UDC 31

Formation of political advantage based on earth sounding from education

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Abstract

The practical problem of assessing risks from space weather impacts of different scales has determined the attention of different users - from government agencies to individual citizens-to this problem. In response to these requests, the scientific community established a group of experts to develop an international programmed of action that identified priorities for research, development and monitoring of space weather in the near and long term.

The review, prepared by the ILWS team, includes a roadmap of agreed actions in three areas: observations and modelling, the creation of a research environment, and the system of interaction between space agencies and users. The idea of the authors consists in the integration of scientific and engineering approaches, on the basis of which a reliable forecast and development of requirements for the design of technological systems (power grids, satellite groupings, navigation and positioning systems, radio communications) is possible. Specific recommendations relate to the use of existing instruments, the development of new ground-based and space-based tools, and the organization of monitoring. At present, we are witnessing a rapid transition from individual studies of processes in near-earth space to the creation of a complete monitoring system based on highly accurate coordinated measurements.

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Keywords

Politics, space, practice, structure, dynamics, development.

Introduction

It is noteworthy that some of them did not meet expectations: obtaining unique structural States during the solidification of highly cooled melt was more productive on Earth. (Note that research using levitators continues in different laboratories in the hope of achieving unique results).

Among the areas of physical and life Sciences works to be undertaken in the next decade, a significant role belongs to search for new ways to improve crystallization processes in space structure of crystalline materials, the characteristics of heat and mass transfer in the liquid volume, the role of surface processes and the search for effective methods of implementation and external influences (vibration, electromagnetic stirring) for the receipt process. These destinations are among the most promising, at least based on the planned flight time to the ISS. Give some examples.

The research program MICAST (microstructure formation during casting of industrial alloys under convection and magnetic field mixing) is designed to clarify the role of gravitational convection and electromagnetic mixing on the structure and properties of industrial aluminum alloys. It was performed first on sounding rockets, and then on MSL equipment on the ISS.

Main part

The aim of the MONOPHAS project was to create the basis to produce monothectic alloys (i.e., with the immiscibility region), where the components differ greatly in density. This project used AlZnBi alloys for later use in the production of bearings.

Full-scale modeling of directed crystallization processes on transparent model substances is implemented on the American French equipment DECLIC, which allows direct observation of the dynamics of the solidification process.

Dozens of other experiments are devoted to the peculiarities of fluid motion, phase separation, problems of influence on fluid flows, thermocapillary convection, modeling of geophysical processes. A summary of the results of the work is given in the reviews [Brett, 2016]; [Gökarıksel, 2018]; [Kingwell, 2009]; [Janzen, 2002]; Merrill, 2004], as well as in the reports of space agencies.

Depending on the results of these studies, the prospects for finding directions for further material science work in space will become clear. Among them, in particular, are the processing and production of practically important structural materials for the space construction of habitable modules, functional materials for life support, etc. In other words, the next 10 years (the period of active existence of the ISS, as well as the time of implementation of unmanned missions) should answer the question whether considerations about the prospects of crystallization methods will become experimentally confirmed foundations of new space technologies.

Priority directions of development of life Sciences in space and forms of cooperation are fixed at the level of the international working Group (ISLSWG) (the last update of the Strategic plan-2010) [Wang, 2015]. In the center of attention of this plan: the General biological problem-knowledge of a role of gravitation in functioning of biosphere, its experimental basis-clarification of mechanisms of influence of microgravity and other factors of space flight at cellular and molecular levels of the organization of living systems, and also on genetic stability, growth, development, reproduction, life expectancy and aging, behavior and orientation of plant and animal organisms in the first and subsequent generations. Research is expanding into the processes associated with the origin, evolution and spread of life in the Universe. The priority areas also include the search for ways to identify and predict biological changes on the Earth on a regional and global scale and to assess the consequences of these changes for the functioning of the biosphere.

In connection with the significant expansion of research on Mars, future human missions to the moon and Mars and his long stay outside the Earth in conditions of different gravitational loads, research on the functioning of human physiological systems – cardiovascular, muscular, skeletal, nervous and endocrine-and their regulation in space flight and ground experiments simulating micro — and hypergravity conditions will continue. The purpose of this work program is to understand the mechanisms underlying the long-term adaptation of man to these conditions, to identify the range of risk to life and work in space and to develop ways to reduce it [Clancy, 2014].

Among the numerous programs in the field of human health, we will highlight the problem of bone loss due to being in microgravity, as well as a deficit of musculoskeletal loads (hypokinesia). It is of great importance for terrestrial medicine, and osteoporosis is considered one of the "diseases of civilization" (according to who, the number of cases in the world by 2025 is estimated at 40 million people, and the cost of treatment and complex social consequences will be 120 billion euros [Mwale, & Lintonbon, 2019]). This is a Prime example of the "terrestrial" application of space exploration, as is the more General possibility of simulating aging processes in space flight.

Here is a sample of the most significant studies of European and American researchers on life Sciences programs.

ESA organizes a long-term program in the field of life Sciences and fundamental physics ELIPS (European Program for Life and Physical Sciences), which includes all of the above experimental facilities, but is mainly focused on the ISS [Gilley, 2014]. Thus, in the field of plant biology in conditions of altered gravity from 2006 to 2016, several cycles of experiments (MULTIGEN, Genara-A, Seeding Growth-1) were conducted, demonstrating the influence of different levels of gravity and stimulating radiation on the development of seeds, the intensity of growth of roots and shoots. In the field of cellular and molecular biology, long-term experiments have been conducted to study endothelial cells (responsible for the body's blood supply); the NMES and UVEC experiments used different types of endothelial cells to develop recommendations for the treatment of vascular diseases and countermeasures in space and on earth. In the field of astrobiology, a series of long-term (up to 22 months) experiments on exposure of various objects (spores, bacteria, organic compounds, microorganisms) on a specialized platform Expose-R. Some of the results (in particular, according to the program VUMEH) on the survival of objects were unexpected, for example, after comparing the data of ground modeling and space experiments. These results are used as the basis for the selection of objects for the EXOMars mission.

In the United States, the ISS has the status of a National laboratory of the United States, within which the following programs are prioritized [Underthun, Kasa, & Reitan, 2011]:

– Studies of protein crystallization by several pharmaceutical companies in the interest of improving the properties of drugs.
– Rodent research by pharmaceutical companies and academic institutions to better understand bone and muscle diseases and test potential drugs.
– Cell culture experiments organized by The national institutes of health to study osteoporosis and immunodeficiency.
– Stem cell experiments by leading academic and non-profit institutions to improve the treatment of cardiovascular disease.
– Biotechnological experiments using the unique effects of spaceflight to study fluid dynamics, in the interest of developing precision medicine by improving diagnosis and drug delivery.

– A model organism study sponsored to explore the possibility of reusing existing drugs for other purposes.
– Research of fundamental principles of plant biology.

Research in the field of fundamental physics includes several different directions, which are determined by the fundamental role of suppression of manifestations of gravitational interaction [Kanyinga, 1998; Roberts, & Roberts, 1986]. These unique conditions allow us to propose new tests of the fundamental principles of General and special relativity and quantum theory, plasma physics, to study critical phenomena in heterogeneous systems, transport phenomena in liquids, and to develop a fundamentally new metrological technique.

Long-term efforts in the field of dust plasma physics were made by the Russian-German team of researchers within the framework of the projects "Plasma crystal" (RK-3, RK-4). The results of experiments and simulations provide unique information about the dynamics of atomic processes in liquids and gases and some applications in the field of semiconductor technology. The structure, which is called a Coulomb or plasma crystal, is like the spatial structures in a liquid or solid. The unique properties of plasma crystals (ease of obtaining, observing and controlling parameters, as well as small relaxation times to equilibrium and response to external perturbations) make them a promising object of study of both the properties of strongly non-ideal plasma and the fundamental properties of crystals. The results will be used to model really atomic or molecular crystals and to study physical processes involving them. In orbital conditions, it is possible to cool matter to extremely small values due to the reduction of the deposition time of individual atoms in conditions close to weightlessness. In orbit, the effect of cooling the particles will last about 10 seconds, while on Earth it lasts a fraction of a second. The cold Atom Lab, A laboratory of cold atoms, has been delivered to the International space station, which will allow a unique experiment to freeze particles of matter to a temperature close to absolute zero. After cooling, the combined action of lasers and electromagnets will slow the atoms to a nearly stationary state. This will make it possible to observe matter under special conditions to study quantum effects.

The metrological section of physical experiments in space is represented by atomic clocks – the most accurate time meters based on the transitions between the energy levels of atoms. Standard atomic clocks working with hot atoms give an error of measuring the frequency of the transition of an atom of about 10“14. However, the error of the clock with cold atoms (cold atomic clock, CAC) can be up to 10“18. The first-generation atomic clocks of space applications achieved measurement accuracy > 10“15 (PARCS (Primary Atomic Reference Clock in Space, RACE-Rubidium Atomic Clock Experiment). The next project of the new space atomic clock DSAC (Deep Space Atomic Clock) on the ISS will improve this figure to 10 7. This watch is based on a laser cooling technique: atoms trapped in a magneto-optical trap are slowed down and cooled by lasers to about 1 MK. On the basis of such watches, a set of experiments to test the basic physical laws is being prepared.

Microgravity conditions allow to significantly reduce the level of gravitational convection in liquids and mixtures and to obtain fundamental data in the field of fluid dynamics. In particular, the European space Agency (IVIDIL, DSC, DSMX-1,2) carried out an extensive set of experiments in the field of diffusion processes and vibration effects; data on diffusion coefficients, thermal diffusion (Soret coefficients), as well as on the role of low-frequency vibration in mixing processes were obtained. In the absence of gravitational convection, it was possible to study the features of vibrational convection as a method of controlling the movement of liquids in space conditions.

In the interests of a huge number of users largely determines the answer to the question " Why Space?". In the space programs of most States, the development of technologies and their use in the interests of consumers are assigned to priorities, and terrestrial applications are not considered as a by-product that justifies the main space activities [Корчагин, Жданов, Чирков, 2015]. The very definition of space activities was adjusted a few years ago and now includes not only the creation and use of space facilities, but also related activities that use information, services and technologies of space origin. This reflects the real state of those spheres of "terrestrial" activity, which today are unthinkable without the space component (weather forecasts, navigation, environmental monitoring, transport management, energy, precision agriculture).

Today, new devices, materials and services based on the use of space technologies have become an integral part of everyday life of citizens: from car navigation systems and satellite television to mobile Internet, Teflon pans and bar code on goods in the supermarket [Featherstone, 2012]. A significant part of space programs is aimed directly at meeting the needs of the earth. The creation of new communication, navigation and monitoring systems is considered, in particular, in European programs as tools to improve the quality of life, personal freedoms and security of citizens. Such a policy has become possible at the present stage as a result of the development of practical Astronautics and the transition from the demonstration stage of the use of space technology to the regime of regular operation of orbital and ground infrastructure [Stepputat, 1994].

The flow of space (and military) technologies into civilian sectors (spin-in) and in the opposite direction (spin off) contributes to meeting new needs. These processes determine the growing role of the space economy, which is developing rapidly and increasingly affects the development of other industries. The emergence of new markets is one of the most visible consequences of the spread of space technologies. Thus, over the past 10 years, the markets of Geoinformatics, satellite navigation and the Internet have more than doubled [Hudson, & Marvin, 2011]. At the same time, the economic center of gravity is shifting from the creation of space products directly (creation of space orbital and ground infrastructure, provision of satellite communications, sale of "raw" space images) towards derivative markets. Some of the economic consequences of innovation and the emergence of a "new economy" are discussed in Chapter 4.

In this Chapter, the main emphasis is placed on the use of technologies that decisively change the traditional spheres of human activity, expand the possibilities of solving earthly problems. In a short period of time, satellite observations of the earth and oceans, space navigation and communication systems have provided humanity with fundamentally new opportunities. However, it is necessary to realize that today's technological advances use a very small part of the resources provided by the space environment. Different forecasts indicate different dates of when promising areas (energy, minerals, colonies and space industries) will become objects of technological development. At the same time, the space policy documents of developed countries already consider space exploration as a necessary condition for the innovative development of the economy, and space technologies as a tool for solving global and national problems.

Satellite observations of the earth and oceans

Like many other applications, satellite observations of the earth's surface and near-earth space have evolved from military programs [Turam, 2013]. The first earth remote sensing satellite (ERTS), launched in 1972 and originally intended for military purposes, marked the beginning of the Landsat series, which was a milestone in Earth observations. In Europe, regular earth observations from space began with the launch of the Meteosat spacecraft in 1977 and the ERS-1 and ERS-2 remote sensing satellites, followed by Envisat. Satellites (as well as aircraft) use remote sensing technology, which is based on the use of sensors that analyze electromagnetic radiation without physical contact with the objects of study [Pugh, 2005]. In principle, this technology is similar to that used to study other planets, only the object of study is the earth's surface. Satellite data can serve as a basis for further analysis, or are integrated into mathematical models describing various terrestrial processes [Fernandes, 2004].

The growing use of remote data is due to several circumstances. First, it is their objective and independent nature. Secondly, the ability to permanently record information allows you to represent a set of individual measurements and information products based on them in the form of digital satellite maps [Hofman, 2015]. A three-dimensional dataset provides a continuous spatial representation of the observational area that is integrated into models or geographic information systems in conjunction with other data types. Thirdly, the possibility of regularly repeated measurements of the same sites allows us to identify the dynamics of a wide range of changes caused by natural processes or human activities. Finally, the rapid access to satellite data contributes to the emergence of new applications [Marino, 2011].

The use of satellite information obtained with the help of modern Earth observation technologies has gone through several stages. Since the 1980s, major progress in this area has been associated with the emergence of previously impossible repetitive measurements of high quality for large areas. The first step was meteorological remote sensing from geostationary orbit, with which almost all real-time weather forecasts are currently compiled. Satellite observations of catastrophic events (forest fires, floods, earthquakes) have become an important resource for minimizing losses and supporting humanitarian missions [Pierre, 2014]. Global observations have made it possible to assess the negative impact of human activities and natural factors on the most important ecosystems on Earth: tropical forests, dry areas (desertification), temperate forests, oceans and coasts (transport of matter, El Nino).

In the late 20th and early 21st centuries, there were qualitative changes in the technologies of remote sensing of the Earth (ERS): there were spacecraft with shooting systems of a new generation, allowing to obtain images with ultra-high spatial resolution (up to 41 cm from the satellite GeoEye-1). Surveys are conducted in hyperspectral and multi - channel multi-spectral modes. The main trends of recent years are the emergence of new ultra-high resolution satellites with improved characteristics (for example, the French Pleiades system), the development of the concept of operational and global survey of the earth's surface with high resolution using small satellite groupings (grouping of German RapidEye satellites). In remote sensing technologies, in addition to traditional areas (improvement of spatial resolution, addition of new spectral channels, automation of processing and operational data provision), there are developments related to operational video shooting of objects from space (for example, the development of SkyBox Imaging, USA) [Tonkiss, 2018].

In 2005, the international community (60 governments) announced the creation of the GEOSS (Geo Earth Observation System of Systems), which marked a new stage in the development of global monitoring and the use of satellite information for critical applications (weather forecasting, climate change, energy, water, land, biodiversity, disaster management, agriculture). Subsequent events-the adoption of the second ten-year implementation plan (2016-2025), the increase in the number of participants to more than 100 countries, the positive results of many projects-have shown that this initiative is becoming the dominant trend in the global monitoring system [Misra, 2012].

The political initiative of the leading space powers has proved attractive to most participants in space activities, and existing international projects and initiatives (such as CEOS - Committee for satellite observations of the Earth, IGOS-Integrated global observing strategy, GCOS-global climate observing system, GOOS-global ocean observing system, GGOS-global geodetic observing system, etc.) are gradually evolving towards the components of GEO or closely cooperate with it. Even the self-sufficient European project (one of the flagships of the European space policy) COPENICUS defines its activities as a contribution to GEOSS. The initial idea of the new international metaproject was to extend the experience of the world meteorological organization, WMO, to all earth surface monitoring activities. In the course of implementation of this idea it was possible to turn the General slogan — satisfaction of needs of users — into concrete technological decisions and new organizational structures (among the last we will allocate the initiative of creation of EuroGEOSS).

GEOSS [Barbosa, & Pereira, 2018] can be characterized as an embodied idea of the modern paradigm of space activities: the end product is user-oriented services, and the created technologies are based on the most effective innovative solutions. First of all, it is the reduction of risks and the preservation of people's lives in disasters and disasters, the control of the environment, new opportunities for managing energy, water and land resources, ensuring reliable weather forecasts and predictions of the consequences of climate change [Kallianos, 2013]. A new level of efficiency in solving these vital problems is achieved not so much by the capabilities of satellite systems (although this is a necessary condition), but by a combination of terrestrial and satellite methods, fundamental improvements in ecosystem models, and the creation of information services to directly provide users.

A new methodology for providing information services (the so-called NEXUS approach) is causing a revolution in the technology of data use [Holifield, 2018]; Weeks, 2004]. We are talking about the Big Data problem, which is caused not only by a large amount of data, but also by their heterogeneity, the necessary speed of processing, filtering, documenting its quality and uncertainties, as well as the requirements for visualization [Monga, 2000]. This problem, which arises in various fields of modern science, is directly related to GEOSS-an integrated system on a large scale, consisting of many independently functioning subsystems, but connected in the interests of solving common problems. The solution is proposed in the framework of the creation of EuroGEOSS and provides for the organization of an intermediary (broker) subsystem-DAB (Discovery and Access Broker), which provides an interface between users and providers [Butler, 2009].

One of the most ambitious goals of GEOSS in the ten-year plan (2016-2025) is to monitor the UN sustainable Development goals (SDG — Sustainable Development Goals). It is expected to track 100 global monitoring indicators, as well as additional national indicators, which together represent the entire spectrum of sdgs related to the environment [Mitchell, Attoh, & Staeheli, 2015]. The solution of this large-scale task, first, faces the mentioned Big Data problem and causes fundamental changes in the use of space monitoring data. Whether it will be possible to build a technological chain from observational data to models of geosystems, and from them to indicators of sustainable development and further to management and political decisions will be shown by the results of several international teams of specialists by 2030.

Conclusion

The international constellation of meteorological and geostationary satellites coordinated by the European members of EUMETSAT, the USA, China, India, Japan, South Korea and the Russian Federation (DMSP, NOAA, MetOp, JPSS series) is of fundamental importance for monitoring weather and climate change. A high level of interaction has been achieved between these countries, which allows to optimize the observation process, calibrate data (within the framework of the Global information calibration system, GSICS), allocate orbital resources (joint us-European polar satellite System, JPS), exchange results (agreement between Europe and China).

The solution of global and regional problems implies a new level of modeling, the requirements for which (as well as for the quality of satellite data) are formulated in the analytical review. The group of experts on behalf of COSPAR prepared a fundamental review of the state and prospects of monitoring of geosystems for the period up to 2025, as well as a roadmap for the development of all components from the point of view of users.

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Формирование политического преимущества на основе зондирования земли от образования

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Аннотация

В работе показано, что педагогическая проблема оценки рисков от воздействия космической погоды различных масштабов определила внимание различных пользователей - от государственных учреждений до отдельных граждан - к этой проблеме. В ответ на эти запросы научное сообщество (COSPAR совместно с международной координационной группой International Living with the Star, ILWS) учредило группу экспертов для разработки международной программы действий, в которой были определены приоритеты для исследований, разработок и мониторинга космической погоды. в ближайшей и долгосрочной перспективе.

Обзор, подготовленный группой ILWS, включает дорожную карту согласованных действий в трех областях: наблюдения и моделирование, создание исследовательской среды и системы взаимодействия космических агентств и пользователей. Идея авторов заключается в интеграции научно-технических подходов, на основе которых осуществляется надежный прогноз и разработка требований к проектированию технологических систем (электросетей, спутниковых группировок, систем навигации и позиционирования, радиосвязи).) возможно. Конкретные рекомендации касаются использования существующих инструментов, разработки новых наземных и космических инструментов и организации мониторинга. В настоящее время мы наблюдаем быстрый переход от отдельных исследований процессов в околоземном космическом пространстве к созданию полной системы мониторинга, основанной на высокоточных скоординированных измерениях.

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Ключевые слова:

Политика, пространство, практика, структура, динамика, развитие.

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