beginning of July due to the perigee of the Earth's orbit, which falls on January 2-5. Almost the entire effect of changes in winter temperature is concentrated in the middle and high latitudes of Eurasia (above 40° N): almost 70% of weather stations belong to 1-38 synoptic regions.

What is the reason for such an uneven distribution of atmospheric temperature? It is clear that in the middle
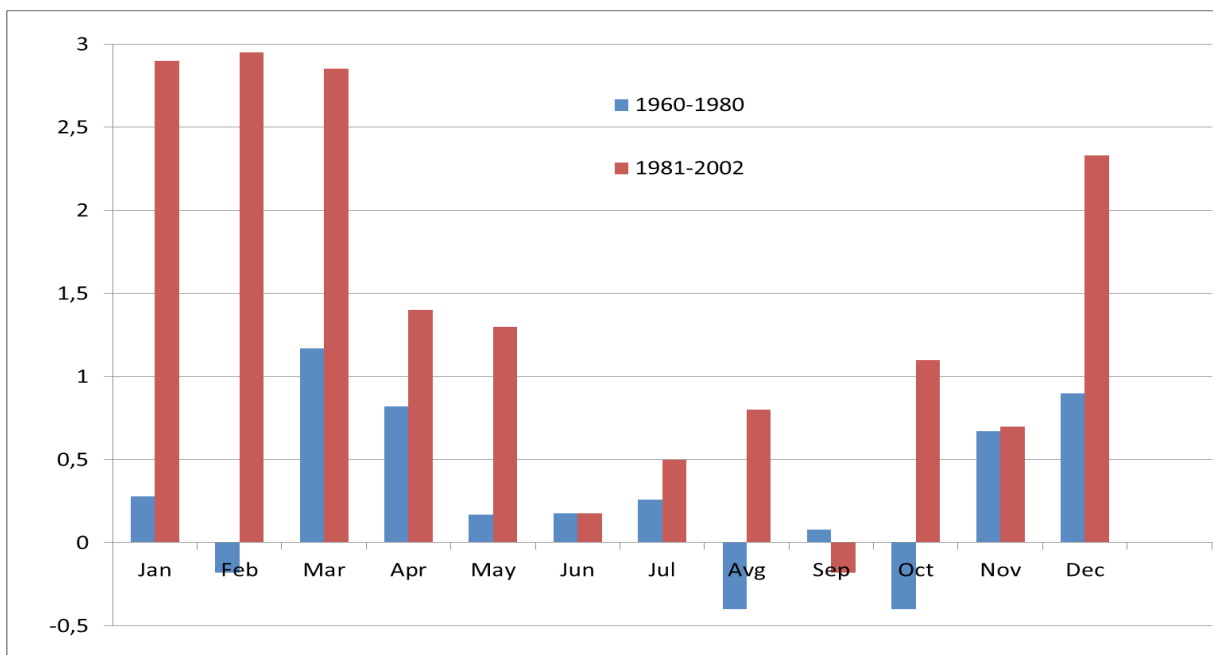

Figure 4. Anomalies of mean monthly near-surface air temperatures in the south of Western Siberia (°C), between periods of 1960-1980 and 1981-2002

and high latitudes of Eurasia, the Gulf Stream is the main factor in the formation of temperature anomalies. But why then similar changes are not recorded in the North America? In our opinion, even if the Pacific Ocean overheats due to the displacement of the Sun, the mountains in the west of North America will block the heating of the surface atmosphere.

Consider the following experiment. Let us calculate the displacement of the Sun from the common center of mass of the Solar system, caused by the motion of the planets, and divide all years into 3 groups: in the first group, we will include those years when the displacement of the Sun was more than 0.5 million km; in the second – those when the displacement of the Sun was less than -0.5 million km; years with a solar displacement of less than 0.5 million km in modulus will be removed from consideration. Further, for each synoptic region, we calculate the average temperature of the surface atmosphere from the data of meteostations of this region for the first and second groups of years and find the difference between them.

Figure 5 shows the result for winter months [17]. There is a statistically significant (Student's t-test at 5% level) difference in mean winter temperatures of the near-surface troposphere, which depends on significant displacements of the Sun.

A theoretical question arose, what will be the temperature field of the surface atmosphere if the solar radiation flux increases? According to the model of E.P. Borisenkov

(personal communication), with an increase in the solar constant by 5% in January (which, of course, is unrealistic), the temperature will change, mainly in the middle and high latitudes of Eurasia by 4-10°C, and in in other regions only up to 2°C, which is in good agreement with our results. But, an imbalance can be created without changing the solar constant: it is enough to change the albedo by the same 5% to get the same result. In fact, as we saw earlier, the albedo changed by 1%.

Taking into account the relationship of the surface temperature of the atmosphere with the displacement of the Sun, shown in the last figure, we will build a climate forecast of temperature dynamics. The algorithm for calculating the forecast is as follows. For each year for the period 1901-2008, the average values from 5 rows of January air temperatures were calculated at the specified weather stations Omsk, Barabinsk, Novosibirsk, Tomsk, Barnaul. The resulting series was transformed into the accumulated sum of anomalies ("norm" is the average for 1901-1985). The second row on the graph is proportional to the accumulated sums of the ordinates of the Sun's displacement (the direction of the ordinate axis is 2 dozen degrees less than the longitude of the Earth in mid-January). The processes under consideration have similar features: synchronous rise of graphs, inflection point in 1990, close local extremes (see Figure 6).

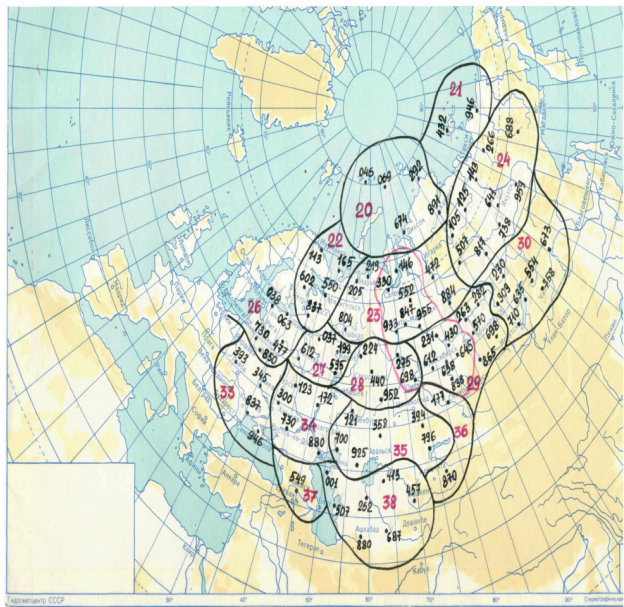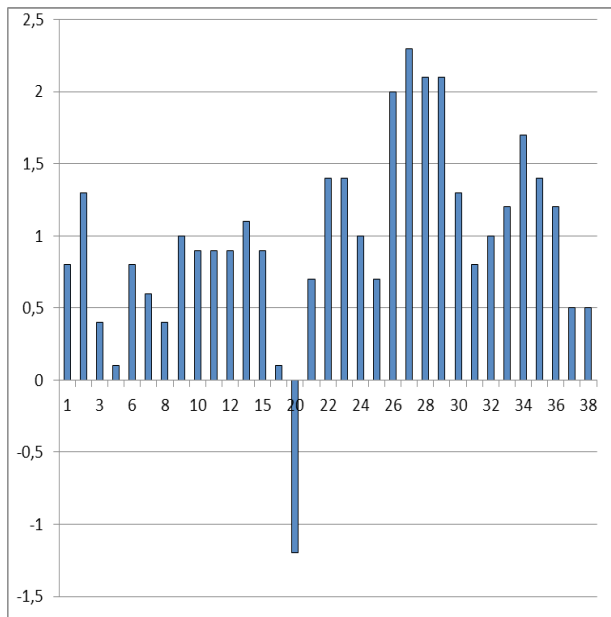However, there are differences. The discrepancies, especially the temperature rise in 2001-2005, can be ex-

Figure 5. Difference DT = T1-T2 (left part) of average winter temperatures of surface air (°C) in natural synoptic regions (right part), depending on the displacement of the Sun. (T1 is the temperature in years when the displacement is more than 0.5 million km, T2 is the temperature in years when the displacement is less than -0.5 million km)
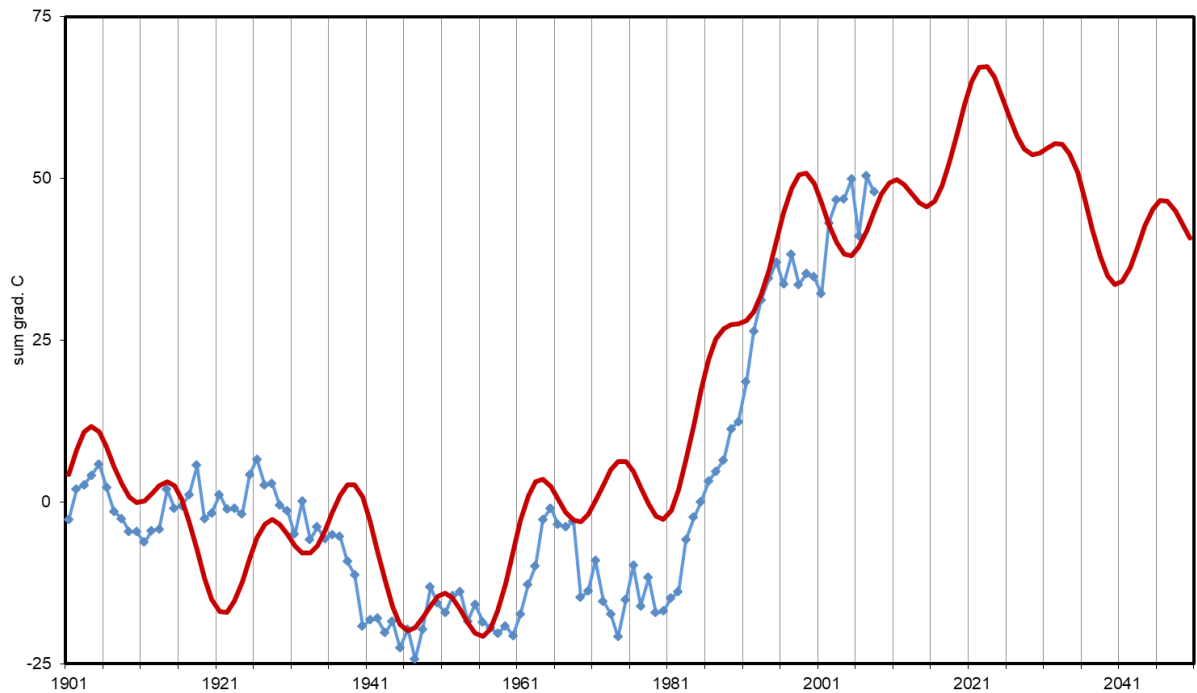
Figure 6. The sum of January surface atmospheric temperature anomalies in the 29th synoptic region (blue line) and the sum of solar displacement ordinate anomalies (brown line).

plained for Western Siberia by a delay of several years in the response from the hydrosphere to the variability of solar radiation, as well as by the obvious fact that the displacement of the Sun is not the only parameter determining the variability of the temperature of the lower atmosphere.

The climate forecast in Figure 6 was published in [14] in 2009. According to the forecast, in the next 2-3 years there will be, at least, a decrease in the rate of growth of the surface temperature of the atmosphere in the 29th synoptic area and, after the generation of positive heat anomalies by the World Ocean, the January temperature in the area will gradually return to normal values.

Taking into account our results, we can expect a similar reaction in Eurasia and on Earth as a whole.

5. Conclusions

The interannual OLR anomaly are analyzed based on the NCEP/NCAR Reanalysis data. It was shown that there is a nonnegative linear trend of the OLR from 1975 to 2012. This fact contradicts the hypothesis of an anthropogenic cause of modern warming.

The paper deals with the natural component of modern warming. The OSR graph is given, from which it follows that the Bond albedo decreased by 0.01 over the period from 1984 to 2000, which corresponds to an increase in

the solar radiation flux by 3.4 W/m^2. This value is enough to heat the lower atmosphere of the Earth by 1°C.

It is shown that heating occurs unevenly over the months of the year due to the Earth's passage through its orbit perigee on January 2-3 and to the unequal distribution of the World Ocean between the Earth's hemispheres: 80% in the Southern Hemisphere and 60% in the Northern Hemisphere. Therefore, on the day of the passage of perigee, the ocean of the Southern Hemisphere receives 7% more heat than the ocean of the Northern Hemisphere in early July. This results in the overheating of the atmosphere in December-January, and additional overheating is realized in February-March due to the thermal inertia of the World Ocean.

Why has albedo changed? The author sees the root cause in the displacement of the Sun from the common center of mass of the Solar system, caused by the motion of the planets. The maximum bias effect was achieved in May 1982. This hypothesis was tested in the synoptic regions of Eurasia based on the winter temperatures of the near-surface atmosphere. Good agreement was obtained between our experiment and the results of E.P.Borisen-kov's model with variations in the solar constant (Bond albedo anomalies). Based on this fact, a climatic forecast of changes in the near-surface temperature of the Earth's atmosphere was given.

References

[1] World Climate Change Conference: Abstracts. – Moscow, September 29 - October 3, 2003. 700 p. In Russian.

[2] IPCC Special Report. Global Warming of 1.5ºC. [Electronic resource]/ URL: https://www.ipcc.ch/sr15/.

[3] Jawarowski Z, 2007. CO_2: The Greatest Scientific Scandal of Our Time // 21st CENTURY Science & Technology. Spring/Summer. P. 14-28. URL: http://21sci-tech.com/Articles%202007/20_1-2_CO_2_Scandal.pdf

[4] Druzhinin I.P., Sazonov B.I., Yagodinsky V.N. Space-Earth. Forecasts. - Moscow: Mysl, 1974. - 288 p. In Russian.

[5] Krymskiy G.F., 2006. Cosmic rays and the Earth's atmosphere: facts and hypotheses // Journal Solar-Terrestrial Physics. No. 9. P.44-46. In Russian.

[6] Svensmark H., 2007. Cosmoclimatology: a new theory emerges" // Astronomy & Geophysics. Vol. 48, No.1. – P. 18-24.
DOI: https://doi.org/10.1111 / j.1468-4004.2007.48118.x.

[7] Jose P.D., 1965. Sun`s motion and sunsports. The Astronomical Journal. Vol.70, No.3. P.193-200.

[8] Golovko V.A., Kondranin T.V., 2003. Statistical models of time series characteristics of the outgoing radiation field of the Earth according to space observations // Electronic journal "Researched in Russia". No.150. P. 147-151. URL: http://zhurnal.ape.relarn.ru/articles/2003/0150.pdf

[9] IPCC. Climate Change 2007. The Physical Science Basis. Summary for Policymakers. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. - Cambridge, UK, and New York: Cambridge University Press. 996 pp.

[10] Goode P.R., Palle E., Yurchyshyn V.B., et al. Sunshine, earthshine and climate change: II. Solar origins of variations in the Earth`s albedo // J. Korean Astron. Soc. - 2002. - Vol. 35, Supp.1- P. S83-S91.
DOI: https://doi.org/10.5303/JKAS.2003.36.spc1.083.

[11] Zavalishin N.N. The model of dependence of the surface atmospheric temperature on the Earth's albedo and thermal inertia of hydrosphere // Optika Atmosfery i Okeana. - 2010. - Vol. 23, No. 06. - P. 480-484. In Russian. URL: http://ao.iao.ru/ru/content/vol.23-2010/iss.06/10.

[12] P. R. Goode, E. Pallé, A. Shoumko, S. Shoumko, P. Montañes-Rodriguez,S. E. Koonin. 2021. Earth's Albedo 1998–2017 as Measured From Earthshine. // Geophyzical rearserch letters. Vol.46, Iss. 17.
DOI: https://doi.org/10.1029/2021GL094888.

[13] Norman G. Loeb, David R. Doelling1, Hailan Wang, Wenying Su, Cathy Nguyen, Joseph G. Corbett4, Lusheng Liang, Cristian Mitrescu, Fred G. Rose, and Seiji Kato, 2018. Clouds and the Earth's Radiant Energy System (CERES) Energy Balanced and Filled (EBAF) Top-of-Atmosphere (TOA) Edition-4.0 Data Product.//Journal of climate.Vol. 31. Iss.2. P. 895–918.
DOI: https://doi.org/10.1175/JCLI-D-17-0208.1

[14] Zavalishin N.N., 2009. Assessment of the impact of the Sun shift from the center of inertia on the temperature of the troposphere // Optika Atmosfery i Okeana. Vol.22, No. 1. P.31-33. In Russian. URL: http://ao.iao.ru/ru/content/vol.22-2009/iss.01/6

[15] Average monthly and annual air temperature at foreign weather stations in the Northern Hemisphere: Description of the data archive - Obninsk: VNIIGMI-MCD, 1980.75 p.

[16] Anomalies of the average monthly air temperature, monthly precipitation as a percentage of the norm and their norms for weather stations of the USSR territory: Description of the data archive. Obninsk: VNIIGMI-MCD, 1981 43 p.

[17] Zavalishin N.N., 2015. A possible mechanism of modern warming: a decrease in albedo caused by the displacement of the Sun from the barycenter. / XI Siberian meeting on climate and environmental monitoring. Abstracts. - Tomsk, P. 24-25. In Russian. URL: http://www.imces.ru/media/uploads/CCKEM2015.pdf