

**Ministry of Science and Higher Education
of the Russian Federation**

2025

ANNUAL REPORT



**St. Petersburg Federal Research Center
of the Russian Academy of Sciences**

**St. Petersburg
2026**

Ministry of Science and Higher Education
of the Russian Federation

ST. PETERSBURG FEDERAL RESEARCH CENTER
OF THE RUSSIAN ACADEMY OF SCIENCES
(SPC RAS)

ANNUAL REPORT
2025

St. Petersburg
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The publication includes the main results of the St. Petersburg Federal Research Center of the Russian Academy of Sciences – scientific, organizational, educational, publishing and production activities in the field of computer science, robotics, nature management and agriculture in 2025.

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GENERAL INFORMATION

The St. Petersburg Federal Research Center of the Russian Academy of Sciences (SPC RAS) is established in accordance with the orders of The Ministry of Science and Higher Education of the Russian Federation of December 18, 2019 No. 1399 and of July 08, 2020 No. 768 (information about the organization is entered in the Unified State Register of Legal Entities (USRLE) by the Federal Tax Service on July 17, 2020 No. 2207803466891) through the reorganization of the St. Petersburg Institute for Informatics and Automation of the Russian Academy of Sciences (SPIIRAS) in a form of joining:

The Federal State Research Institution “North-West Research Institute of Agricultural Economics and Rural Development” (IAERD);

The Federal State Research Institution “North-West Centre of Interdisciplinary Researches of Problems of Food Maintenance” (N-W CIRPFM);

The Federal State Institution of Science “St. Petersburg Scientific Research Centre for Ecological Safety of the Russian Academy of Sciences” (SRCES RAS);

The Federal State Institution of Science “Institute of Limnology of the Russian Academy of Sciences” (IL RAS);

The Federal State Research Institution “Novgorod Scientific Research Agriculture Institute” (NSRAI – Branch of SPC RAS).

According to the Charter the SPC RAS (the SPIIRAS successor) was founded as Leningrad Research Computer Center of the USSR Academy of Sciences by the Decree of the Council of Ministers of the USSR of December 19, 1977 No. 2643-p and the Decision of the Presidium of the USSR Academy of Sciences of January 19, 1978 No. 194.

The scientific and methodological management of the SPC RAS activities is performed by RAS through: St. Petersburg Branch of RAS, Department of Nanotechnologies and Information Technologies of RAS, Department of Earth Sciences of RAS, Department of Agricultural Sciences of RAS.

According to the Resolution of the SPbB RAS Presidium dated May 22, 2024 No. 16, SPC RAS is included in the List of organizations comprising the Joint Scientific Council for Applied Sciences and Technological Industrial Development of the SPbB RAS.

SPC RAS is headed by the Director: Andrey L. Ronzhin, Doctor of Technical Sciences, Professor, Professor of RAS, appointed by the Order of The Ministry of Science and Higher Education of the Russian Federation of February 19, 2024 No. 10-2/48 p-o based on the Minutes of the labor collective General Meeting of November 24, 2023.

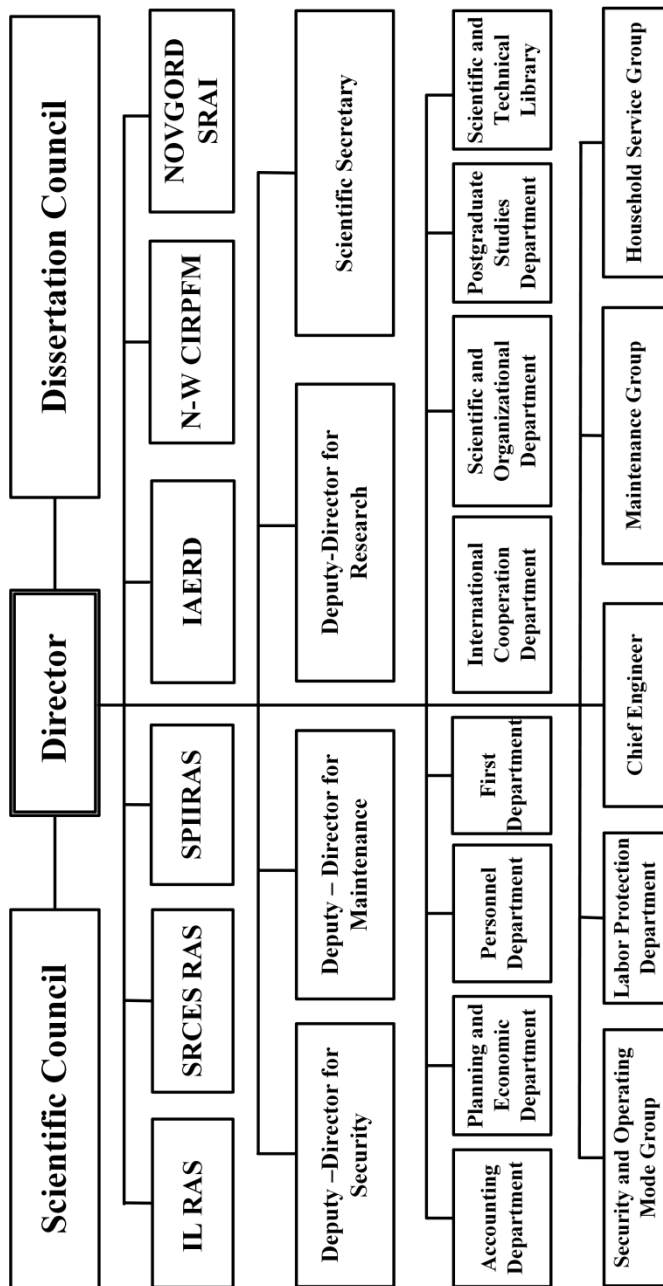
The Scientific Secretary of SPC RAS is Alexandra A. Zaitseva, Candidate of Technical Sciences.

The Deputy Director for Research is Sergey V. Kuleshov, Doctor of Technical Sciences.

The purpose and subject of SPC RAS activities are basic, exploratory and applied research aimed at acquiring new knowledge in computer science and automation, management methods and information and communication technologies, environmental safety, environmental protection, food security, economy and organization of the agro-industrial complex, contributing to its technological, economic and social development, implementation of scientific advancements and best practices, training of highly qualified professionals.

SPC RAS takes the experience and the heritage of the united scientific organizations and successfully continues research aimed at developing and implementing strategic digital technologies and robotic systems designed to increase the efficiency of managing processes responsible for the socio-economic development of the North-West region of Russia, as well as ensuring security and enhancing the citizens' life quality.

Digitalization, ecology, agriculture form the core scientific research topics of the Center and correspond in importance to global trends. The institutes and centers involved in the SPC RAS establishing have unique scientific groundworks, as well as human resources to implement the tasks of food, environmental and information security.



Research Activity

Basic, exploratory and applied research and developments are done in the following areas in accordance with the SPC RAS Charter:

- fundamentals of information society development and the digital economy in Russia;
- fundamentals of complex modeling, automation of proactive monitoring and management of information processes in complex (info -, bio-, eco-, agro-, cogni-, socio-, geo-, aviation-space and transport) systems;
- fundamental and technological basics of artificial intelligence, big data, development of intelligent integrated decision support systems, multi-modal user interfaces in human-machine and robotic complexes;
- fundamentals and technological basics of information and cyber security, post-quantum cryptosystems;
- fundamentals of rational use of the territories' agricultural resources potential, conservation and reproduction of biological diversity of agricultural animals and crops to ensure food and environmental security of the Russian Federation;
- fundamental and technological basics for optimization of reclamation systems, construction and reconstruction of reclamation facilities that ensure the preservation of natural resources potential and increase the productivity of agro-landscapes;
- fundamentals and technological models aimed at effective management of the agroecosystems' production process based on adaptation, environment formation and biologization;
- fundamental and technological basics at cultivating economically expedient agricultural crops in order to create highly productive agro-phytocenoses;
- fundamental and applied technological basics of agricultural production that meet the needs of various population groups in a balanced high-quality agricultural raw materials for high-quality food supplies production;
- fundamental and applied basics of rational environmental management in the Arctic zone of the Russian Federation, given the

- first priority to production and consumption of locally produced food stuffs with a high level of environmental and biological safety;
- fundamentals of innovative and investment development of agricultural sectors and enterprises;
- fundamentals of integrative processes development in regional agro-industrial complexes;
- fundamentals of rural territories development, land relations and land use in the economy's agrarian sector;
- basic ecology-economic and legal problems for ecological safety ensuring;
- fundamentals of ecosystem health assessment and maintenance, methods for their state diagnostics and prompt warning an occurrence of threats to ecological safety;
- fundamental and applied basics of transformation and migration of ecotoxins in the environment;
- basic and applied research of life cycles of natural and economic systems and objects of past environmental damage, methods and processes of rehabilitation of disturbed and polluted ecosystems and man-made landscapes, waste management systems;
- basic research on the origin, evolution, functioning, sustainability, and lakes restoration in different physical and geographical zones;
- development of the theory of eutrophication and pollution of internal water basins, formation of their water quality and scientific forecast of these processes based on long-term studies, accounting for natural, climatic and anthropogenic factors;
- research fundamentals for assessing and forecasting trends in the natural resource potential of the Russian Lake Fund, its protection and rational use, accounting for the socio-economic regions' development;
- basic and applied complex research of Lake Ladoga – the Neva river – the Gulf of Finland system as a geostrategic water object.

Within the Government Order approved by The Ministry of Science and Higher Education of the Russian Federation in 2025 SPC RAS worked on 18 State Budget tasks:

- Models, methods and technologies of digital transformation of the Russian society and economy under a ubiquitous use of artificial intelligence systems and robots (SPIIRAS).

- Development of theory and technology basics to analyse non-structured data and multimodal users' interaction, intelligent support of decision-making in digital communities (SPIIRAS).
- Development of methodology, methods and intelligent technologies to ensure the viability of existing and prospective domestic integrated state and commercial information management and telecommunication systems, networks and supply chains at various stages of their life cycle (SPIIRAS).
- Theoretical fundamentals and advanced technical solutions for seamless control of the UAVs group within non-deterministic environments when performing agricultural tasks (SPIIRAS).
- Theoretical fundamentals and new technical solutions for proactive behavior management of corporate socio-cyberphysical systems based on the heterogeneous big data analysis (SPIIRAS).
- Methods of intelligent furnishing the cybersecurity in socio- and cyber-physical systems and their practical applications (SPIIRAS).
- Development of theoretical and technological fundamentals for storing and systematization of the author's heritage and automation of philological, source studies and bibliographic research at the creation of the scientific and enlightenment resource "Pushkin digital" (SPIIRAS).
- Theoretical and technological fundamentals in the personalized users' service of financial, technical and sociooriented systems implementing generative models for processing multimodal data and digital footprints (SPIIRAS).
- Theoretical and technological basics of personalized service for users of financial-technical and socially-oriented systems using generative models for processing multimodal data and digital traces (SPIIRAS).
- Topic 31.1 (SPIIRAS).
- Topic 31.2 (SPIIRAS).
- Topic 31.3 (SPIIRAS).
- Research approaches, priority lines and mechanisms for the sustainable development of agro-industrial production, accounting at that for the processes of digitalization of the economy, improving supply chains and land management systems, and ensuring the

growth of life standards and quality for rural populations in the North-West macro-region (IAERD).

- Improvement of the scientific and technological fundamentals in the production of high-quality crops and reindeer products on the principles of adaptability, nature likeness and environmental safety in the Russia North-West and the Arctic zone of the Russian Federation (N-W CIRPFM).
- Development of theoretical and technological fundamentals for increasing agricultural production under the climate change in the Novgorod region to ensure food security and import substitution (Novgorod Research Agriculture Institute).
- Studying the processes of distribution, accumulation and transformation of new and little-studied ecotoxins in ecosystem components, assessment of their impact on living organisms at the cellular and population levels (SRCES RAS).
- Development of methods for monitoring the ecosystems health in the North-West of Russia (SRCES RAS).
- Ecosystems of Lake Ladoga, its basin reservoirs and surrounding territories under the influence of natural and anthropogenic factors against the background of climatic changes (IL RAS).
- Current threats to water bodies and innovative methods of their conservation, restoration and rational use (INOZ RAS).

Research done in 2025 on 72 projects encompassed: 37 projects – on the grants of the Russian Science Foundation and the grants of the St. Petersburg Science Foundation (including 2 international ones); 35 projects – on the grants and projects of the Russian ministries, services and other.

The following organizations acted as customers:

“The Khrunichev State Research and Production Space Center”; “Transoil” LLC; The Interparliamentary Assembly of Member Nations of the Commonwealth of Independent States (IPA CIS); Kaliningrad State Technical University; The Karelian Research Centre of RAS (KarRC RAS); “bcc” LLC; “Surgutneftegas” PJSC; ITMO University; “Lengiprotrans” JSC; “ECOS SECURITY RUS” LLC; “Transneft Primorsk Port” LLC; “SPESHEMSERVICE” LLC; “GAZINFORMSERVICE” LLC; “INTEKHEKSPERTIZA” LLC; “Gazprom Neft” PJSC; “Sberbank” PJSC; “Russian Presidential Academy of National Economy and Public Administration” (RANEPA);

“KHLEBNIK” LLC; Yaroslavl “Demidov” State University; A.N. Tupolev Kazan National Research Technical University (KNRTU-KAI); “KINO-ALIANS” LLC; “Giprosvyaz Consulting” PJSC; “NORTHERN CAPITAL AIR GATE” LLC; “IIS” LLC; “LINTEX” LLC; Lobachevsky State University of Nizhny Novgorod (UNN); Leningrad Region FSI “Vyborg Region Animal Disease Control Station”; “SPRUT” LLC; “SEDLICKIE” LLC; “AGRO-ALLIANCE” JSC; “DST-URAL” LLC.

In 2025, 277 of the Center professionals attended 162 conferences, published over 700 scholarly articles, including:

- 71 publications indexed in the WoS system (of them 65 articles in professional journals, including 19 articles in Q1 journals);
- 193 publications indexed in the Scopus system (of them 144 articles in professional journals, including 32 articles in Q1 journals);
- 476 publications indexed in the RSCI system (of them 247 articles in professional journals included in the Higher Attestation Commission list, and 144 – in journals included in RSCI), 166 articles in the journals included in the version 2023 whitelist (of them 39 articles in the journals of the 1 level and 87 articles the journals of the 2 level)

Some results of the SPC RAS intellectual activity in the year of 2025: 5 patents for inventions, 2 certificates of state registration of Databases and 32 certificates of state registration of computer programs.

During 2025 the Center contributed to the organization of 12 international scientific conferences, proceedings of 5 of them are indexed in the international databases WoS/Scopus.

The Center employs over 450 staff members, including: 6 Honored Scientists of the Russian Federation, 3 Academicians of the Russian Academy of Sciences, 2 Corresponding members of the Russian Academy of Sciences, 2 Professors of the Russian Academy of Sciences, 55 doctors of sciences and 114 candidates of sciences.

Educational Activity

SPC RAS has a right to maintain education activities as stipulated by the programs for training research as well as scientific and pedagogical personnel in postgraduate and continuous education according to a perpetual license (registration number L035-00115-78/00096292 dated 02.09.2020) issued by the Federal Service for Supervision of Education and Science and also has a perpetual state accreditation for education

activities in the training directions (registration of October 21, 2020 No. 3436) and scientific specialities for the postgraduate students.

The training lines are as follows:

09.06.01 Computer Science and Engineering:

- direction “System analysis, control and information processing, statistics”;
- direction “Mathematic- and soft – ware of computers, computer complexes and computer networks”

10.06.01 Information Security:

- direction “Methods and systems of information security, information assurance”;

38.06.01 Economics:

- direction “Economics and national economy management”:
 - training profile – economy, organization and management of industries, complexes – agro-industrial complex and agriculture;
 - training profile – regional economy.

Group of scientific specialities 2.3. Information technologies and telecommunications (by scientific specialities):

- 2.3.1. System analysis, control and information processing, statistics;
- 2.3.5. Mathematic- and soft- ware of computers, computer complexes and computer networks;
- 2.3.6. Methods and systems of information security, information assurance.

Group of scientific specialities 5.2. Economics (by scientific speciality):

- 5.2.3. Regional and branch economics.

As of December 31, 2025, the post – graduate course counts 39 post graduate students.

Doctoral dissertation Council functions in specialities:

2.3.1. System analysis, control and information processing, statistics;

2.3.5. Mathematic and soft- ware of computers, computer complexes and computer networks;

2.3.6. Methods and systems of information security, information assurance. In 2025 one candidate theses in technical sciences had been defended.

SPC RAS administers two basic departments in the leading St. Petersburg universities as well as three joint research laboratories

Basic Departments:

- Research Automation at *The St. Petersburg State Electrical Engineering University, established in 1979.*

- Information Technologies in Logistics at *The St. Petersburg School of Economics and Management NRU HSE, established in 2018.*

Laboratories:

- R&D Laboratory of Information Technologies in Transport Systems, Power Engineering, Automation and Modeling Systems at *Mari State Technical University, established in 2012.*

- Virtual Joint Laboratory at *The Military Teaching and Research Center of the RF Air Force “Military Air Force Academy”, Voronezh, established in 2015.*

- Joint Research Laboratory for Robotic Systems’ Design and Programming at *The St. Petersburg State University of Aerospace Instrumentation, established in 2016.*

Sessions of the city seminar on “Informatics and Automation” at the Scientific Council for Informatization of St. Petersburg are regularly held by the Center under the leadership of Professor Osipov, V. Yu.; http://conference.spiiras.nw.ru/seminar_ICT/.

The Center keeps scientific and technical collection of computing equipment of SPIIRAS; the collection presents exhibits demonstrating the main directions of computer technologies development over preceding years. The collection history is inextricably linked with the history of establishing in 1974 the Computer Engineering Department at the Joffe Physical and Technical Institute (further LRCC, LIAN, SPIIRAN and SPC RAS). The Center occupies the building that used to be the Carl May School premises with the current museum of the same name. In 2025 The Museum celebrate its 30-th anniversary/ Among the Carl May School alumni: 40 members of the Russian Academy of Sciences and the Academy of Fine Arts, 156 Full Professors, two ministers, seven governors, four members of the State Council, twenty generals and admirals, three Heroes of Socialist Labor, two pilot-cosmonauts (G. M. Grechko and A. I. Borisenko).

Using the Museums' factual database the SPC RAS staff members run enlightenment and educational activities at the secondary and higher schools of St. Petersburg promoting, at that, the best scientific, pedagogic, cultural and ethical traditions of the Russian education and science.

Publication Activity

SPC RAS is a developer of an electronic editorial platform that provides automation of routine operations of publishers and editorial offices of scientific journals, transparency of the editorial process, generation of citation statistics and import/export of data to the global indexes and aggregators of scientific information. In 2025, the platform hosted 4 journals: 'Information and Control systems'; "Bulletin of Plant Protection", "Intelligent Technologies in Transport", "Informatics and Automation" also articles' processing for the proceedings of two international conferences: Interactive Collaborative Robotics (ICR), Agriculture Digitalization and Organic Production (ADOP) has been performed. SPC RAS is a co-founder of the journal "Izvestiya Russkogo Geograficheskogo Obshchestva".

Scientific Journal "Informatics and Automation"

Print media and online media – The journal "Informatics and Automation" (Proceedings of SPIIRAS) has been published since 2002, since 2016 is in the international database Scopus (CiteScoreTracker 2020: 1,9 SJR: 0,24), in the List of the Higher Attestation Commission since 2011, in RSCI since 2018, ISSN: 2713-3192, E-ISSN: 2713-3206. Subscription Index (Catalogue "Post of Russia"): P5513. Languages: Russian, English. Publication Frequency: 6 issues a year.

The journal main categories:

- Mathematical Modeling and Applied Mathematics.
- Artificial Intelligence, Data and Knowledge Engineering.
- Digital Information and Telecommunication Technologies.
- Robotics, Automation and Control Systems.
- Information Security.

In accordance with the nomenclature of scientific specialities approved by the Ministry of Education and Science of the Russian Federation through the order of February 24, 2021, No. 118 the journal publishes articles on the following specialities:

1.1.4. Probability theory and mathematical statistics (physical and mathematical sciences),

2.3.1. System analysis, management and information processing (technical sciences),

2.3.2. Computing systems and their elements (technical sciences),

2.3.5. Mathematical and software support of computer systems, complexes and computer networks (technical sciences),

2.3.6. Methods and systems of information protection, information security (technical sciences).

Full-text versions of the articles are available on the journal's website: <http://ia.spcras.ru>.

Profile of the journal Informatics and Automation in Scopus: <https://www.scopus.com/sourceid/21100793186>.

Scientific journal “Russian Geographical Society News”

Print media and electronic media – Journal "Izvestiya Russkogo Geograficheskogo Obshchestva" is published since 1865, in the List of the Higher Attestation Commission (VAK), indexed in the core of RSCI, ISSN: 2079-9705, E-ISSN: 2079-9713. Language: Russian. Publication frequency: 6 issues a year. The journal publishes articles on the speciality: 39.00.00 Geography.

The journal articles are available on the website of the Russian Geographical Society: <https://izv.rgo.ru/jour/issue/archive>.

Conferences Organized in 2025

- 33-rd International Conference on Parallel, Distributed and Network-Based Processing (PDP 2025), special session "Security in Parallel, Distributed and Network-Based Computing (SPDNBC)", March 12-14, 2025, Turin, Italy, <https://pdp2025.org/> (*Kotenko, I.V.*).
- XX Jubilee All-Russian Scientific and Practical Conference "Prospective Systems and Management Tasks» (Dombaj Conference), April 7-11, 2025, Dombaj, Karachay-Cherkess Republic, Russia, <https://psct.ru/>, (*Ronzhin, A.L.*).
- VI All-Russian Scientific and Practical Conference "Modern Tendencies in Development of Chemical Technology, Industrial Ecology and Environmental Safety", April 10-11, 2025, St. Petersburg, Russia, <https://vshte.ru/> (RSCI) (*Tronin, A.A.*).

- 5-th Jubilee International Conference on Agriculture Digitalization and Organic Production (ADOP – 2025), June 03-06, 2025, Barnaul, Altai Krai, Russia, <http://adop.nw.ru>. (Scopus, Springer, SIST, Q4). (*Ronzhin, A.L., Surovtsev, V.N.*).
- 11-th Interdisciplinary Workshop “Analysis of Spoken Russian” ASR-2025, June 30- July 01, 2025, St. Petersburg, Russia, jointly with SPbSU, (*Karpov, A.A.*).
- XI All-Russian Scientific and Practical Conference “Advanced Lines of Development in National Information Technologies” (PNROIT-2025), September 23-27, 2025, Sevastopol, Crimea, Russia, <http://pnroit.code-bit.com> (RSCI), (*Sokolov, B.V., Kasatkin, V.V.*).
- XXII National Conference on Artificial Intelligence with International participation, October 6-10, 2025, St. Petersburg, Russia, <https://rcai2025.raai.org/> (RSCI) (*Kotenko, I.V.*).
- 27-th International Conference “Speech and Computer” SPECOM-2025, October 13-15, 2025, Seged, Hungary, <https://specom.nw.ru/> (Scopus, Springer LNCS/LNAI, Q2) (*Karpov, A.A.*).
- 12-th All-Russian Theoretical and Practical Conference: “Simulation. Theory and Practice” (IMMOD-2025), October 15-17, 2025, St. Petersburg, Russia, <http://simulation.su/static/ru-immod-2025.html> (*Sokolov, B. V.*).
- XIV St. Petersburg Interregional Conference “Information Security of the Russian Regions (ISRR-2025)”, October 29-31, 2025, St. Petersburg, Russia, <http://spoisu.ru/conf/ibrr2023> (RSCI) (*Sokolov, B. V., Kasatkin, V. V.*).
- 9-th International Conference “Intelligent Information Technologies for Industry” (IITI'25), November 05-07, 2025, Federal Territory of Sirius, Russia, (Scopus) (*Kotenko, I.V.*).
- X Jubilee International Conference “Interactive Collaborative Robotics” (ICR-2025), November 10-13, 2025, Hanoi, Vietnam, <http://icr.nw.ru/> (Scopus, Springer LNCS/LNAI, Q2) (*Ronzhin, A.L.*).

Conferences to Be Organized in 2026

- 34-th International Conference on Parallel, Distributed and Network-Based Processing (PDP 2026), proposed special session "Security in Parallel, Distributed and Network-Based Computing

- (SPDNBC)", March 25-27, 2026, Cluj-Napoca, Romania, <https://pdp2026.org/> (*Kotenko, I.V.*).
- XXI All-Russian Scientific and Practical Conference "Prospective Systems and Management Tasks» (Dombaj Conference), April 6-10, 2026, Dombaj, Karachay-Cherkess Republic, Russia, <https://psct.ru/>, (*Ronzhin, A.L.*).
 - 6-th International Conference on Agriculture Digitalization and Organic Production (ADOP – 2026), June 01-05, 2026, Kalinigrad, Russia, <http://adop.nw.ru>. (Scopus, Springer, SIST, Q4). (*Ronzhin, A.L.*).
 - XII Interdisciplinary Workshop "Analysis of Spoken Russian" ASR-2026, June, 2026, St. Petersburg, Russia (RSCI) (*Karpov, A.A.*)
 - XI International Conference "Interactive Collaborative Robotics" (ICR-2026), August 17-20, 2026, Vladivostok, Russia, <http://icr.nw.ru/> (Scopus, Springer LNCS/LNAI, Q2) (*Ronzhin, A.L.*).
 - 28-th International Conference "Speech and Computer" SPECOM-2026, September 16-18, Ohrid, North Macedonia, <https://specom.nw.ru/> (Scopus, Springer LNCS/LNAI, Q2) (*Karpov, A.A.*).
 - XII All-Russian Scientific and Practical Conference "Advanced Lines of Development in National Information Technologies" (PNROIT-2026), September 22-26, 2026, Sevastopol, Crimea, Russia, <http://pnroit.code-bit.com> (RSCI), (*Sokolov, B.V., Kasatkin, V.V.*).
 - XX Jubilee St. Petersburg International Conference "Regional Informatics (RI-2026)", October 28-30, 2026, St. Petersburg, Russia, <http://spoisu.ru/conf/ri2026> (RSCI) (*Sokolov B.V., Kasatkin, V.V.*).

International Cooperation

The engagements with international research community were continued by strengthening the existing interactions and international scientific cooperation through international contracts, agreements, the R&D contacts, information exchange.

By the end of 2025 has been accomplished a bilateral project with the Belarusian State University "Detection of malicious activity in the infrastructure of an industrial and educational Smart City based on hybrid intelligent systems with components of explainable deep learning", 2023-2025 (Grant from the St. Petersburg Science Foundation to support scientific and scientific-technical projects jointly executed by educational

and scientific organizations located in the territories of St. Petersburg and the Republic of Belarus No. 23-RB-01-09 2023-2025).

For the period of 2025-2027, an application has been submitted for consideration and approved in the course of a similar competitive selection for the project: "Hybrid explainable detection of cybersecurity threats to an industrial and educational Smart City with due account for attacks against artificial intelligence components".

Bilateral joint project is in a due realization with the Institute of Information Technologies (IoIT) of the Vietnam Academy of Science and Technology (VAST): "Theoretical foundations of parameterizable unified methods for specifying finite associative algebras and development of post-quantum cryptographic public-key algorithms". Project No. 24-4104006, granted by RSF for 2024-2026, SPIIRAS.

In response to the RSF's announced competition for joint projects with scientific organizations of the People's Republic of China, two institutions SRCES RAS (RF) and Zhejiang Normal University, ZJNU (PRC) jointly filed an application for a project: "The synergetic effect of key toxic components of particulate matter on human health under conditions of environmental overheating during sand and dust storms". The above application was approved for funding starting December 2025.

Also professional contacts were maintained based on framework agreements in regard to scientific cooperation and separate agreements on running joint scientific events within and outside the Russian Federation (conferences' series like ADOP, SPECOM, ICR, etc.).

International research and other professional contacts and information exchange were maintained and developed. Delegations of scientists and specialists: from the People's Republic of China were received: representatives of Shenzhen Xinhongxing Multilayer PCB Co., Ltd (3); researchers from Harbin Polytechnic Institute (1), Kaiyuan International Mathematical Sciences Institute (KIMSI) (3); employees of Alpha (Fujian) Bio-Tech Co., Ltd (5) and Huawei (6); from India – employees of the National Technological Center of Ports, Waterways and Coasts (2); from Republic of Kazakhstan – researcher of the L.N. Gumilyov Eurasian National University (1); from France – professor of the University of Toulouse (1). Young scientists mainly doctoral students from: Germany (1), Republic of Belarus (1), Socialist Republic of Vietnam (1), Republic of Chad (1), Algeria (1), Republic of Kazakhstan (3), People's Republic of China (5), Republic of the Congo (1), Republic of Haiti (1), Republic of

Uzbekistan (2), Republic of Yemen (1), Republic of Mali (1), Republic of Senegal (1), studying in St. Petersburg were accepted.

Fourteen scientists from SPC RAS took part in eleven international scientific events outside the Russian Federation (Portugal, Armenia, Belarus, Italy, China, Vietnam, Hungary, Finland, Czech Republic, Japan), over 40 scientists participated in 29 international scientific events within the Russian Federation.

In the current situation major interactions of researchers and professionals with international scholars acquired on-line format (workshops dealt with discussing and coordination of the terms and topics of joint research projects, the projects exercising, and participation in 128 international events).

Professional contacts were maintained with the following institutions:

- Secretariat of the CIS Interparliamentary Assembly (CIS);
- Institute of Control Systems of the Ministry of Science and Education of the Republic of Azerbaijan (Azerbaijan);
- Armenian National Agrarian University (Armenia);
- Belarusian State University (Republic of Belarus);
- University of Informatics and Radioelectronics (Republic of Belarus);
- Central Research Institute for Multipurpose Water Use (RUE “CRIMWU”) (Republic of Belarus);
- Institute of Experimental Botany of the National Academy of Sciences of Belarus (Republic of Belarus);
- Institute of Information Technologies (Vietnam);
- Vietnam Academy of Science and Technology (Vietnam);
- Vietnam National University (Vietnam);
- Le Quy Don Technical University (Vietnam);
- Almaty University of Energy and Communications (Kazakhstan);
- L. N. Gumilyov Eurasian National University (ENU) (Kazakhstan);
- KATU named after S. Seifullin (Kazakhstan);
- A.Baitursynov Kostanay Regional University (Kazakhstan);
- “Astana” International Research Complex (Kazakhstan);
- Zhejiang University of Technologys (China);
- Wenzhou University (WZU) (China);
- Liaoning University (China);
- Huawei Technologies Co. Ltd (China);

- Harbin Polytechnic Institute (China);
- Mexican National Autonomous University – UNAM (Mexico);
- Institute of Mathematics and Informatics of the Academy of Sciences of Moldova (Moldova);
- Mongolian Academy of Agricultural Sciences (MAAN) (Mongolia);
- University of Novi Sad (Serbia);
- Center for Arctic Research at the University of Northern Iowa (USA);
- FDP Data Transfer and Use Agreement (USA);
- Open Innovations Association FRUCT (Finland);
- Paul Sabatier University (Toulouse III) (France).

Expeditions

In 2025, over 30 field trips were undertaken to various districts of St. Petersburg, the Pskov and the Leningrad Regions, including: Vyborg, Kingisepp, Luzhsky, Gatchinsky, Pechorsky ones. Particularly the totality included the following 22 expeditions:

- 4 expeditions to Lake Ladoga aboard research vessel “Poseidon”;
- 1 littoral expedition along the entire perimeter of Lake Ladoga;
- 3 expeditions and 3 field trips to the littoral zone of Lake Ladoga;
- 1 expeditions to the Ladoga skerries;
- 3 expeditions to the island of Valaam;
- 7 expeditions to the lakes Uzkoie (Kuznechny settlement, Leningrad region);
- 3 detours along the tributaries of Lake Ladoga;
- 10 field trips to the Limnological Station on the lake. Krasny (Karelian Isthmus, Leningrad Region);
- 1 expedition to Antarctica;
- 1 expedition to. Karelia (Lake Verkhne Pulongskoye);
- 7 trips to the Gardens of the State Russian Museum (Summer Garden, Mikhailovsky Garden, Engineering Square);
- 2 exits to the Chernaya River;
- 1 exit to the Narva River;
- 1 expedition to Khanty-Mansiysk Autonomous Region;
- 2 exits to the Gulf of Finland of the Baltic Sea next to the port of Primorsk;

- 1 visit to the subject of accumulated environmental damage, Kirovsky municipal district;
- 7 expeditions to Salekhard, reindeer herding brigade;
- 8 field trips to NTF SPC RAS (forming the orthophotoplanes, pesticide treatments of potatoes and weeds);
- 12 trips to the training ground of the Ministry of Internal Affairs.

Monographs and Textbooks

1. Savelyev A.I., Yerashov A.A., Cherskikh E.O., Shmakov O.A. Mathematical and Software for Calculating Kinematic Parameters of Manipulators. Training manual . St. Petersburg: SPC RAS, 2025. 81 p.
2. The Book of Remembrance: Live and Remember. A collection of memoirs and stories. Second edition, expanded. St. Petersburg: SPC RAS, 2025. 264 p.

Conferences Proceedings

Speech and Computer. 27th International Conference, SPECOM 2025, Szeged, Hungary, October 13-15, 2025, Proceedings, Part I. Springer 2025. Alexey Karpov, Gábor Gosztolya (Eds.). LNCS/LNAI, vol. 16187. 347 p. ISBN 978-3-032-07955-8. ISSN 0302-9743. DOI: 10.1007/978-3-032-07956-5.

Speech and Computer. 27th International Conference, SPECOM 2025, Szeged, Hungary, October 13-15, 2025, Proceedings, Part II. Springer 2025. Alexey Karpov, Gábor Gosztolya (Eds.). LNCS/LNAI, vol. 16188. 347 p. ISBN: 978-3-032-07958-9. DOI: 10.1007/978-3-032-07959-6.

Interactive Collaborative Robotics. 10th International Conference, ICR 2025, Hanoi, Vietnam, November 10-13, 2025, Proceedings, Part I Springer Nature Switzerland. Andrey Ronzhin, Xuan-Tung Truong, Roman Meshcheryakov (Eds.): LNCS/LNAI. 2025. vol. 16303. 380 p. ISBN 978-3-032-11900-1, ISSN 0302-9743. DOI: 10.1007/978-3-032-11900-1.

Interactive Collaborative Robotics. 10th International Conference, ICR 2025, Hanoi, Vietnam, November 10-13, 2025, Proceedings, Part II Springer Nature Switzerland. Andrey Ronzhin, Xuan-Tung Truong, Roman Meshcheryakov (Eds.): LNCS/LNAI. 2025. vol. 16304. 380 p. ISBN 978-3-032-11903-2, ISSN 0302-9743. DOI: 10.1007/978-3-032-11903-2.

Agriculture Digitalization and Organic Production. Proceedings of the Fifth International Conference on Agriculture Digitalization and

Organic Production (ADOP 2025), Volume 1, Barnaul, Altai Region, Russia, June 03-06, 2025. Springer Cham. Andrey Ronzhin, Valentina Kundius, Vladimir Surovtsev (Eds.): SIST. 2025. vol. 453. 518 p. ISBN 978-3-032-07173-6, ISSN 2190-3018. DOI: 10.1007/978-3-032-07171-2.

Agriculture Digitalization and Organic Production. Proceedings of the Fifth International Conference on Agriculture Digitalization and Organic Production (ADOP 2025), Volume 2, Barnaul, Altai Region, Russia, June 03-06, 2025. Springer Cham. Andrey Ronzhin, Valentina Kundius, Vladimir Surovtsev (Eds.): SIST. 2025. vol. 475. 436 p. URL: <https://link.springer.com/book/9783032174062>. ISBN 978-3-032-17406-2, ISSN 2190-3018.

Information Security of the Russian Regions (ISRR-2025). XIV St. Petersburg Interregional Conference. St. Petersburg, October 29-31, 2025: Conference proceedings/SPb, 2025, 551 p. URL: <http://spoisu.ru/conf/ibrr2025/materials> (RSCI). ISBN 978-5-00182-159-5.

Advanced Lines of Development in National Information Technologies (PNROIT-2025), Proceedings of XI All-Russian Scientific and Practical Conference; science editor B.V. Sokolov. Sevastopol September 23-27, 2025, Sevastopol: SSU, 2025. (RSCI)

Regional informatics and Information Security. Collection of works. Issue 14 / St. Petersburg, 2025, 464 p. ISBN 978-5-00182-160-1.

Regional Informatics and Information Security. Collection of works. Issue 15 / St. Petersburg, 2025. 298 p. ISBN 978-5-00182-161-8.

Proceedings of the XX Jubilee All-Russian Scientific and Practical Conference "Promising Management Systems and Tasks" and the XVI Youth School seminar "Management and Information Processing in Technical Systems". Taganrog: DirectSines (IP Shkurkin, D.V.), 2025. 483 p. ISBN 978-5-605-18658-8.

Honors and Awards

- Arkhipov, M.V. – Title of Honor “Honored Scientist of the Russian Federation”.
- Ronzhin, A.L., Salukhov, V.I., Sokolov, B.V. – Gratitude of the Governor of St. Petersburg for a great contribution to the science development in St. Petersburg and many years of conscientious work.
- Karetnikov, S.G., Medvedeva, N.G. – Title of Honor “Honorary Worker of Science and High Technologies of the Russian

- Federation” for merits and achievements in the field of scientific activity, as well as for the conscientious work.
- Guzeva, A.V. – Breastplate "Young Scientist" of the Ministry of Science and Higher Education of the Russian Federation for merits and achievements in the field of scientific activity, as well as for the conscientious work.
 - Sukhorukova, N.T. – Breastplate "Veteran" of the Ministry of Science and Higher Education of the Russian Federation for professional merits and long term work.
 - Myskin, F.V., Stanislavskaya, E.V., Kholodkevich, S.V. – Gratitude of the Ministry of Science and Higher Education of the Russian Federation for a contribution to the development of science activity and conscientious work.
 - Grigorjev, A.V., Danilova, T.A., Dzhabrailova, B.S., Egorova, L.I., Zhukova, M.Yu., Kotova, Z.P., Lashkova, T.B., Petrova, G.V., Smirnova, V.V., Shkodina, E.P., Yuzhakov, A.A. – Gratitude of the Ministry of Agriculture of the Russian Federation for many years of conscientious work in the agro-industrial complex.
 - Gerasimov, A.O., Kiselev, A.V., Kudryavtseva, V.A., Kukhareva, G.I., Lyubimtsev, V.A., Polyak, Yu.M., Surovtsev, V.N. – Gratitude of the Committee on Science and Higher Education for many years of conscientious work and great personal contribution to the development of scientific potential of St. Petersburg.
 - Nikonova, N.A., Rakhimova, E.A. – Gratitude of the Committee for the Agro-industrial and Fisheries Complex of the Leningrad Region for conscientious and faultless work, and scientific contribution to the development of the agro-industrial complex of the Leningrad region.
 - Blokhinova T.K., Gerasimov A.O., Egorov A.N., Zabrodin V.A., Zelentsov V.A., Karetnikov S.G., Klimov O.V., Kukhareva G.I., Lyubimtsev V.A., Medvedeva N.G., Myskin A.V., Rzhimsky V.G., Stanislavskaya E.V., Tyukalov Yu.A., Kholodkevich S.V., Epstein D.B. – Certificate of Honor from the Russian Academy of Sciences for conscientious work, great contribution to the development of Russian science, achieving high results in scientific and scientific-technical activities and in connection with the anniversary.

SPIIRAS – Structural Division of SPC RAS

St. Petersburg Institute for Informatics and Automation of the Russian Academy of Sciences was founded according to the Decree of the Council of Ministers of the USSR of December 19, 1977 and to the Decision of the Presidium of the USSR Academy of Sciences of January 19, 1978 as Leningrad Research Computer Center (LRCC) of the USSR Academy of Sciences based on the Department of Computer Science of Ioffe Physical and Technical Institute. Based on the Leningrad Research Computer Center (LRCC) was established one of the first global information and computer networks in the country, that is, AcademNet “North – West”. In 1985 LRCC was transformed into the Leningrad Institute for Informatics and Automation of the USSR Academy of Sciences.

In 1992 the Leningrad Institute for Informatics and Automation of the USSR Academy of Sciences was renamed to St. Petersburg Institute for Informatics and Automation of the Russian Academy of Sciences (SPIIRAS) since the historic name of St. Petersburg had been returned to the city of Leningrad. In compliance with the Russian Federation Government Order dated December 30, 2013 No. 2591-p the Institute was turned over to the management of the Federal Agency for Scientific Organizations. By the Order of the Russian Federation Government of June 27, 2018 No. 1293-p the Institute is transferred to the management of The Ministry of Science and Higher Education of the Russian Federation

In accordance with Order of The Ministry of Science and Higher Education of the Russian Federation of July 08, 2020 No. 768 SPIIRAS acquired a status of SPC RAS structural department.

SPIIRAS does research in informatics, automation and robotics, information and telecommunication technologies.

Doctor of Technical Sciences Professor Osipov, Vasily Yu. is the Intitute Director.

Candidate of Military Sciences, Silla, Evgeny P. is the Institute Scientific Secretary.

Laboratory of Information Technologies in System Analysis and Modeling

Head of Laboratory: Sokolov, Boris V., Chief Researcher, Doctor of Technical Sciences, Professor, Honored Scientist of the Russian Federation, two-time Winner of the Government of the Russian Federation Prize in Science and Technology – basic and applied research as regards the problems of complex modeling and proactive management of dynamic systems with a tunable structure, development of mathematical models and decision support methods in complex organizational and technical systems under uncertainty and multi-criteria, sokolov@iias.spb.su.

Laboratory research areas

Development, study and implementation of methodological, methodological and technological foundations for automation and intellectualization of complex modeling processes, proactive monitoring and management of complex objects at various stages of their life cycle.

New Research Results

1. Model-algorithmic and software modeling of the functioning of weakly formalizable dynamic systems represented by a multilevel factorial scheme based on a fuzzy-probability approach, characterized by an integrated consideration of spatial, temporal, technical and technological constraints specific for complex organizational, technical and agrobiological.

2. Methodologic fundamentals and model-algorithmic support for integrated automation in solving problems at multi-criteria assessment, analysis and selection of models and polymodel complexes for the integral analysis of the stability of forest ecosystems under the impact of natural and anthropogenic factors, with due account for the use of calculations of remote sensing data, the specifics of their joint processing with ground-based measurement data, and ensuring automation of the processes of analyzing the stability of forest ecosystems.

3. New approach to the study of multimode complex organizational and technical systems in conditions of significant situational structural and parametric uncertainty is proposed based on the concept of a parametric genome structure and the differentiation operation of the second kind fuzzy hypergraph, that are a formal representation of technological cycles of these objects' management.

4. Combined models, methods, algorithms and information technology of autonomous group control of a multi-satellite system of small spacecraft in the case of cluster construction have been developed, ensuring minimal participation of the ground complex in the management of the grouping, autonomous group planning of the target application of the grouping as a whole and based on information interaction, autonomous planning of the target application of each spacecraft in the process of information interaction.

Laboratory of Computer Aided Integrated Systems (Head of the Laboratory Smirnov, A.V.)

Head of Laboratory: Smirnov, Alexander V., Doctor of Technical Sciences, Professor, Honored Scientist of the Russian Federation – intelligent configuration management of virtual and network organizations, logistics of knowledge, socio-cyberphysical systems, smir@iias.spb.su.

Laboratory research areas

Methods and technologies of knowledge logistics and intelligent management of virtual resource networks, artificial intelligence, socio-cyberphysical systems, data mining, machine learning, human condition monitoring.

New Research Results

1. Methodology and an integrated approach to decision-making support at configuring the sociotechnical systems (CSS) have been developed, with a specificity of multidimensional representation and semantic integration, different than those in the existing model-algorithmic apparatus, accounting, at that, for contextual information as regard the CSS themselves and their environment, using deep neural networks and generative design, as well as allowing for increasing the level of automation and intellectualization of decision-making processes (in particular, the degree of automation for the automated maintenance process of semiconductor manufacturing was increased by 37% and 270 expert hours were saved when evaluating the quality of modeling configurations of complex products of an industrial company, at that, 80% accuracy was achieved when generating CSS models and business processes).

2. Approach to developing decision-making support systems is proposed that combines conversational, generative, and evaluative types of artificial intelligence (AI), characterized by combining and mutually enriching methods focused on the use of data, knowledge, and models, as well as by using big language models as a tool for ensuring interaction between humans and the system during the decision-making process. It also allows for using the structured and unstructured knowledge through hybrid AI methods and provides an explicable and verifiable decision-making process using evaluative components and the preservation of natural human control through conversational interfaces.

3. Architecture of the human-machine environment of collective actions has been developed to support the scenario due to an arranging of

purposeful collective behavior of participants in the process of joint solving a problem, as well as a scenario of intelligent support for participants in the digital community based on an example of solving the problem of forming recommendations for reconfiguring the city's road network. The mentioned approach is expected to be introduced into practice by the digital community working group within the commission for road safety under the city administration and consisting of representatives of the relevant municipalities and software agents.

4. Method to analyze electroencephalographic data has been developed, characterized by the use of the entropy indicators for the electroencephalogram signal and a trained deep neural network, intended for determining the psychophysiological state of a person based on data mining, which allows determining the state of concentration and valence of emotion experienced by a person with an accuracy over 75%.

5. Hybrid method has been developed for extracting the spatiotemporal characteristics of events out of unstructured textual data, characterized by a combination of text normalization, timestamp extraction using regular expression-based rules, comparison of geographical references with a localized gazetteer and contextual validation of results using a large language model and allowing for reliable identification of relevant event attributes under variability of linguistic constructions, homonymy of toponyms and the presence of irrelevant details.

Laboratory of Speech and Multimodal Interfaces

Head of Laboratory: Karpov, Alexey A., Chief Researcher, Doctor of Technical Sciences, Profesor, Winner of the Government of the Russian Federation Prize in Science and Technology- development of speech and multimodal human-machine interfaces and intelligent systems, karpov@iias.spb.su.

Laboratory Research Areas

Study and development of natural human-computer interaction of methods. Automatic audio-visual recognition and speech comprehension. Multimodal interfaces. Smart spaces and smart rooms. Assistive technologies and information support systems for people with disabilities. Analysis of the Russian sign language. Computer paralinguistics. Affective calculations. Recognition of psychoemotional states. Multimodal recognition of human cognitive impairments.

New Research Results

1. System for multimodal recognition of the users' composite psychoemotional states has been developed, distinguished by simultaneous analysis of facial expressions, visual scenes, automatic recognition of speech and speech text transcriptions via combining neural network transformer models with cross-modal attention mechanisms and generating the results of scene analysis through a visual large language model (Visual LLM) allowing for automatic recognition of seven classes of basic emotions (joy, sadness, fear, anger, disgust, surprise, and a neutral state), as well as composite psychoemotional states, when two basic emotions simultaneously dominate; the use of the system made it possible to win the competition within the framework of the 9th international competition for the analysis of natural affective states and user behavior ABAW at the ICCV Computer vision Conference (reported to Department of Nanotechnology and Information Technology (ONIT RAS) as the most important result).

2. Automatic speech recognition system has been developed to recognize Karelian connected speech and furnished with a support for switching language codes (from Karelian to Russian), distinguished by the use of a fully trained integrated neural network model based on Wav2Vec 2.0 BERT and an external language model trained on Karelian-language texts augmented by automatic translating the randomly selected words into

Russian and replacing them by the words with intra-word language code switching, which can be used for automatic shorthand of speech in Karelian, thus, representing practical interest for linguistic field research aimed at studying, supporting and preserving the low-resource Karelian language, and contributing to the overall development of speech recognition and synthesis technologies in low-resource languages of the Russian Federation.

3. Dynamic hand gesture recognition system has been developed, combining optical information and depth data using an adaptive mechanism for matching intermodal representations and ensuring temporal consistency, which increases the robustness of gesture recognition to spatial ambiguities, variability of gesture performances and video noise with a limited amount of training data., neural network models based on state space architectures provide effective modeling of the spatiotemporal dynamics of gestures over long intervals with reduced computational complexity and high stability of features, thanks to the facts the system can be applied in automatic sign language recognition systems and contactless interfaces of human-machine interaction [17, 20].

4. Mathematical software and a software system for audiovisual recognition of the Russian sounding and sign speech have been developed, characterized by the use of the method of adjustable transformers and the method of interlanguage transfer of learning, supporting an automatic two-way sign language translation due to the operation of four modules (visual recognition of sign language/speech, audiovisual recognition of spoken speech, synthesis of spoken speech and synthesis of sign language/speech), effectively applicable to the organization of contactless communication between deaf and hearing people automatic.

5. Method has been developed for multimodal determination of the presence of depression in a user by analyzing his audio, video and text information, characterized by the use of semi-automatic data markup, allowing for improving the quality of data used in model training, as well as for refining the timestamps and utterance texts, combined with the use of predominantly expert feature sets (OpenFace, Word2Vec, DenseNet et al.) and classical deterministic machine learning methods (Catboost et al.), possessing the property of models interpretability. On a whole, the method has improved the accuracy of automatic recognition of depression, and can possibly be used in expert systems for multimodal recognition of cognitive impairments, including the primary healthcare.

6. New research multimodal Russian-language data corpus has been collected and annotated encompassing virtual communication participants' interaction (ENERGI ENgagement and Emotion Russian Gathering Interlocutors) with duration of 6.4 hours of audiovisual recordings of group teleconferences, containing expert markup of data over three classes of participants' engagement, their emotional arousal and valence of emotions, as well as over ten classes of communicative gestures, whose advantages contain the multimodality and Russian-speaking audiovisual data, balanced distribution of informants and their group communication in “field conditions” of professional teleconferences.

Laboratory of Research Automation

Head of Laboratory: Kuleshov, Sergei V., Chief Researcher, Doctor of Technical Sciences, Profesor of RAS – associative and ontological approach to the analysis of Internet content, digital software-defined infocommunication systems, image and video data processing, data compression, text processing, search engines, kuleshov@iiias.spb.su.

Laboratory Research Areas

Semantic analysis of audio, video, and text data. Associative and ontological approach to the analysis of Internet content, development of information and analytical systems, automatic monitoring of the Internet environment. Technical vision tools for autonomous robotic systems. Software defined reconfigurable infocommunication systems. Active data, distributed virtual machines.

New Research Results

1. Method has been developed to dynamically control the level of image compression, characterized by the allocation of equientropic regions with different information significance, proved by the fact that the bimodal entropy distribution with a known variance is a convex function, whose extremum corresponds to the maximum information saturation, allowing to determine the most informative image areas for dynamic control of the compression level, what increases the subjective image quality while reducing the total bit volume, can possibly be used in image recognition tasks, filtration and automatic exposure.

2. Method has been developed to assess trends in reserach subject matter at the retrospective analysis of scientific publications in the technical field, characterized by the use of artificial neural networks and data enrichment methods, providing trend forecasting based on time series analysis

3. Theoretical justification for the principles of processing the unstructured data by a distributed virtual machine with an object-oriented communication environment is proposed, that allows software engineers and data scientists for applying typical programming paradigms (OOP, functional flows) to tasks being solved in a distributed execution environment, at that, hiding the complexity of implementing the distributed interaction.

4. Algorithms for measuring the geometric parameters of objects on stage are proposed to increase the accuracy of UAV localization, distinguished by the use of technical vision.

Laboratory of Computer Security Problems and International Center for Digital Forensics

Head of Laboratory: Kotenko, Igor V., Chief Researcher, Doctor of Technical Sciences, Profesor, Honored Scientist of the Russian Federation – information security, artificial intelligence technologies, information and telecommunication systems, ivkote@comsec.spb.ru.

Head of the Center: Chechulin, Andrey A., Leading Researcher, Candidate of Technical Sciences, Associate Professor – information security, artificial intelligence technologies, security visualization, digital forensics, chechulin.a@spcras.ru.

Laboratory and Center Research Areas

Information security, including information management systems for information, security events and incidents; security policy management, access control, authentication, security analysis, detection of computer attacks, firewalls, false information systems, protection against viruses and network worms, analysis and verification of security protocols and information security systems, protection of software against hacking and digital rights management, modeling and visualization technologies for countering cyberterrorism, intellectualization of security services for critical infrastructures, modeling and analysis of attacking impacts on cyber-physical systems.

Artificial intelligence, including multi-agent systems, soft and evolutionary computing, machine learning, intelligent data analysis based on neural networks, knowledge extraction, data analysis and integration, intelligent decision support systems, processing of incomplete and contradictory information. Telecommunication systems and Internet of Things networks, including those aimed at decision-making support and planning of communication systems, analysis and synthesis of secured multi-service networks. Modeling the functioning processes for industrial Internet of Things' systems as applied to cyber-physical security systems, energy and water supply, railway transport, mobile self-organizing networks, etc.

New Research Results

1. Methods for analyzing the cybersecurity risks, proactive and reactive response to identified cyber attacks have been developed, having due account for environmental safety risks and vulnerability of the

wastewater treatment system, software based on the semantic domain model in a form of the SecWat-O ontology, which links system components, their criticality assessment, vulnerability databases (CVE) and attack tactics MITRE ATT&CK, as well as mechanisms for detecting and preventing attacks [3].

2. Techniques and tasks for the complete randomization of the digital signature S in algorithms with a hidden group based on the computational complexity for solving large systems of power equations have been developed, and methods for fixing the hidden group within the framework of the mechanism for setting the complete randomization of the digital signature and algorithms for generating vectors defining hidden groups with the required properties, and algorithms for generating open and the secret key.

3. General approach and architecture of a system for integrated security analysis of critical infrastructure facilities using Internet of Things technologies are proposed, distinguished by the use of an ontological model describing threats, vulnerabilities, weaknesses, attack techniques and protection measures in information systems, including critical infrastructure using Internet of Things devices.

4. Combined model to detect attacks in wireless sensor networks has been developed, distinguished by combining the built basic classifiers within an ensemble of machine learning methods for certain types of attacks, decentralized detection and data processing in a secured distributed storage, that provides identification of the main types of attacks, including wormhole, sinkhole, Sybil, Flooding attack, role assignment attack, interference to the monitoring module and the distributed storage overflow attack, etc. The above allows for improving the quality of detection under simultaneous execution of several different types of attacks.

5. Approach of software's reverse-engineering has been developed based on solving the optimization problem of converting a program in its current representation (e.g., of machine code) to its earlier representations (e.g., to its source code), distinguished by a principally different direction of reverse-engineering – not from the subsequent representation of the program to the preceding one, but vice versa – by intelligent sampling the preceding one as it approaches the specified one (after compilation), thus, providing a significant increase in the efficiency of vulnerability search in the best preferable form for the expert and the matchig software.

Intelligent Systems Laboratory

Head of Laboratory: Iskanderov, Yury M., Doctor of Technical Sciences, Professor, Academician of the Russian Transport Academy – automation and informatization of large complex heterogeneous dynamic systems, system analysis and integration of information resources, knowledge engineering, intelligent transport systems, iskanderov.y@iias.spb.su.

Laboratory Research Areas

Integration of information resources for large complex heterogeneous dynamic systems. Transport global information systems. Intelligent support for transport management processes. System analysis and structuring of information resources in transport systems. Informatization and automation of regional and urban agglomerations' transport systems. Information and computer security of the transport systems. Specialized information search engines. Systems for collecting, acquiring and presenting spatial data on the state and functioning of complex systems, including those using geoinformation technologies. Multi-agent systems theory and technology. Multi-agent logistics models. Methods and technology of distributed learning and distributed decision-making (hierarchical and P2P models). Multi – agent modeling. Big Data intelligent processing and application models. Third-generation recommendation systems, big data processing, semantic data models, image enhancements obtained via mobile devices.

New Research Results

1. New methodological approach has been developed to solve the problems of automation and intellectualization for ensuring the viability of supply chains (CP) operating in a turbulent environment, distinguished by the ability to link together factors characterizing goals of the CPU formation and functioning of (goals, functions, life cycle), the quality of CPU controls (skills), the quality and quantity of resources (capabilities), the conditions of exposure to external and internal factors, the risk levels of critical situations' emergence, and effectively implemented on a multi-agent platform in an intelligent CPU management support system [2].

2. Method is proposed for allocating and selecting the time series segments based on the use of the quality functionality of regression data processing models at the analysis and assessment of the complex systems' state. The novelty and feature of the method are an objective and

application of these models in the obtained segments, which best ensure their compliance depending on the result of machine learning and the value of the calculated quality functional. The use of the method allows for forming the effective aggregated data processing models relevant to the set goals of system research.

3. New method for estimating the cost of complex objects Based on the fundamental principles of game theory is proposed. A formal formulation of the evaluation problem as a cooperative game has been developed, and a corresponding solution based on the Shapley vector has been obtained. Calculation formulas have been developed to ensure the necessary assessment of the objects' costs with minimal time consumption when using large amounts of source data.

Laboratory of Applied Informatics and Problems of Information Society

Head of Laboratory: Geyda, Alexander S., Chief Researcher, Doctor of Technical Sciences, Associate Professor – scientific fundamentals of computer science, problems of digital transformation of the economy, informatization of society, theory of potential, effectiveness of the introduction and use of information technologies, geida@iias.spb.su.
использования информационных технологий, geida@iias.spb.su.

Laboratory Research Areas

Theoretical fundamentals of computer science, problems of information society development in the digital economy, applied informatics, information and national security, data processing, complex simulation of radiation fields of natural environments in remote sensing of the Earth and space geoinformatics, research of electrophysiological signal processing processes to support medical decision-making, program-targeted planning and management of technological processes in corporate systems.

New Research Results

1. New methods of mathematical modeling for the processes of digital transformation of society and the economy, allowing to reduce the cost of analyzing these processes and improve the accuracy of the obtained forecasts of their development.

2. New version of the CIAO v.3 language has been implemented for specifications of cooperative Interaction of Automata Objects (CIAO) with automatic verification of programs according to formal specifications of a certain class of real-time systems.

Laboratory for Applied Artificial Intelligence

Head of Laboratory: Abramov, Maxim V., Senior Researcher, Candidate of Technical Sciences, Associate Professor – artificial intelligence: generative artificial intelligence, big language models, machine learning, data analysis; information security: socioengineering attacks, analysis of information system users' security against the intruders' socioengineering attacks; analysis of information dissemination over social networks; analysis and modeling of social networks; client-server technologies; study of interrelations between content published by users in the social networks, and behavior in an offline environment, mva@dscs.pro.

Laboratory Research Areas

Development of algorithms and software tools based on artificial intelligence for data processing and analysis at interdisciplinary research. Technologies for analyzing behavior in social networks: methods and tools for detecting the activity patterns, modeling interactions, and predicting user's actions. Intelligent systems for assessing the severity of personality traits based on digital footprints. Intelligent data processing in logistics: development of algorithms for predicting cargo arrival dates and optimizing transport operations.

Advanced algorithms intended for optimizing the neural networks. Development of new methods for introduction of big language models to solving the specific application problems, benchmarks development, and further training of big language models. Theoretic and technologic fundamentals, algorithmic support and software tools of Bayesian networks of probabilistic graphical models.

New Research Results

1. Universities' rating methodology has been developed and tested, distinguished by the use of an automated classifier for the university graduates' managerial positions and supporting the processing of large amounts of open data, what allowed to identify three stable groups of universities in the field of management, whose graduates differ in career dynamics.

2. Accurate polynomial algorithm for optimizing the refueling plan on a fixed route has been developed and investigated; the algorithm is distinguished by an integer solution and lower asymptotic complexity compared with graph and linear methods and provides a stable

computational advantage over heuristic strategies while limiting the number of stops.

3. Machine learning models have been developed to predict the psychological characteristics of social media users based on their digital footprints, differing by the use of modern neural network text and image processing tools and the use of BAM, and providing personalization of career guidance and marketing solutions.

4. Benchmark for big language models (BLM) has been developed, characterized by the use of Python code generation for professional financial exams, that provides a comparative analysis of big language models based on the skills in processing large tables.

5. Approach to the justified selection and modern optimizers configuring (fine-tuning) at training neural and fuzzy neural models for regression problems has been developed and experimentally tested, featuring a comparison between standard and chosen hyperparameter configurations, thus, enhancing the prediction quality or accelerating the learning convergence at comparable computational costs.

6. Classification of socioengineering attacks in the context of digital trust has been developed, as well as models for the use of BLM at identifying opinion leaders and growth points in the development of marketing strategies, distinguished by a multidisciplinary approach and ensuring the implementation of personalized solutions in financial and technical as well as in socio-oriented systems.

Laboratory of Big Data Technologies of Socio Cyber Physical Systems

Head of Laboratory: Levonevsky, Dmitry K., Senior Researcher, Candidate of Technical Sciences – information systems, socio-cyberphysical systems, programming technologies, mathematical and software modeling, levonevskij.d@iias.spb.su. levonevskij.d@iias.spb.su.

Laboratory Research Areas

Big data Fundamentals and technologies for socio and cyberphysical systems, research and development of models, methods, algorithms of virtual representation of objects of the external environment in socio and cyberphysical systems, processing of big and heterogeneous data.

New Research Results

1. Structure and a recurrent mechanism for constructing optimal approximations of a grayscale image that minimize the total quadratic error with a different number of brightness gradations have been developed, and it has been found that the corresponding splits of the brightness histogram have a pronounced regular structure that allows for restoring all optimal splits and actually encodes the image histogram and reduce the computational complexity of segmentation compared with direct iteration, at that maintaining the result quality.

2. Classification of anomalies in the corporate access control systems is constructed, including frequency, integrity, spatiotemporal, identification and role violations, characterized by a scheme for detecting the anomalies based on access system modeling, event log vectorization and time series analysis, thus, ensuring detection of both expected effects (a sharp decrease in activity during the holiday periods) and failures related to data integrity violations.

3. Approach to managing corporate socio and cyberphysical systems has been developed, characterized by linking the intent ontologies with a dynamically tunable knowledge graph and allowing autonomous components to interpret goals as states, evaluate deviations based on a formalized value function and select control actions, what ensures the adaptation of system changes and the implementation of high-level corporate processes without centralized control [23, 24].

4. Architecture of a socio and cyberphysical system has been formed, distinguished by the structure of a digital human twin with a description of anatomical, psychological, cognitive, social and professional

levels, ensuring the automatic formation and adjustment of individual educational trajectories when applied with an educational environment, checking the completeness and integrity of curricula and comparing the competencies of trainees with the requirements.

Laboratory of Autonomous Robotic Systems

Head of Laboratory: Saveliev, Anton I., Senior Researcher, Candidate of Technical Sciences – mathematical models of control of robotic means, methods and algorithms for constructing motion trajectories of robotic systems, cyber and physical space services, image processing, saveliev@iias.spb.su.

Laboratory Research Areas

Development of mathematical, software and hardware support for autonomous robotic systems, including methods of group control, modular robotics, kinematics and motion dynamics of multi-link systems, control of unmanned aerial vehicles and ground vehicles, image processing and development of prototypes of distributed systems for information processing aboard robots.

New Research Results

1. Numerical algorithm for tomography of a vertical profile of the tropospheric refractive index has been developed for measuring the transmission parameters of a known radio signal, characterized by the use of the DeepONet architecture and an automatically differentiable parabolic equation for learning the inverse operator, and providing the ability to control parameters of the tropospheric waveguide in real time without using a priori information on the distribution of the desired profile.

2. Algorithm for adaptive control of a ground-based agricultural robot has been developed, distinguished by an analysis of the feasibility of tasks in crisis situations caused by failures of one or more aboard devices, with due account for their functional purpose and significance. It ensures prompt decision-making, experimentally confirmed by simulation results: from 0.0072 ms (with minimal load) to 0.0112 ms (with partial failures with a search of available devices).

3. Cascade method has been developed for configuring gyroscopic data filtering cascades on various types of UAVs, characterized by the distribution of functions suppressing various types of noise between sequentially connected elements – low-pass filter, notch filters, adaptive alpha-beta Kalman filter and exponential filter, and providing high performance at a small window size (2-5 samples), reaching maximum values of quality metrics (signal-to-noise ratio and Pearson correlation coefficient) at the adaptive alpha-beta filter stage, as well as improving

control accuracy and stability of a quadcopter control at angular speeds, thus, contributing to a more stable following the set trajectory.

4. Method of dynamic synthesis of adaptive LQR controller coefficients in combination with a PID controller in a multirotor UAV control system has been developed, characterized by the use of dynamic LQR synthesis of gain coefficients based on the adaptation of weighting coefficients of the cost matrices Q and R, as well as the parameters of the dynamic UAV model in real time, and providing the increased reaction accuracy, reducing the transition time about five times, reducing the control delay to ~ 0.1 s and increasing the correlation coefficient of the control action with the desired angular position by 26% (up to 0.9772 versus 0.7776 for the classic PID controller), what is confirmed by stress testing and modeling, demonstrating the prospects of integrating the proposed controller into a method to increase the reliability and stability of the control system of multirotor aboard UAV control systems, followed by planning of experimental tests on multirotor devices.

5. Route planning method has been developed for groups of multirotor UAVs, characterized by the representation of the trajectory of each device as a capsule air corridor – 3D volume of a fixed radius, sequentially formed along the route segments, and providing constructive spatial redundancy, ensuring that there are no intersections of trajectories at the planning stage, eliminating the need for online coordination or reactive conflict prevention, as well as generating safe, non-overlapping routes using a modified RRT* algorithm with hierarchical spatial filtering based on the Loose Octree structure. This guarantees computational efficiency at the cost of eliminating obviously disjoint objects. Numerical experiments on a 1 km² site with groups of 2 to 32 vehicles confirm the predictable increase in planning time and number of iterations due to the expansion of reserved space, and also demonstrate the key advantages of the approach. – spatial independence, fault tolerance, scalability, lack of requirements for data synchronization and exchange in real time, the ability to directly load trajectories into the aboard software in a form of control points and, as a result, ensure the complete mission autonomy, what makes the method especially promising for agro-industrial scenarios with increased requirements to reliability and stability.

Department of Prototyping the Robotic and Embedded Systems

Head of Department: Dashevsky, Vladimir. P., Senior Researcher, Candidate of Technical Sciences – concepts and prototypes of aboard computers for autonomous robotic complexes based on ETX, COM Express, SMARC standard system modules and application systems based on them, specialized FPGA-based computers, automated control systems based on microcontrollers, control units for CNC machines, dashevskiy.v@ias.spb.su.

Department Research Areas

Embedded computers. Systems on a module. Digital signal processing. High-performance specialized real-time systems. Distributed Systems Data collection and Monitoring (SCADA). Embedded system applications. Software as a Service (SaaS).

New Research Results

1. CNC milling machine with automatic change of tools processing aluminum and plastic parts of instrument housings has been completed and put into regular operation, what provided the manufacture of the first parts for a mobile platform for automatic maintenance of agricultural drones (multicopter-type agricultural UAVs).

2. SMARC1_TB.1 stand was designed and manufactured for software development and commissioning of SMARC serial modules, thus, allowing for full automation of the process for acceptance testing of SMARC-AM3352 serial modules, registration of their digital passport, installation of a system and application software on them in accordance with their intended purpose. Due to the introduction of four stands into the production process, it appeared possible to completely eliminate the human factor out of routine operations for testing and initial configuration of modules, so, it increased the output productivity by almost 8 times. As a result, 5,944 modules were manufactured in 2025, what is approximately equal to the total output over the previous 5 years, from 2020 to 2024 (5,949 units).

IAERD – Structural Division of SPC RAS

Institute of Agricultural Economics and Rural Development (IAERD) started out as the Research Institute for Economics and Organization of Agricultural Production for the RSFSR non-Chernozem zone under the VASHNIL Department for the RSFSR non-Chernozem zone, in accordance with the Decree of the RSFSR Council of Ministers dated September 14, 1977 No.483 and the Order of the VASHNIL Department for the RSFSR non-Chernozem zone dated September 27, 1977 No. 120.

In compliance to the Decree of the President of the Russian Federation "About the Russian Academy of Agricultural Sciences" dated January 30, 1992 No. 84 the united Russian Academy of Agricultural Sciences was established based on the Russian Academy of Agricultural Sciences and the All-Union Academy of Agricultural Sciences, and the Research Institute for Economics and Organization of Agricultural Production in the Russian Federation non-Chernozem zone was transferred to its management.

In accordance with the Order of the Russian Academy of Agricultural Sciences dated January 28, 1998 No. 14 the Research Institute for Economics and Organization of Agricultural Production in the Russian Federation non-Chernozem zone was renamed to the North-West Research Institute of Economics and Organization of Agriculture.

Based on the Federal Law "On the Russian Academy of Sciences, reorganization of State Academies of Sciences and amendments to certain legislative acts of the Russian Federation" of September 27, 2013 No. 253-Φ3 and Decree of the Government of the Russian Federation of December 30, 2013 No. 2591-p NWRIEOA was turned over to the management of the Federal Agency for Scientific Organizations.

By the Decree of the Russian Federation President of May 15, 2018 No. 215: "On the structure of Federal Executive Authorities" and by the Order of the Russian Government of June 27, 2018 No. 1293-p NWRIEOA is transferred to The Ministry of Science and Higher Education of the Russian Federation management.

On May 27, 2020, the reorganization was completed in a form of joining the St. Petersburg Institute for Informatics and Automation of the Russian Academy of Sciences (SPIIRAS). The order of the Ministry of

Education and Science of the Russian Federation of December 18, 2019 No. 1399 and the order of SPIIRAS of May 26, 2020 No. 50-k.

According to the Order of the Ministry of Science and Higher Education of the Russian Federation of July 08, 2020 No. 768 NWRIEOA was renamed into IAERD and received a status of the SPC RAS structural division.

IAERD does basic, exploratory and applied research aimed at increasing the efficiency of scientific support of the Russian Federation in matters of economic, food and environmental safety. The research is intended for obtaining new knowledge in the rational use of agricultural resources of the of Russian North-West, the economy of the agro-industrial complex, innovative and investment development of agricultural sectors that contribute to technological, economic, social and human development, as well as sustainable development of rural areas of the Non-Chernozem zone of Russia.

Institute Head: Dibirov, Abusupyan A., Leading Researcher, Candidate of Economic Sciences, Associate Professor – economics and organization of agricultural enterprises, processes of cooperation and integration in agriculture, management systems of integrated associations, mechanisms of rural development, szniesha@gmail.com, dibirov.a@spcras.ru.

Head of the R&D Theme: Nikonova, Galina N., Chief Researcher, Doctor of Economics, Professor, Corresponding Member of the Russian Academy of Sciences – economics and national economy management, agrarian relations, institutional foundations and organizational and economic mechanism of sustainable development of agriculture and rural areas, state regulation of land relations, nikonova.n@spcras.ru, galekos@yandex.ru.

Institute Research Areas

Theoretical and methodological basics of spatial development of rural areas. The theory of the forming a neo-endogenous paradigm of sustainable agricultural development and spatial development of the region. Institutional fundamentals and concepts of socio-economic and demographic development of rural areas, improving the life standard of the rural population. A strategy for mobilizing domestic resources and attracting investments aimed at infrastructure development and diversification of the rural economy, overcoming territorial imbalances in the context of regionalization and the specifics of modern institutional processes.

The institutional framework for regulating land relations, with due account for peculiarities of the reproductive process in the agricultural sector. Models of state regulation of land relations and the agricultural land market, at that, accounting for the rental potential of the regions in the North-West of the Russian Federation. Development of conceptual provisions for improving the market turnover of land. Strategies for increasing economic efficiency at the use of agricultural land.

Development of scientific and theoretical fundamentals in the sustainable development of agricultural production over the Northwest macro-region based on a systematic application of digital technologies. Improving the directions and forms of state support for agricultural production. Adaptation of methods intended for assessing the effectiveness of the development of digital technologies, robotization and biologization of agricultural production to the conditions in the North-West of Russia.

Development of economic links for AIC under the digital transformation. The processes of cooperation and integration in AIC; investment processes in agricultural holdings. Management systems for integrated associations, enterprises and cooperative systems. The impact of integration and cooperation processes on solving food security problems and improving logistics chains for product promotion.

New Research Results

1. The theoretical and methodological concepts of possible mechanisms of sustainable adaptation of subjects of the agrarian economy in the current realities of increasing external shocks and resource constraints of production are refined. Regarding the specifics of functioning, the author's definition for the notion of "sustainable development of agro-industrial production" is formed; the goals and set of principles are defined, coordinated with the United Nations Sustainable Development Goals to ensure the sustainability of its development dynamics. Using Rosstat data, the proposed theoretical and methodological provisions were tested on the materials of the regional AIC in the North-West, particularly, to analyze changes in the dynamics stability for the gross value added in the field of AIC, etc. The study results can be possibly used by agribusiness management bodies at all levels while implementing the agricultural and rural development programs in the Northwestern Federal District.

2. Based on the results of calculating the sustainability coefficients of indicators of the level and quality of life, some patterns have

been identified for rural areas of the Northwest, including a downward trend in rural poverty with varying degrees of sustainability (high, low, weak, absent), as well as the degree of intraregional income inequality between rural and urban populations. In the light of reproduction of the rural population, the indicators of the dynamics stability of the net reproduction coefficient over the regions in the Northwestern Federal District from 2003-2022 were considered. Specially were separated over the periods from 2003-2012 and from 2013-2022, including an assessment of the sustainability of the longevity index of the rural population in the Northwestern Federal District from 1991-2023, with a conclusion about diametrically opposed trends in these processes.

3. Approaches to selecting the indices, indicators and methods for studying the sustainability of agro-industrial production were justified, and a set of indices and indicators has been formed duely accounting for the specifics of agricultural production in the Northwest under the economy digitalization. It has been revealed that the indicators of the stability of the dynamics of both the physical volume of GVA and the stability of the dynamics in the growth rate of agricultural production in the Northwestern Federal District are deteriorating. The proposed research approach to further studying the sustainability of agro-industrial production in the North-West of Russia, accounting for the digitalization of the economy, involves an assessment of aggregate factor productivity (AFP) and its components, primarily technological efficiency.

4. Objectives, basic principles, indicators and indicators of the sustainability of supply chains in the AIC are substantiated in the context of changes in intersectoral price parities, increasing inequality of intersectoral exchange between agriculture and other sectors of AIC. By calculating the coefficient of stability for agricultural production dynamics based on the Spearman rank correlation, with adjustments for the inflation rate relative to 2014, differences in the stability of the supply chain formation between agricultural enterprises and farms in their long, short and ultrashort chains, including the increasing polarization of the intraregional development of supply chains of milk and dairy products, were revealed.

5. Scientific approaches, principles, priorities and mechanisms for ensuring the sustainability of land use in the Northwest regions with large areas of persisting abandoned agricultural land are substantiated. The methodological positions of the study, indicators, dynamics, the degree

of intensity of territorial shifts in agricultural land use and urgent tasks at all levels of AIC are identified, allowing to mitigate the risks of land disposal from economic turnover.

N-W CIRPFEM – Separate Structional Division f SPC RAS

North-West Centre of Interdisciplinary Researches of Problems of Food Maintenance (N-W CIRPFEM – SPC RAS) is the legal successor of the VASHNIL Department for the non – Chernozem zone of the RSFSR, established by the Decree of The Central Committee of the Communist Party of the Soviet Union and Council of Ministers of the USSR of March 20, 1974 No. 206.

By the Decree of the RSFSR Council of Ministers dated April 3, 1990 No. 107, the VASHNIL Department for the non – Chernozem zone of the RSFSR was transformed in the Regional Department of the Russian Academy of Agricultural Sciences for the non-Chernozem zone of the Russian Federation. In compliance to the Decree of the President of the Russian Federation "About the Russian Academy of Agricultural Sciences" dated January 30, 1992 No. 84 the united Russian Academy of Agricultural Sciences was established based on the Russian Academy of Agricultural Sciences and the All-Union Academy of Agricultural Sciences, and N-W CIRPFEM was transferred to its management.

Due to liquidation of the Regional Branch of the Russian Agricultural Academy for the non-Chernozem zone of the Russian Federation, and by the Order of the Russian Agricultural Academy dated January 04, 1996 No. 29 was established the North-West Scientific Center of the Russian Agricultural Academy. In compliance to the Order of the Russian Agricultural Academy dated November 16, 2001 No. 85 the North-Western Scientific Center of the Russian Agricultural Academy was transformed into the State Research Institution: North-West Scientific-Methodical Center of the Russian Agricultural Academy. According to the Order of the Russian Agricultural Academy dated June 23, 2009 No. 81 the State Research Institution: North-West Scientific-Methodical Center of the Russian Agricultural Academy was converted into the State Research Institution: North-West Regional Scientific Center of the Russian Academy of Agricultural Sciences.

Based on the Order of the Federal Agency for Scientific Organizations dated December 15, 2014 No. 1320, the State Research Institution: North-West Regional Scientific Center of the Russian Academy of Agricultural Sciences was renamed to the Federal State

Research Institution: "North-West Center for Interdisciplinary Researches of Food Maintenance".

In compliance with the Federal Law "On the Russian Academy of Sciences, reorganization of State Academies of Sciences and amendments to certain legislative acts of the Russian Federation" of September 27, 2013 No. 253-F3 and Decree of the Government of the Russian Federation of December 30, 2013 No. 2591-p N-W CIRPFM was turned over to the management of the Federal Agency for Scientific Organizations.

By the Decree of the Russian Federation President of May 15, 2018 No. 215: "On the structure of Federal Executive Authorities" and by the Order of the Russian Government of June 27, 2018 No. 1293-p N-W CIRPFM is transferred to The Ministry of Science and Higher Education of the Russian Federation management.

According to the Order of the Ministry of Science and Higher Education of the Russian Federation of July 08, 2020 No. 768 N-W CIRPFM received a status of the SPC RAS separate structural division.

N-W CIRPFM – SPC RAS does basic, exploratory and applied research in the field of food security, with due account for the developing and mastering innovative technologies for the production, storage and processing of environmentally safe agricultural products.

Candidate of Technical Sciences Yury A. Tyukalov is the Center Director.

Candidate of Agricultural Sciences Danilova, Tat'yana A. is the Center Scientific Secretary.

Department of Agriculture and Crop Production

Head of Department: Arkhipov, Mikhail V., Chief Researcher, Doctor of Biological Sciences, Professor, Winner of the USSR Council of Ministers Prize, Honored Scientist of the Russian Federation – methods of microfocus radiography, X-ray technology for assessing latent damage to grain and seeds of agricultural crops, X-ray selection of grain batches with a minimum level of latent injury, scientific problems of food safety and agricultural raw materials safety, tyukalov.y@spcras.ru, maikl.arh1pov@yandex.ru.

Department research areas

The fundamental basics of developing the adaptive farming systems, managed seed production and agrotechnologies aimed at acquiring new knowledge in the conservation and reproduction of soil fertility, effective use of the natural resource potential of the North-West of Russia and the production of competitive and high-quality crop products to ensure food and environmental safety.

New Research Results

1. New knowledge and experimental data on the assessment of the agronomic effectiveness in the use of meliorants of products for technological processing of woody and shrubby vegetation (WSV) of various nature on annual grasses under contrasting agroecological conditions (soils of heavy and light granulometric composition, natural and precision soil moisture regimes), proving that use of a complex of traditional meliorants (CTM) increases productivity of herbs by 36% and completely eliminates the negative effects of plowing down various WSR products into the soil.

2. New knowledge on visualization of hidden defects in the grain of spring wheat of phytosanitary origin (in a form of darkening of a groove), whose proportion varies from 45 to 72% depending on the region of cultivation, as well as experimental data on developing new digital system for integrated grain quality control based on identified violations of the internal structure of the grain and the relationship between crops and technological indicators of grain quality (correlation coefficients range from 0.5 to 0.8).

3. New experimental data on the evaluation of the effectiveness of potato tubers saturation with selenium due to the introduction of micro

fertilizers into the soil and foliar treatments with sodium selenate on soils of varying degrees of cultivation in order to control the production process and self-fortification.

4. New knowledge on evaluating the effectiveness of new promising bacterial cultures based on *Bacillus* sp. strains against root rot and helminthosporiosis spots on barley, that increase the photosynthetic ability and resistance of the plant to diseases and environmental stress factors.

Department of Animal Husbandry and Environmental Management of the Arctic

Head of Department: Layshev, Kasim A., Chief Researcher, Doctor of Veterinary Sciences, Professor, Academician of the Russian Academy of Sciences – Arctic zone of the Russian Federation, sectors of conventional nature management, epizootic and epidemiological welfare, reindeer husbandry, improved reindeer husbandry technologies, problems of rational nature management and environmental safety of the Arctic, layshev@mail.ru. йш K.A.)

Department Research Areas

Development and implementation of innovative technologies for rational use of biological resources of the Russian Federation's Arctic zone to ensure food and environmental safety of the region, obtaining new knowledge on monitoring and forecasting the most common new bacterial, viral, parasitic infections, invasions and improving the control system for animal diseases of various etiologies in the Far North of Russia based on the effective diagnostic and treatment schemes and prevention, new knowledge on the basic principles in developing methods for effective use of the gene pool and management of the breeding process in order to further enhance the genetic potential of reindeer husbandry.

New reesearch results

1. New knowledge as regards the comparative assessment of craniometric parameters of Siberian and Far Eastern taiga deer and the analysis of seasonal metabolic changes in Nenets reindeer, proving that craniometric studies, as part of comparative phenotypic studies of deer of different megaecotypes, show significant constancy of these parameters over the past 50 years and thus allowing for their use at the identification of northern deer via neural networks. The analysis of seasonal metabolic changes in Nenets reindeer under year-round grazing conditions made it possible to establish that the biochemical parameters of domestic reindeer only in the summer season are not subjected to fluctuations depending on gender.

Novgorod SRAI – Branch of SPC RAS

The Novgorod Research Institute of Agriculture (NSRAI) was established as the Novgorod Regional Integrated Agricultural Experimental Station in accordance with the Decree of the Council of Ministers of the USSR dated January 30, 1950 and the Order of the Ministry of Agriculture of the USSR dated February 08, 1950 No. 237.

“Novgorod SRAI” is the legal successor of the Novgorod Research and Design – Technological Institute of Agriculture, formed in accordance with the Decree of the USSR State Agricultural Committee of August 19, 1988 No. 63 and the Order of the VASHhNIL Department for the non – Chernozem zone of the RSFSR of September 19, 1988 No. 127.

In compliance to the Decree of the President of the Russian Federation "About the Russian Academy of Agricultural Sciences" dated January 30, 1992 No. 84 and the All-Union Academy of Agricultural Sciences, the unified Russian Academy of Agricultural Sciences was established, and “Novgorod SRAI” was transferred to its management.

Based on the Federal Law "On the Russian Academy of Sciences, reorganization of State Academies of Sciences and amendments to certain legislative acts of the Russian Federation" of September 27, 2013 No. 253-F3 and Decree of the Government of the Russian Federation of December 30, 2013 No. 2591-p “Novgorod SRAI” was turned over to the management of the Federal Agency for Scientific Organizations.

By the Decree of the Russian Federation President of May 15, 2018 No. 215: “On the structure of Federal Executive Authorities” and by the Order of the Russian Government of June 27, 2018 No. 1293-p “Novgorod SRAI” is transferred to The Ministry of Science and Higher Education of the Russian Federation management.

In accordance with the Order of The Ministry of Science and Higher Education of the Russian Federation of December 18, 2019 No. 1399 “Novgorod SRAI” became a branch of St. Petersburg Federal Research Center of the Russian Academy of Sciences

The Novgorod Research Institute does basic and applied research in the technological, economic, and social development of the agro-industrial complex of the Novgorod region and the Russian Federation as a whole.

Candidate of Agricultural Sciences Zhukova, Maria Yu. is the Branch Director, zhukova.m@spcras.ru.

The Branch Research Areas

Optimization of doses of mineral and organic fertilizers for agricultural crops, resource-saving technologies in the use of mineral fertilizers for agricultural crops, databases intended for designing the adaptive landscape farming system (ALFS) and agrotechnologies. Feeding the farm animals, feed additives and their effect on the body of farm animals of different age groups, cattle breeding and stock rearing, crossbreeding of cattle in various trends of productivity. Patterns of forming the long-term agrophytocenoses, agroecological tests of non-traditional, new and introduced crops. Drainage modes, drainage technologies, design of drainage systems, environmental aspects of drainage.

New Research Results

1. Theoretical foundations have been developed for developing a project aimed at improving the technology of restoration and construction for reclamation systems and the production of feed out introduced crops of sorghum and millet under the climate change as based on the analysis of references and experimental data; as well as the improved feed crop rotations using microbiological fertilizers in technological operations – "Arksoil Nitrogen" and "Arksoil Phosphorus" along with mineral fertilizers that ensure the production of environmentally friendly feed with a productivity over 7.6 thousand tons. units/ha, the nutritional value of digestible protein is over 0.41 t/ha and the energy intensity of production of thousand of tons of feed units is from 2.5 to 2.7 GJ.

2. New knowledge has been gained on the formation of ecological regimes in land reclamation systems under abnormally wet growing season, when shallow and standard drainage structures with backfilling of the drainage trench with chips, as well as hollows, including the combination with a cultivation strip, increased the yield of hay of perennial grasses by 25-50%; new knowledge on the introduction of sorghum and millet crops as fodder crops in the Novgorod region. The varieties of paiza Krasava, Stapize, Gulliveria, Sudanese grass Sofia, Yanika, Zlata, Zemlyachka, SSG Navigator, millet of the seed Satellite and Regent showed high adaptive properties. The yield of green mass was 23.5-32.4 t/ha for paiza varieties, 30.1-59.0 t/ha for Sudanese grass, 31-38 t/ha for SSG Navigator, and 19.7-20.3 t/ha for one crop of Sudanese Zemlyachka grass and sugar sorghum; new knowledge on the use of ultrafine humatesapropel suspension in the diets of young cattle, obtained from extracts of lake sapropel. The UDGSS preparation, due to the high

concentration of biologically active substances included in its composition, at a dose of 5 ml per head per day, improves the digestibility of nutrients in the diet, normalizes blood composition, reduces feed costs per unit of production by 8.1-9.0%, and increases average daily gains by 8.8%.

CRCES RAS – Separate Structural Division of SPC RAS

Scientific Research Center for Ecological Safety of the Russian Academy of Sciences (SRCES RAS) was established as an Institute of the USSR Academy of Sciences based on the Decree of the Presidium of the USSR Academy of Sciences of March 19, 1991 No. 74 and the Decree of the Presidium of the Leningrad Scientific Center of the USSR Academy of Sciences of April 2, 1991 No. 01-78; in accordance with the Decree of the Presidium of the Russian Academy of Sciences of December 18, 2007 No. 274 renamed to the Institution of the Russian Academy of Sciences St. Petersburg Scientific Research Center for Ecological Safety of the Russian Academy of Sciences. Based on the Decree of the Presidium of the Russian Academy of Sciences dated December 13, 2011 No. 262, the name of SRCES RAS was changed to the Federal State Institution of Science St. Petersburg Scientific Research Center for Ecological Safety of the Russian Academy of Sciences. In compliance with the Federal Law "On the Russian Academy of Sciences, reorganization of State Academies of Sciences and amendments to certain legislative acts of the Russian Federation" of September 27, 2013 No. 253-Φ3 and Decree of the Government of the Russian Federation of December 30, 2013 No. 2591-p SRCES RAS was turned over to the management of the Federal Agency for Scientific Organizations. By the Decree of the Russian Federation President of May 15, 2018 No. 215: "On the structure of Federal Executive Authorities" and by the Order of the Russian Government of June 27, 2018 No. 1293-p SRCES RAS is transferred to The Ministry of Science and Higher Education of the Russian Federation management. According to the Order of the Ministry of Science and Higher Education of the Russian Federation of July 08, 2020 No. 768 CRCES RAS received a status of the SPC RAS separate structural division.

CRCES RAS – SPC RAS does basic and applied research in environmental safety.

Doctor of Geological and Mineralogical Sciences Tronin, Andrey A. is the Center Director.

Candidate of Legal Sciences Kodolova, Alyona V. is the Center Acting Deputy Director for Research.

Manvelova, Alexandra B. is the Center Acting Scientific Secretary

Laboratory for Bioelectronic Methods of Geoecological Monitoring

Head of Laboratory: Kholodkevich, Sergey V., Chief Researcher, Doctor of Technical Sciences, Academic Title – Senior Researcher – bioelectronic systems, methods for assessing the state of aquatic and terrestrial ecosystems, pollution biomarkers, kholodkevich.s@spcras.ru, kholodkevich@mail.ru.

Laboratory Research Areas

Development of bioelectronic systems and methods for early diagnostics of threats to environmental safety. Assessment of the ecological state of coastal marine and freshwater areas and terrestrial ecosystems, identification of biological effects of pollution of natural waters and sediments on representatives of local biota, functional state of aquatic invertebrates, cardio activity, intensity of aerobic metabolism (aerobic capacity) of invertebrates, testing the health of benthic invertebrates using the functional test method; analysis of the results of atomic adsorption spectrometry of heavy metal accumulation in soft tissues and shells of mollusks; biochemical parameters of oxidative stress in aquatic animals; effects of heavy metals, pharmaceutical preparations, etc. on the functional characteristics of invertebrates; comprehensive methods for assessing the environmental safety of marine and freshwater areas.

New Research Results

1. Simultaneous experimental assessment of the quality of biologically treated wastewater (BTW) at the South-Western Sewage Treatment Plants (SWP) at "Vodokanal of St. Petersburg" via the BioArgus bioelectronic system for continuous monitoring the water quality using narrow-toed crayfish *Pontastacus leptodactylus* as bioindicator and a standardized biotesting method on *Daphnia magna* Straus did not reveal any significant chronic toxic effect of BTW on these benthic and planktonic crustaceans. The results obtained indicate the adequacy of using biomonitoring technology based on the BioArgus bioelectronic system to assess the biological effects of chronic exposure to BTW.

2. Using the examples of local species of freshwater mollusks of the genera *Dreissena* and *Unio*, who live in most of natural reservoirs in the North-West and the European part of the Russian Federation, various characteristics of dynamic changes in the heart rate of bivalves, determined

by testing their adaptive capacity via functional testing methods, were proposed and tested as potential biomarkers for their functional state.

3. Based on the results of hydrobiological studies, a comparative study of the health indices of Dreissen mollusk and the content of pollutants in bottom sediments from two locations in the water area of the Bjerkesund Strait, in the reference location (Ravica Island) and in the area of production facilities (aquaculture landfill) “Transneft – Port Primorsk” LLC, as well as the content of petroleum products in the tissues of whitefish, was assessed the impact of the economic activities of “Transneft – Port Primorsk” LLC on the ecological state and biota of the Gulf of Finland.

Laboratory of Biological methods of Environmental Safety

Head of Laboratory: Kuzikova, Irina L., Leading Researcher, Candidate of Biological Sciences – biotechnology, environmental safety, biological damage of materials, physical disinfection methods, microbiology, biodiversity, kuzikova.i@spcras.ru, ilkuzikova@yandex.ru.

Laboratory Research Areas

Mechanisms of transformation of natural and anthropogenic ecotoxins and their impact on biota. New environmentally friendly materials and natural biocides for non-medical purposes. Innovative plasma technologies for disinfection of surfaces and liquid media contaminated by microorganisms. Stress responses of microorganisms of various taxonomic groups to the effects of ecotoxins. Methods of bioremediation of environmental objects contaminated with natural and anthropogenic ecotoxins.

New Research Results

1. It has been stated for the first time that the autochthonous microbiota of lakes in the cryolithozone (Yakutia, Russia) exhibits high efficiency in the degradation of MC-LR, regardless of the level of trophic activity, the presence or absence of toxic "blooms" in previous years. However, the bacterial community of the hypertrophic Dachnoye and Ytyk-Kyuyol lakes degraded MC-LR more actively and with a lower lag phase compared with the eutrophic Saysary and Ierely lakes, where no "blooming" had previously been observed.

2. Metagenomic analysis revealed changes in the taxonomic composition and species diversity of water microbiomes during the transformation of microcystin-LR. The taxonomic composition of the microbiomes of all the studied lakes during the MC-LR biodegradation is characterized by a low degree of similarity with the control variants (β -diversity), while the species diversity of prokaryotic microbiomes (α -diversity) increases. The dominance of Proteobacteria, in particular α - and β -proteobacteria in the process of destruction of MC-LR in the water samples of all studied lakes suggests that proteobacteria significantly contribute to the process of algotoxin biodegradation. The increase in the number of bacteria from the families Pseudomonadaceae (γ -proteobacteria), Sphingomonadaceae, Rhodobacteraceae, Rhizobiaceae

(α -proteobacteria) and Burkholderiaceae (β -proteobacteria) strongly indicates that they are actively involved in the degradation of MC-LR.

Laboratory of Remote Methods for Geo-ecological Monitoring and Geoinformatics

Head of Laboratory: Gorny, Victor I., Leading Researcher, Candidate of Geological and Mineralogical Sciences – remote sensing, image processing, thermodynamics of ecosystems, theoretical foundations of satellite mapping of risks and damages, gornyy.v@spcras.ru, v.i.gornyy@mail.ru.

Laboratory Research Areas

Study of the response of ecosystems to anthropogenic impact, reflected in the spatial and temporal variability of remotely measured characteristics of the underlying surface. Development of generalized criteria for ecosystem health, mapped from remote surveys. Assessment and forecast of risks and economic damages caused by climate warming in urbanized areas.

Thermodynamics of ecosystems, including urbanized ones served as the theoretical basis for assessing ecosystem health. On this theoretical basis, the risks and economic damages from premature mortality of the population caused by overheating of the urban environment, satellite mapping of atmospheric pollution and precipitation of aerotoxicants, and the impact of climate change on ecosystems, including agro – and urban ecosystems, are assessed. The main research method is digital processing of aerospace survey materials and ground-based observations.

Using the example of the Novgorod region, a method for the introduction of thermophilic crops in the Non-Chernozem zone of Russia is being developed jointly with the Novgorod Research Institute of Agricultural Sciences – SPB FIT RAS. The basis of this technology is the processing of long-term large amounts of digital information from satellite thermal surveys and the selection of the most heat-efficient agricultural land.

New Research Results

1. Digital map of the mesoclimatic indicator of the intensity of precipitation of air pollutants is theoretically justified as based on the example of the catchment area of the Gulf of Finland. Mesoclimatic conditions conducive to the precipitation of air pollutants have been identified in the south of the Leningrad Region, what explains the contamination of the territory of the Izhora Plateau with uranium and cesium isotope.

2. From the standpoint of environmental safety, the main directions of geoengineering projects to combat global climate change were considered and two groups of projects were identified: solar radiation management, reduction of greenhouse gas concentrations in the Earth's atmosphere. The positive and negative consequences of the possible implementation of these projects to environmental safety have been identified. A critical analysis of the main international legal principles of geoengineering contained in modern international documents is given, and the need for further development is emphasized.

3. Statistical processing of long-term satellite data on the content of aerotoxicants, water vapor, and the intensity of solar radiation in the atmosphere was performed over all regions of Russia, and showed a reliable association of high concentrations of nitrogen dioxide and sulfur with urban and industrial agglomerations. For most subjects of the Russian Federation, there has been an increase in the content of nitrogen dioxide and sulfur, aerosol and solar radiation, although in regions with high concentrations of nitrogen dioxide, such as Moscow, St. Petersburg, Moscow and Leningrad regions, there is a decrease. In most regions, there is a decrease in the average annual concentrations of formaldehyde, carbon monoxide and water vapor.

4. To study the impact of forest fires and transboundary pollution from China on air quality in the Russian Far East in July 2015 and January 2023, three-dimensional numerical modeling (WRF-Chem) was used in combination with ground-based and satellite observations of NO₂, CO, SO₂, O₃, aerosols. A reliable coefficient of statistical relationship between the concentrations modeled and observed at meteorological stations has been identified for NO₂ and CO.

Laboratory of Studying Migration Forms of Ecotoxics in Environment

Head of Laboratory: Kudryavtseva, Valentina A., Head of Laboratory, Candidate of Chemical Sciences – patterns and mechanisms of processes in water systems involving heavy metal compounds, adequacy of research methods, environmental safety, kudryavtseva.v@spcras.ru, valenkud@yandex.ru.

Laboratory Research Areas

Study of ecotoxicant migration processes in the environment; search and study of environmental risk zones, including: development of methodology and adequate methods for studying coexisting forms of ecotoxics and their transformation processes under the influence of natural and anthropogenic conditions; study of mechanisms of transformation, migration and accumulation of ecotoxics (heavy metals) in systems including complexing agents and sorbents of natural and anthropogenic origin; study of kinetic patterns of redistribution of metal ions in homogeneous and heterogeneous systems; development of new physico-chemical indicators that allow for a multifunctional and multiparametric assessment of the state of environmental objects.

New Research Results

1. Detected that changes in the physico-chemical state of the bottom sediments of the Chernaya Rechka of St. Petersburg in the period 2023-2025 lead to a significant increase in the concentration of soluble forms of zinc and cadmium in the bottom water layer, what is associated with anthropogenic impact and may have long-term consequences for the biogeochemical cycles of elements and the state of aquatic ecosystems, what requires further research and development of effective measures for their rehabilitation.

2. Set of sensitive biotest systems has been identified, including representatives of various systematic groups that characterize negative changes in the urban river ecosystem under anthropogenic influence, which will increase the reliability of ecotoxicological monitoring.

Laboratory of Full-Scale Ecological and Chemical Research

Head of Laboratory: Zhakovskaya, Zoya A., Leading Researcher, Candidate of Biological Sciences – instrumental analysis of environmental pollution, the problem of new (emerging) pollutants, transformation of pollutants in the environment, natural ecotoxins
zhakovskaya.z@spcras.ru, zoya.zhakovskaya@gmail.com.

Laboratory Research Areas

The problem of new ("emerging") environmental pollutants. Non-targeted ("sample of unknown composition") and targeted analysis of new and little-studied environmental pollutants in the water bodies of the North-Western region. The problem of harmful "blooms" in reservoirs: a study of the structure of phytoplankton communities and their toxic metabolites. Development of analytical procedures for determining trace amounts of anthropogenic and natural ecotoxins in environmental objects. Instrumental physico-chemical methods of analytical chemistry (chromatography-mass spectrometry, giant raman scattering (GCR), biosensor systems). Study of transformation processes of various groups of anthropogenic ecotoxins. Prediction and study of biologically active properties of newly synthesized organoelement compounds.

New Research Results

1. For the first time, based on data obtained in the interval from 2017-2023, a general positive trend has been set to reduce contamination with organotin compounds (OOC) in the bottom sediments of the eastern part of the Gulf of Finland with the existence of separate zones of abnormally high pollution.

2. For the first time, based on a multifactorial analysis of the observation results, an anthropogenic correlation factor was identified between the presence of environmental pollutants in sediments and pollutants (Pb, V, Zn, Co, Br), which can be used to predict the formation of environmental accumulation zones and their mapping.

3. For the first time, three organophosphorus esters (OPEs) were detected in bottom sediments and biomass of aquatic plants from four lakes in Yakutia: TCPP, TCEP, TEP, confirming the ability of aquatic vegetation to accumulate OPEs.

4. For the first time, N,N-diethyl-m-toluamide (DEET), being a marker of anthropogenic pollution of aquatic ecosystems, was detected in bottom sediments and biomass of aquatic plants from four lakes in Yakutia.

5. In a model experiment to evaluate the effect of a new ecotoxicant, organophosphorus flame retardant/plasticizer trichloropropyl phosphate (THPP) on aquatic biota, the negative effect of concentrations of 500 and 1000 ng/l of THPP observed in reservoirs on key vital parameters of benthic crustaceans (amphipods) was shown. A high bioremediation potential of a number of aquatic plants (hornwort, elodea, duckweed) in relation to THPP in concentrations in water at a level below the MPC was detected.

6. New information has been obtained on the structural, chemical and biologically active properties of new synthesized compounds (E)-(2-chloro-2-phenylethenyl)(diamine)phosphine oxides. Their biological activity against enzymes of the cholinesterase family has been proven.

Laboratory of Methods for Rehabilitation of Technogenic Landscapes

Head of Laboratory: Bakina, Lyudmila G., Doctor of Biological Sciences, Associate Professor – soil ecology, toxicological studies, methods of rehabilitation of technogenically disturbed soils, bakina.l@spcras.ru, bakinalg@mail.ru.

Laboratory Research Areas

Assessment of soil quality and health under various types of man-made impacts, primarily pollution (oil, heavy metals, complex pollution). Determination of critical values of stress factors leading to significant violations of soil functioning. The study of the patterns of self-healing processes depending on the type of soil and the type of disturbance. The study the suitability and effectiveness of rehabilitation methods for technogenically disturbed (polluted) soils, depending on the type of soil and the bioclimatic conditions of the area.

New Research Results

1. Study of nitrogen cycle processes in oil-polluted soils of the podzolic type revealed that oil, as a source of carbon and a toxic compound at the same time, affects the microbiological transformation of nitrogen compounds in two ways, first inhibiting and then stimulating the processes of ammonification and nitrification, what was established by studying mobile nitrate and ammonium forms of nitrogen. The most important results of the study are the detected patterns of changes in the content of total and mobile nitrogen in oil-polluted sod-podzolic soil, depending on the concentration gradient over 20 years of field experience.

2. For the first time, metabolic profiling (non-targeted metabolomics) has been used to determine the metabolites of podzolic soils and their trends of change under conditions of oil pollution. In polluted soils, the content of sterols and flavonoids decreases, but most of the metabolites that oil has a negative effect on are found among carbohydrates. An increase in the content of phenolic compounds, terpenoids, and organic acids in oil-contaminated soils indicates that these metabolites are specific to such soils and indicates the possibility of their use as biomarkers of contamination.

3. In a long-term field experience on oil pollution of podzolic soils, it has been set that a characteristic feature of the taxonomic structure

of micromycete complexes of oil-polluted soils is the presence of species with phytotoxic properties that predominate in number. Soil toxicity caused by the allelopathic activity of micromycetes increases in time, despite the fact that the phytotoxic effect of petroleum products themselves decreases. The dynamics of changes in the allelopathic activity of micromycetes during oil pollution indicates a long-term negative effect on the biological properties of the soil and its fertility. The nature of the change in allelopathic activity depends on the type of soil. The highest allelopathic activity and the associated toxic effect on plants persist the longest in ecologically vulnerable soils depleted of organic matter and nutrients – sandy podzols.

4. Comprehensive studies have been performed on the agrochemical, toxicological and microbiological assessment of compost from municipal solid waste (MSW) (organo-mineral fraction less than 10 mm) produced at the Novy Svet-ECO landfill (Leningrad Region). The potential agronomic value of compost as a fertile soil for plant growth in terms of the content of basic nutrients and indicators of acid-base properties has been detected. A set of parameters has been proposed and tested to assess the degree of stabilization of organic matter and the readiness of compost for safe use based on the dynamics of their microbial respiration, indicators of nitrogen cycle processes and toxicity. The studied toxicological parameters of the compost allowed for classifying them as hazard classes IV-V (low-risk and practically non-dangerous) in accordance with MNR Order No. 536.

5. Detailed study of the chemical and biological parameters of soils in the gardens of the Russian State Museum identified a contradiction between their negative ecological and chemical assessment (exceeding the existing MPC and APA standards for heavy metals, petroleum products and benz(a)pyrene) and very satisfactory indicators of soil quality and health (more than favorable agrochemical properties, absence of toxicity and stable functioning of the complex soil microorganisms in terms of respiratory activity). This casts doubt on the objectivity of the standards developed in the 70s and 80s of the last century and necessitates their adjustment for urban soils based on an assessment of the real quality and health of soils at different levels of pollution.

Laboratory for Economic Problems of Environmental Safety

Head of Laboratory: Donchenko, Vladislav K., Chief Researcher, Doctor of Economic Sciences, Professor, Honored Scientist of the Russian Federation, Winner of the Academician M.I. Budyko Prize awarded by the Government of St. Petersburg and the St. Petersburg Scientific Center – economics of environmental management, environmental policy, environmental safety, donchenko.v@spcras.ru, donvk2020@mail.ru.

Laboratory Research Areas

Analysis of ecological, economic and legal approaches to the assessment of ecosystem health, ecosystem adaptation processes to climate change. Comparative analysis of legislation in the field of ecosystem health, environmental monitoring, adaptation to climate change, and hydrometeorological safety in Russia and the CIS member states. The study of institutional foundations, the determination of objects, subjects of a unified system for monitoring a health status of ecosystems in the North-West of Russia, the structure of a unified system for monitoring the health status of ecosystems in the North-West of Russia.

New Research Results

1. Gaps have been identified in the Russian environmental legislation, expressed in the absence of a distinction between monitoring of natural resources and the environment, the inability to establish a legal regime for meteorological and hydrological monitoring, as well as legal uncertainty regarding the levels of such monitoring, which should be eliminated by amending the legislation of the Russian Federation current legislation.

2. In 2025, the model law "On Environmental Monitoring" was adopted, as developed by NITSEB RAS – SPB FIT RAS.

IL RAS – Separate Structural Division of SPC RAS

In February of 1944, the Presidium of the USSR Academy of Sciences issued an Order on Establishing the All-Union Laboratory of Lake Science within the Department of Geological and Geographical Sciences in Leningrad, the main task assigned was "development of theoretical issues of lake science: origin and history of the development of main types of lakes; study of the lakes' water chemical and thermal balance; lakes' mineral, energy, plant and animal raw materials basis; lakes' influence upon the climate". The founder and ideological inspirer of the Laboratory development was an outstanding limnologist G.Yu. Vereshchagin.

Institute of Limnology of the Russian Academy of Sciences (IL RAS) was founded by the Decree of the Presidium of the USSR Academy of Sciences of July 29, 1971 No. 731. Based on the Decree of the President of the RSFSR of November 21, 1991 No. 228 "On the organization of the Russian Academy of Sciences", IL RAS became a part of the Russian Academy of Sciences as the Institute of Limnology of the Russian Academy of Sciences. In compliance with the Decree of the Presidium of the Russian Academy of Sciences dated December 18, 2007, No. 274 IL RAS was renamed to the Institution of the Russian Academy of Sciences: Institute of Limnology RAS. By the decree of the Presidium of the Russian Academy of Sciences dated December 13, 2011 No. 262, IL RAS was renamed into the Federal State Institution of Science: Institute of Limnology of the Russian Academy of Sciences.

In compliance with the Federal Law "On the Russian Academy of Sciences, reorganization of State Academies of Sciences and amendments to certain legislative acts of the Russian Federation" of September 27, 2013 No. 253-FL and Decree of the Government of the Russian Federation of December 30, 2013 No. 2591-p IL RAS was turned over to the management of the Federal Agency for Scientific Organizations. By the Decree of the Russian Federation President of May 15, 2018 No. 215: "On the structure of Federal Executive Authorities" and by the Order of the Russian Government of June 27, 2018 No. 1293-p IL RAS is transferred to the Ministry of Science and Higher Education of the Russian Federation management.

According to the Order of the Ministry of Science and Higher Education of the Russian Federation of July 08, 2020 No. 768 IL RAS received a status of the SPC RAS separate structural division.

IL RAS – SPC RAS does basic and applied research in limnology; developing methods intended for in-depth comprehensive study of the structural and functional features of lake ecosystems, restoration of lakes and reservoirs, their use for drinking water supply purposes, fish farming and recreation; solving lakes' monitoring and managing problems as well as tasks of their natural resources' rational use.

Doctor of Geographical Sciences Anokhin, Vladimir M. is the Institute Head.

Trifonova Mariya S. is the Institute Acting Scientific Secretary.

Laboratory of Geography and Hydrology

Head of Laboratory: Naumenko, Mikhail A., Doctor of Geographical Sciences, Professor – thermal processes in lakes, lake morphometry, climate change, remote methods, naumenko.m@spcras.ru, m.a.naumenko@mail.ru.

Laboratory Research Areas

Study of hydrological aspects of the transformation of energy and matter in various types of water bodies. Study of thermal and dynamic processes in Lake Ladoga and other large dimictic lakes in contact – via remote methods in a changing climate. History of lakes, bioindication, evolution of lake ecosystems, paleolimnological methods, application of GIS technologies in complex limnological research. Assessment of the natural resource potential of the Russian lake fund and its role in the water resources of Eurasia through the GIS technologies. Pronosing the trends of changes in the volume of Eurasian water resources and their ecological status, with due account for the socio-economic development of the regions; developing basic research fundamentals as regards the protection and rational use of lake natural resources; innovative approaches to the use and regulation of aquatic ecosystem resources.

New Research Results

1. Phenomenological model of annual changes in bottom temperatures depending on the depth of the Limnic region of Lake Ladoga has been developed. The model parameters are climatically significant physical characteristics that are important both for comparison with other dimictic lakes in the world, as well as for analyzing climate changes and verifying thermohydrodynamic models.

2. The ecological and geochemical features of the accumulation of heavy metals in the bottom sediments of lakes in the RF North-West, experiencing varying degrees of anthropogenic stress, including those applicable to aquaculture purposes, have been determined. A comprehensive assessment of both the total metal content and their chemical forms, determining the potential environmental hazard, has been performed for different types of reservoirs. It has been specified that zinc is the main element accumulating in bottom sediments in areas affected by cage trout farming, what is important for assessing the risk of secondary

contamination of the water column and developing methods for geoecological monitoring of aquaculture reservoirs.

3. Results of the paleolimnology group.

4. Based on palynological analysis, new data have been obtained in the North and Southeast of Lake Ladoga on the history of the lake basin in the Late Pleistocene and Holocene. The patterns of accumulation of phosphorus, metals and organic matter in the Holocene under the influence of revealed changes in climatic characteristics and under the influence of anthropogenic factors have been established. In the skerry area of Lake Ladoga, patterns of changes in the species composition of diatom complexes and the content of siliceous microalgae characteristic of the open part of Lake Ladoga, which were observed in the second half of the Holocene, have been confirmed for the first time.

- Formation of new lakes on the Island of Valaam is going on for the last 3,000 years. The reconstruction of the stages of the isolation process of these lakes made it possible to identify the features of the restructuring of lake ecosystems during this period. In all the lakes studied, the separation process was accompanied by a reduction in species diversity or the complete disappearance of macrophytes.
- Distinctive feature of bottom sediments from the areas of Lake Ladoga, less remote from the shores, was revealed, expressed in a sharp decrease in the organic matter content of about 4000-3600 cal. l.n., what allows it to be considered a regional signal of the activation of erosion processes as a result of the formation of the Neva River and the fall in the level of Lake Ladoga.

5. Using reanalysis data, weather station materials, and satellite data, a methodology has been developed for data deficiency conditions and the total evaporation for the months of the warm period (May-September) from 2016 to 2022 has been calculated for 512 lakes in the forest-steppe zone of the Tobolsk-Ishim interfluvium. On the example of Lake Baikal. Bolshoe Berdyyuzhye the dependence of the water level in September on the climatic parameters of the warm period is considered. The highest correlation of the level was established with the indices of aridity and total evaporation.

Hydrobiology Laboratory

Head of Laboratory: Dudakova, Dina S., Researcher, Candidate of Biological Sciences – hydrobiology, limnology, meiobenthos, lake landscape studies, dudakova.d@spcras.ru, judina-d@yandex.ru.

Laboratory Research Areas

Development of theory of evolution, functioning, sustainability and restoration of lakes in various geographical zones; development of theory of eutrophication process of inland water bodies and scientific forecast for restraining this process considering natural-climatic and anthropogenic factors; comprehensive study of Lake Ladoga – the largest lake in Europe; influence of alien species on ecosystems of inland water bodies; metabolomics of aquatic photosynthetic organisms; theory and practice of combating cyanobacterial "blooming".

New Research Results

1. In a result of the work carried out in 2025 on a network of stations in the Southern part of Lake Ladoga, results were obtained on a previously unexplored biological community – microphytopsammon – on landscapes represented by sands of different types. In the landscape structure of Lake Ladoga, the southern part is allocated to a separate landscape district. Its maximum area is occupied by a flat, slightly sloping glacial-lacustrine coastal plain composed mainly of sandy sediments with sands of varying degrees of size. In the ecosystem structure of southern landscapes, microphytopsammon, using sandy sediments as a substrate, plays a significant role in the flows of matter and energy. Studying this component of the ecosystem allows us to get an idea of the spatial and component structure of the autotrophic link and use it to analyze trophic relationships at subsequent trophic levels. For the studied stations covering a depth range of 3.5-25 m, it was found that planktonic species that settled to the bottom, but continued to actively vegetate, played the most significant role in the formation of algae accumulations at all depths. In shallow water, species of other ecological groups participated in the formation of microphytobenthos, but conditions in the littoral do not allow the formation of sufficiently large masses of algae.

2. In a study of the elements of the ultrastructure of the shell of achnanthoid diatoms using scanning electron microscopy (SEM), the presence of the *Achnanthidium sublineare* species belonging to the

Achnantheidium minutissimum species complex, as well as *A. anastasiae*, *A. parallelum* and *A. pussillum*, previously classified in the genus *Rossithidium*, was determined for the first time in the diatom flora of Ladoga. The assessment of the ecological occurrence of *A. anastasiae*, *A. parallelum*, and *A. pussillum* has shown that these species have a high indicator value in regard to various trophic conditions. *A. parallelum* is characterized as a species that prefers mesotrophic conditions, while *A. anastasiae* and *A. pussillum* are types of eutrophic conditions. *Achnantheidium sublineare* prefers waters of low mineralization and oligotrophic trophic conditions. Thus, the use of SEM has significantly increased the accuracy of determining the species composition of the *Achnantheidium minutissimum* complex, and the morphologically difficult-to-distinguish group of achnantheid diatoms in general, which ultimately increases the effectiveness of using diatoms in bioindicating environmental conditions in the Ladoga littoral.

Hydrochemistry Laboratory

Head of Laboratory: Ignatieva, Nataliya V., Senior Researcher, Candidate of Geographical Sciences – hydrochemical regime of lakes, anthropogenic transformation of lake ecosystems, mass transfer at the water-bottom interface, internal load, reservoirs of urbanized territories, geochemistry of bottom sediments, ignatieva.n@spcras.ru, natali_ignatieva@mail.ru.

Laboratory Research Areas

Development of a theory of the process of eutrophication of inland reservoirs and a scientific forecast of the containment of this process, taking into account natural, climatic and anthropogenic factors. Development of the theory of transfer and transformation of chemicals in the "catchment area – reservoir – bottom sediments" system. Comprehensive study of Lake Ladoga. The study of the role of natural and anthropogenic factors in the evolution of lakes in the geological past by geochemical parameters.

New Research Results

1. For the lake located in the Northwestern Ladoga region. A narrow one, the meromictic status of which was confirmed by routine studies in 2025, revealed the accumulation of reduced iron compounds in non-miscible hypolimnion (monimolimnion), while hydrogen sulfide was only occasionally detected organoleptically in some layers of the anaerobic zone in trace concentrations below the sensitivity limit of the analytical definition, which gives reason to classify the type of hypolimnial anoxia of the lake as "iron" (ferruginous, siderotrophic). There are few reservoirs with the ferruginous type of meromixia in the world, and in Russia, according to the data of 2021, only seven are known.

2. Results of studying the hydrochemical regime of the main tributaries of Lake Ladoga confirmed the presence of a downward trend in the concentration of total phosphorus in the water of all rivers of the southeastern coast, which began in 2019. For the Volkhov River, the main supplier of this most important biogenic element to the lake, since 2011, the decrease in phosphorus intake into the lake has been statistically significant. According to observations made on Lake Ladoga in the summer, changes in the hydrochemical regime have been revealed, indicating the predominance of destructive processes in recent years – a decrease in the values of the

hydrogen pH index and a decrease in the heterogeneity of its distribution, undersaturation of the surface layer of water with dissolved oxygen in a significant part of the water area, a noticeable deficiency of mineral phosphorus not only in the water of the coastal zone and in the epilimnion, but also in the hypolimnion of the deep-water zones of the lake, which can limit the productive activity of phytoplankton in the trophogenic layer.

3. In the littoral zone of Lake Ladoga, where, as in previous years of research, the values of a number of hydrochemical indicators differ markedly from those typical for the main body of water of the lake, the areas most susceptible to the process of eutrophication are Shchuchy Bay and Volkhovskaya Bay. Relatively high concentrations of the reduced form of nitrogen in the area of Priozersk and in some areas of the littoral of the northern skerry region may indicate the presence of contaminations.

4. Based on the results of geochemical analysis of the sediment column selected in the least studied southeastern part of Lake Ladoga, it was set that sedimentation in this zone occurred under unstable conditions, however, reliable division of the sediment column into zones by the nature of the vertical distribution of forms of phosphorus, petrogenic elements and metals is not possible. In the lake. In the Nikonovsky – island lake ecosystem of the northern part of Lake Ladoga, the conditions and parameters of sedimentation differed significantly from those for the open part of Ladoga, while undergoing significant changes at different stages of the lake ecosystem development.

Laboratory of Complex Problems of Limnology

Head of Laboratory: Anokhin, Vladimir N., Leading Researcher, Doctor of Geographical Sciences – geomorphology, coastal processes, anohin.v@spcras.ru, vladanokhin@yandex.ru.

Laboratory Research Areas

Study of the structure of bottom layers in freshwater reservoirs using geophysical methods, the search for places of discharge of groundwater via isotopic methods. Development of ultrasonic methods to combat cyanobacterial blooming in small reservoirs. Determination of the composition and concentration of trace elements in loose bottom sediments, assessment of the degree of microplastic contamination of the water column and bottom sediments of various types of water bodies, including Lake Ladoga. Study of the modes of accumulation of biogenic compounds in bottom sediments. Development of methods for obtaining an ultrafine suspension of humic sapropel and its use in agriculture to increase its efficiency. Aquatic mycology, waters' toxicity and reservoirs' ecology.

New Research Results

1. Based on the results of long-term bottom sampling over the entire area of Lake Ladoga and granulometric analysis, a new version of the Ladoga sediment scheme has been compiled, which shows the distribution features of various types of precipitation: the bottom in the central and northern parts of the lake is mainly covered by polytuff – siltstone deposits, in the southern – sandy deposits of various dimensions. The underwater hills are composed of clays and sands, mostly of glacial origin.

2. Study of environmental impact of the trout farms continued. A study of the ecological and geochemical features of the accumulation of heavy metals in the bottom sediments of lakes in the North-West of the Russian Federation, experiencing varying degrees of anthropogenic stress, including those used for aquaculture purposes has been exercised. Local and general patterns of accumulation of trace elements in bottom sediments under trout farms, necessary for the development of a monitoring system for fish farming in the regions of the Russian Federation, have been identified. Role of organic matter from the lake bottom sediments in binding potentially toxic metals into stable complex compounds has been assessed.

3. In a result of studying the microplastic content in the water, fish and shellfish of Lake Ladoga, it was found that the highest microplastic

content is recorded in the organisms of predatory fish species, what is associated with their trophic features; velocity models have been developed describing the effect of microplastics on metabolic processes and the natural death of zooplankton, it was found that in Ladoga this effect is minimal.

4. According to the data of a large-scale landscape bottom photography close to PPM in Pitkyaranta, a landscape diagram was obtained, that among other deposits, showed an area with soil consisting of pulp production waste, free of living organisms, what presented an evidence of the ecological hazard caused by the dumping waste from the central processing plant into the waters of Lake Ladoga.

5. Geological and geomorphological route studies in the inner zone of the island of Pellotsaari revealed a system of steep subvertical ledges up to several tens of meters high, linearly elongated mainly in the submeridional and north-northwesterly directions, which gives a reason to consider these ledges expressions of tectonic faults – discharges. This new fact clarifies the tectonic structure of the island of Pellotsaari and its surroundings.

Laboratory of Mathematical Modeling Methods

Head of Laboratory: Kondratyev, Sergey A., Chief Researcher, Doctor of Physical and Mathematical Sciences, Honorary Worker of Science and Technology of the Russian Federation – mathematical modeling of mass transfer processes in the catchment area – watercourse – reservoir system, forecasting possible changes in the external load on water bodies as a result of climatic and anthropogenic factors, kondratyev.s@spcras.ru.

Laboratory Research Areas

Development of the theory of transfer and transformation of matter and energy in the catchment area-watercourse-reservoir system by mathematical modeling methods. Performing predictive assessments of changes in water bodies and their catchments under the influence of anthropogenic and climatic changes.

New Research Results

1. Model of the external load of heavy metals on a water body from a catchment area has been developed. It has been identified that the intake of pollutants from the surface of the catchment area into a water intake with surface runoff and with soil washout products determines the quality of water and bottom sediments in a water body. And the heterophase-nonconservative mass transfer in the "water body – sediments – alluviums" system determines the dynamics of the hydrochemical and geochemical composition of the individual components of this system. At the same time, unregulated economic activity in the catchment area makes a significant contribution to the diffuse and point-to-point influx of pollutants into the water body. Methods for assessing the intake of pollutants, in particular, the developed model of the external load of heavy metals on a water body will make it possible to assess the contribution of the anthropogenic component to the overall pollution of a water body, calculate the effectiveness of implementing the best available technologies as a result of numerical experiments, and the calculation results using these methods will provide initial information for models of the internal load of pollutants.

2. Model of the internal load on a water body with heavy metals from bottom sediments has been developed. The model is based on hydrodynamic equations supplemented by two-phase mass transfer algorithms and algorithms for accounting for the diversity of bottom sediments to calculate the mass of pollutants adsorbed on bottom soil

particles. The model has been tested on the dambed of the Kuibyshev reservoir in calculations of the gross copper content in the water area under adverse hydrometeorological events.

3. First stage of the development of a methodology for remote estimation of the watershed-lake models parameters in areas that are difficult to access for field observations has been completed via using satellite images. The main result of the investigation is an automated methodology for assessing the boundary and surface structure of catchments based on satellite images. The model developed in the framework of this study is an integrated automated algorithm in the QGIS environment that combines hydrological analysis and methods of decoding the underlying surface into a single scheme, which is planned to be supplemented in the future by assessing the biogenic load on the reservoir from the catchment area. The model has been initially tested on the lakes of the Ladoga catchment area and has shown its operability.

4. Based on the results of 3D modeling, the estimates of the spatial and temporal variability of the parameters of hydrothermodynamic (HTD) processes in Lake Ladoga for the period from 1990 to 2020 were performed. The variability of ice conditions in the lake, its temperature regime, as well as the time of origin, existence, and degradation of the thermal frontal zone, the thermobar, was assessed. The calculation results confirmed that the main contribution to the increase in the vertically averaged average annual temperature of the lake is due to the mitigation of winter climatic conditions. The temperature increase in all areas of the lake occurs during the ice age, whereas there are no temperature trends during the open water period. The calculated temperature indicators correspond to the results obtained from the time dynamics of the RICI arctic index, which indicate a warming of the regional climate in winter.

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