

## Decreased Sun's activity will lead to a small ice age

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Due to the cold weather in 2014 and 2018-2019, millions of people around the world began to pay attention to the problem of «global cooling». In our country this problem has become known thanks to the publication of an article of physicist H. Abdussamatov in «Science and Life» (2009) and an interview with an English Professor of Mathematics V. Zharkova in a popular Russian newspaper «Komsomolskaya Pravda» (2018). During the preparation of the materials, we talked with many climate researchers in Russia and abroad, and we met some unanimous opinions based on the firm belief that climate warming will occur. The point of view of «climate warming» is so widespread that it seems a self-evident truth, it is unequivocal and does not need special evidence, and any attempt to challenge it may seem a hopeless effort. But Russian physicist H. Abdussamatov and English Professor of Mathematics V. Zharkova firmly claim the onset of global cooling in the middle of this century. We asked them to tell us about the latest results of their research.

### The Sun determines the Earth's climate

In 2007, the journal «Bulletin of the Crimean Astrophysical Observatory» published an article of a Russian scientist and astrophysicist H. Abdussamatov «On long-term variations of the total irradiance and decrease of global temperatures of the Earth after a maximum of the XXIV cycle of activity and irradiance «In the article the author makes the following conclusion: «The onset of the next sufficiently deep minimum activity, radiation flux and radius of the 200-year cycle of the Sun is predicted almost at the level of the Maunder minimum approximately near  $2040 \pm 10$  years, and then with a lag of  $17 \pm 5$  years – the onset of another deep cooling of climate» [1].

Maunder's minimum is the period in which sunspots almost disappeared (1645 – 1715). It is named after the English astronomer Edward

Maunder (1851-1928). The first official 11 year solar cycle started in 1755, the 24th solar cycle began in January 2009. The «global cooling» hypothesis is not new. It is on par with the hypothesis of «global warming» which had been actively discussed in scientific journals until the middle of the last century, but since the 70s the hypothesis of «global warming» has been dominating.

Russian astrophysicist and astronomer H. I. Abdussamatov published an article in the journal of the Presidium of the Russian Academy of Sciences «Research of the Earth from space»: «Comparative analysis of the error of monitoring the global energy budget of the Earth by the Lunar Observatory and orbital spacecraft» [2]. The article is devoted to the methods of solving the problem of climate warming. Habibullo Ismailovich proves the advantages of the Lunar Observatory for accurate measurements of The Earth's thermal budget in comparison with



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measurements from the orbital spacecraft. The author wrote to us that: «The Sun, being the only powerful source of energy for the Earth, is the main and fundamental factor controlling the climate system. Thus, the average of Earth's annual energy budget and, consequently, its global climate depend only on incoming energy – the solar constant (GSC) and total energies spread into space, determined by the Bond albedo and the power of its own thermal radiation. The Earth's climate is determined exclusively by the long-term (over a period of time of about 20 years or more) change in the global thermal state (heat content) of the entire planet, which is dependent on the average annual value of its global energy budget, affected by the excess or deficit of the difference between incoming solar energy absorbed by the Earth and energy, outgoing into outer space, emitted by the Earth's own thermal energy.»

In correspondence with the Editorial Board of the Journal, Habibullo Ismailovich outlined the main conclusions obtained as a result of his research on climate change: "The temperature is always lower in periods of low solar activity and warmer in periods of high, this fact is generally recognized by the world scientific community as an important aspect of solar climate impact. The climate changes depend on the solar cycle. Since about 1990, there has been a decrease in the GSC of the quasi-two-century cycle. The deficit of incoming solar energy in the phase of decline of the quasi-two-century cycle has not been compensated since about 1990 by a decrease in the energy emitted into space, since the Earth, which does not have time to cool down, but continues to radiate heat in the former high vol-

ume. As a result, the thermal balance between the Earth and surrounding space has been disturbed for a long time. However, the observed almost proportional decrease in the amount of GSC absorbed by the Earth since 1990 has not been offset by a decrease in the average annual energy emitted into space due to the thermal inertia of the oceans. Since about 1990, the Earth, which has not had time to cool down, radiates more energy back into space than it absorbs.

Variations of GSC in 22-24 cycles allowed us to predict the onset of the phase of the minimum quasi-two-century cycle of GSC Maunder type in cycle 27 ( $\pm 1$ ) in the year  $2043 \pm 11$ . As a result, the negative average annual energy budget is preserved and will remain on the Earth. This gradual loss of the total solar energy, accumulated by the oceans during the twentieth century, led to the beginning of a century of a new Little Ice Age after the maximum phase of cycle 24. After the beginning of the deep minimum GSC in cycle  $27 \pm 1$  in the year  $2043 \pm 11$  due to the thermal inertia of the world ocean, the beginning of the deep cooling phase in a new Little Ice Age is expected in the year  $2060 \pm 11$ .

Habibullo Ismailovich argues that: "Ocean Level is the most reliable integral indicator of temperature change than measuring air temperature using a thermometer. Since 1992, the melting of polar ice caps (over land) has resulted in an increase in the ocean level, averaging  $0.59 \pm 0.2$  mm/year [3]. This has been the most accurate integral indicator of the practical lack of climate warming and the rise of the water level in the oceans since 1998." According to the Russian astrophysicist: "This is the result of



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an accelerating decline in the solar constant since about 1990 ... Warming ended in 2016, the temperature began to decline." A well-known Russian scientist concluded that: "quasi-two-century and thousand-century cyclic variations of the GSC are the only factors of climate change for at least 800,000 years" [4].

### **Large solar minimum can lead to cooling from 2020 to 2053.**

Cold climate similar to the period of Maunder low solar activity (1645-1715) can occur from 2020 to 2053. These findings were made by Professor Valentina Zharkova (Northumbria University) in collaboration with an international team of scientists - Dr. Elena Popova from the Faculty of Physics, Lomonosov Moscow State University, Professor Simon Shepherd (University of Bradford) and Dr. Sergei Zharkov from the University of Hull [5].

It is known that the Sun has its magnetic field, which varies in a wide range in time. The formation and decay of strong magnetic fields in the solar atmosphere lead to changes in electromagnetic radiation, an intensity of plasma flows from the Sun, and the number of sunspots on its surface.

V. Zharkova et al. in 2012 published the results of their analysis based on the method of principal components of the solar background magnetic field for the 21-23 solar cycles according to the Wilcox Solar Observatory and magnetic sunspots for the 23rd solar cycle according to SOHO/MDI.

Based on these studies, the authors identified two main components of solar magnetic waves circulating independently, probably in the outer solar atmosphere and sun's interior layers. They found that sunspots appear as a result of the interaction of these two components [6]. Over the past ten years, Professor V. Zharkova and her colleagues have identified the patterns of circulation of the two components and reconstructed solar activity backward 3000 years ago and forward 1200 years. The prediction of magnetic activity in the 24<sup>th</sup> cycle gave 97% accuracy compared to the main components

obtained from observations. The authors found that the divergence of the two main solar components at the poles of the Sun reduces the interaction of these two waves and reduces the number of sunspots. It was convincingly shown that the solar great minima occurred on a semi-regular basis in the last 5 millennia and will occur in the next millennium [7].

Professor V. Zharkova says: "The upcoming grand minimum will be seen only during the cycles 25-27 (2020-2053). After this time in cycle 28, the visible solar activity will be restored back to normal. Moreover, even in these years 2020-2053 the most reduced activity will be seen during the minima of solar activity between cycles 25 and 26, cycle 26 itself and then later between cycles 26 and 27. These 3 cycles will be a modern grand solar minimum; similar to the one we had in centuries 17-18 (Maunder Minimum) but twice shorter than the one in century. The solar activity goes regularly through these grand solar minima (e.g. Wolf, Oort or Homer) as described in our papers published recently [7]." Zharkova et al. have shown that visible solar activity is formed by a packet of magnetic dynamo waves generated inside the two layers of the solar interior not only by traditional dipole magnetic sources assigned from magnetic poles but also by quadruple, sextuple and other sources [8]. Similarly to the set of the electromagnetic light waves of different wavelengths as seen via a glass prism (violet, indigo, blue, green, yellow, orange, red) forming a white light, this packet of magnetic waves is also formed by dipole, quadruple and sextuple etc. waves defining the resulting view of magnetic activity seen on the solar surface [9].

This helps to decode visible stochasticity of solar activity, and to understand that, in fact, it reflects very rigid electrodynamic laws, which these magnetic waves follow inside the solar interior.

At the end of our conversation, she concluded: "The severe winter frosts in the US, Canada and all Europe are a good confirmation of our prediction."

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