

FORUM ‘USPEKHI-2021’: CLIMATE CHANGE AND GLOBAL ENERGY ISSUES

(Joint Scientific session of the Physical Sciences Division, Chemistry and Materials Sciences Division, Division of Earth Sciences and Division of Energetics, Machinery, Mechanical Engineering and Control Processes of the Russian Academy of Sciences, January 19, 2021)

Preface to the special issue of the journal “Physics–Uspekhi” (“Uspekhi Fizicheskikh Nauk”), dedicated to the publication of the materials of the forum ‘USPEKHI-2021’

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The awarding of the 2021 Nobel Prize in Physics to S Manabe and K Hasselman for modeling climate change is, on one hand, the recognition of the achievements of science in determining the causes and predicting trends of climate warming, and on the other hand, evidence of the impact on society that climate problems have today among other global challenges. Despite the varying degrees of concern about these problems in different countries and the presence of influential skeptics, a common position of the world community is being formed, which reflects the views of the majority of professional scientists dealing with climate and global energy balance.

The essence of this position is that the observed rapid warming of the climate has an anthropogenic impulse, it is fraught with dangerous and even catastrophic consequences for society and nature on our planet, these consequences should be prevented through collective and responsible actions of all states to reduce the anthropogenic load on nature.

It is fair to admit that in 2007 the Nobel Committee already awarded the Peace Prize to scientists and politicians for their efforts to draw the attention of mankind to anthropogenic influences on nature and climate. The award-winning organization IPCC (Intergovernmental Panel on Climate Change) continues to be the most influential interdisciplinary community of scientists in this field, whose opinion is certainly taken into account by leading politicians around the world, including in the preparation to the

Glasgow summit. Also noteworthy was the 1955 Nobel Prize in Chemistry awarded to Sherwood Rowland, recognizing the freon gas destruction of the atmospheric ozone layer.

It will also be no less fair to recall the names of those outstanding founding scientists and the schools they created in the second half of the 20th century, who, with their work, inspired the emergence of a new scientific field that studies climate change under the influence of anthropogenic effects.

In the Soviet Union, this is, first of all, the school of Academician M Budyko, who headed the Voeikov Main Geophysical Observatory. In 1955, he was the first in the world to compile an atlas of the heat balance of our planet, and a year later he published the famous monograph *The Heat Balance of the Earth's Surface* (Leningrad: Gidrometeoizdat, 1956).

An important role was played by the schools of Academicians Y Izrael (meteorology), G Marchuk (numerical climate modeling), and M Obukhov (physics of the atmosphere). Just listing the names of schools testifies to the multidisciplinary nature of the discussed range of problems. Their scope becomes even wider when taking into account the role of energy factors, both technogenic and natural, and the role of energy production mode for evolution of the climate. In general, we can say that the topic “Climate change and global energy” is turning into one of the scientific, economic, and political dominants of modern society.

The focus of topics may vary from one country or one continent to another, depending on the structure of the economy and geographic location. For Russia, the issues of warming in the Arctic zone, degradation of permafrost, carbon footprint of hydrocarbon and coal energy are of particular importance. In countries with hot climates, deforestation, agricultural land degradation, and diminished water resources are threatening prospects.

While most professional climatologists come to a consensus regarding the causes of warming and current trends in climate evolution, there is a considerable uncertainty and diversity of opinions in forecasts for the coming decades. This is largely due to insufficient knowledge of feedbacks occurring in natural processes when changes in the climatic variables are extraordinarily rapid for the planet. It is

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We are pleased to announce the 2021 Uspekhi Forum

JOINT SCIENTIFIC SESSION OF DIVISION OF PHYSICAL SCIENCES, DIVISION OF CHEMICAL SCIENCES, DIVISION OF EARTH SCIENCES AND DIVISION OF ENERGETICS, MACHINERY, MECHANICAL ENGINEERING AND CONTROL PROCESSES OF THE RUSSIAN ACADEMY OF SCIENCES

Uspekhi Forum on Climate Change and Global Energy Issues

Tuesday, January 19, 2021, 8:00 pm (GMT+3)
www.uspekhiforum2021.org



Alexander Sergeev
(Russia, Co-chair)
President of the Russian Academy of Sciences

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Toshiki Tajima
(USA, Co-chair)
Norman Rostoker Chair Professor,
University of California, Irvine

This important event which will include several international scientists who have been spearheading research on climate change and/or its associated energy issues and possible solutions. Our Forum is an three-hour meeting at the Russian Academy of Sciences in Moscow on January 19, 2021 at 8:00 pm. This meeting will include 10 talks. Key speakers of the conference:

 <p>Stepan Kalmykov (Russia, Acting Dean of the Chemistry Department, Moscow State University) «Novel strategy for nuclear energy generation»</p>	 <p>Igor Semiletov (Russia, Head of the Arctic Research Laboratory, Pacific Oceanological Institute, Far Eastern Branch of the Russian Academy of Sciences) «Coupling between climate change and permafrost thawing in the Arctic land-shelf system: current understanding»</p>
 <p>Zinifer Ismagilov (Russia, Scientific Director, Federal Research Center for Coal and Coal Chemistry, Siberian Branch of the Russian Academy of Sciences) «Local and Global Climate change impact of coal mining, storage, transportation, processing and power generation»</p>	 <p>Michl Binderbauer (USA, Tri Alpha Enterprises, CEO) «Fusion Energy Solutions»</p>
 <p>Philippe Drobinski (France, Research Director, Ecole Polytechnique of France) «Integrating climate variability and change in renewable energy planning»</p>	 <p>Allen Weeks (Belgium, Director General, The Extreme Light Infrastructure) «Sustainable Research and Operations at the Extreme Light Infrastructure: Meeting the Challenges of the 21st Century at Europe's Large-scale Laser Facility»</p>
 <p>Eric Rignot (USA, Donald Bren Professor, Earth System Science, University of California, Irvine) «Impact of global warming on sea level and solutions»</p>	 <p>Katherine Mackey (USA, Assistant Professor of Earth System Science, University of California, Irvine) «Our Changing Oceans: Exploring causes, consequences, and solutions»</p>
 <p>Ning Li (USA, Managing Director, Transform Insight Partners) «New Paradigm for Civilian Nuclear Energy – Perspectives from Energy Hierarchy and Fundamental Safety»</p>	

The reviews and papers based on the talks to be given at the Forum "USPEKHI-2021" will be published in one of the issues of the journal "Physics–Uspekhi" ("Uspekhi fizicheskikh nauk")

The Organizers and the invited speakers of the Uspekhi Forum of Climate Change and Global Energy Issues (January 19, 2021)

possible that some of the already started processes are characterized by positive feedbacks (for example, when the ice cover melts in the Arctic, the absorption of solar energy by the Earth increases, which leads to a further increase in temperature and further melting of ice). In such conditions, climate control simply by reducing the anthropogenic load may turn out to be a late measure, and we need to rely on the Earth's own adaptive capacity to stabilize the climate through the manifestation of other natural processes with negative feedbacks.

Perhaps the most definite conclusion that can be drawn today in connection with the predictions of the future of our planet until the end of this century is that it is necessary to multiply our efforts and resources to study the processes of natural and man-made origin that determine climatic

changes. As much experimental data and information as possible is needed from ground-based, atmospheric, marine, and space monitoring with detailed spatial and temporal resolution. The highest computing power available is required for data analysis and climate model calculations. With the help of scientific arguments, we must figure out as early as possible whether the planet Earth, with our help, will be able to adapt to the sharp endogenous impulse in its global state, or whether there will be a departure into hitherto unknown states of the planet, which can threaten humanity with the most dramatic consequences.

Based on the recognition of the above, diverse recent efforts are based on the work of prominent scientists who contributed to the betterment of the environment by pursuing novel, cleaner, and safer approaches. In this Uspekhi Forum

on Climate Change and Global Energy Issues held at the Russian Academy of Science on January 19, 2021, co-organized by Prof. Alexander Sergeev (President of the Russian Academy of Sciences) and Prof. Toshiki Tajima (Norman Rostoker Chair Professor of the University of California at Irvine), we explore both the current climate changes and our possible solutions in the realm of energy. We note that in our human civilization, an overwhelming majority of human efforts have been invested into the betterment of our living standard by improving what may be called our ‘kitchen side’ (the entry side of food and energy) through constant development, from steam engine to nuclear reactors, etc., while we humans often left our ‘toilet side’ (the exhaust side of food and energy cycle) neglected, resulting, e.g., in medieval pest pandemics due to the foul city environments. Thus when one of us (TT) was appointed as Director General of the Kansai Research Establishment of Japan Atomic Energy Research Institute (2002), he advocated for the need for us to vigorously pursue what he called ‘toilet science’ in nuclear energy.

Nearly two decades later (including after the Fukushima 2011 and countless weather disasters), we currently face an even more precarious situation. At the Forum nearly equal shares of talks were on the current status of the climatic changes and on possible solutions to these situations. The list of speakers, in accordance with the Forum program, is shown on p. 1118.

For example, Prof. Katherine Mackey discussed the changing condition of oceanic environment, and Prof. Igor Semiletov demonstrated the arctic climatic changes such as permafrost melting. Prof. Eric Rignot discussed the sea level rise due to the global warming as well as Antarctic conditions. Prof. Zinifer Ismagilov mentioned the impacts of the coal mining and power generation on the local and global climate

changes. Prof. Philippe Drobinski presented an integrated approach to the climate changes and renewable energy. Both Prof. Stepan Kalmykov and Prof. Ning Li discussed novel approaches in nuclear energy. Prof. Toshiki Tajima brought up one approach of the ‘toilet science’ to reduce the nuclear waste by laser-driven photo-nuclear processes. Prof. Allen Weeks mentioned the new capability of his novel laser facility toward the sustainable energy frontier. Prof. Michl Binderbauer presented their vision and progress in adopting aneutronic fusion as a solution to the global crisis we face.

In this special issue of *Physics–Uspekhi* (*Phys. Usp.* **65** (11) 1113–1208 (2022)), we publish review articles based on the talks given by P Drobinski (see p. 1119), E Rignot (p. 1129), Z R Ismagilov (p. 1139), N Li (p. 1155), S N Kalmykov (p. 1188), and T Tajima with collaborators (p. 1193) at the ‘Uspekhi-2021’ Forum. The program announced for the ‘Uspekhi-2021’ Forum is shown on page 1116 as it was published in the January (2021) issue of *Physics–Uspekhi*, available at www.ufn.ru (also see <https://youtu.be/pdkPTU6Lt-Y> and <https://ufn.ru/ru/articles/2021/1/a/> for the video recording of the Forum).

We remain very grateful to all the presenters and the authors of review articles, in particular, for their tremendous effort in their pioneer research. Thanks to them, this Forum emerged as a premier conference on this subject. As mentioned above, our Forum in fact preceded important epoch-making events (including the 2021 Nobel Prize award). We are also grateful to the Editor-in-Chief of *Physics–Uspekhi*, Prof. Valery Rubakov, for having graciously accepted these papers for his prestigious review journal. We are also thankful to Prof. Valery Bukhtyanov, Dr. Sergei Malenko, Mr. Sergei Sharakshane, Mr. Sergei Polikarpov, Ms. Ekaterina Vtorushina, Ms. Alison Lara, and Ms. Jan Strudwick for help.

At the last stage of our special issue editing, we became aware that the Editor-in-Chief, Professor Valery Rubakov just passed away. We mourn his untimely death and convey our condolences to his family on behalf of all the authors of this issue of *Physics–Uspekhi*.