

70 YEARS OF THE GEOPHYSICAL CENTER OF THE RUSSIAN ACADEMY OF SCIENCES: HISTORY AND CURRENT STATE

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Abstract: This paper outlines the main milestones in the evolution of the Geophysical Center of the Russian Academy of Sciences (GC RAS) over its 70-year history. It covers the period from the establishment of the Interdepartmental Committee for the Preparation and Conducting the International Geophysical Year under the Presidium of the USSR Academy of Sciences to the formation of a progressive academic institute. Particular attention is paid to the individuals who contributed to the development of the scientific potential of the institute. We discuss the modern directions of fundamental research of the GC RAS and emphasize those, which are highly demanded in solving crucial applied problems.

Keywords: International Geophysical Year, Russian Academy of Sciences, geophysical observatories, magnetic survey, geoinformatics, geomagnetism, space weather, radioactive waste disposal, Russian Arctic, artificial intelligence.

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Background

The first steps in coordinating worldwide research in geosciences were taken in the first half of the 19th century, including the discovery of new lands and the expedition of Alexander von Humboldt. However, the real onset of the international cooperation in geophysics dates back to August 1, 1882 when the First International Polar Year (IPY) started. This scientific program united 12 countries and coordinated 15 polar expeditions. Its research areas included studying the processes in the high latitudes of the Northern Hemisphere, weather, climate, ice drift and geomagnetic phenomena. Over 1882–1883, the President of the International Polar Commission was Heinrich von Wild, the Academician of the Saint Petersburg Academy of Sciences. 50 years later, the Second IPY started on August 1, 1932. It was aimed mainly at studying magnetic storms, ionosphere, cosmic rays and relationships with solar activity. Forty-four countries participated in the implementation of the Second IPY. During one year, more than 100 stations were deployed both in the Northern and Southern polar regions. Despite the general success of the two IPYs, some failures were also revealed. For instance, the neglect of providing the centralized, secure and reliable storage for the collected data led to their significant loss during World War II. Thus, both the achievements of the Second IPY and its faults confirmed the need for coordinated efforts by geophysicists around the world.

In 1952, the International Union of Geodesy and Geophysics (IUGG), International Union of Radio Science (URSI) and International Council of Scientific Unions (ICSU) put forward an initiative to conduct the International Geophysical Year (IGY) in 1957–1958. By the decision of the Council of Ministers of the USSR, the Interdepartmental Committee for the Preparation and Conducting the IGY under the Presidium of the USSR Academy of Sciences (IGY Committee) was created on July 19, 1954 (Figure 1). Academician Grigory Gamburtsev, a prominent geophysicist and Director of the Geophysical Institute of the USSR Academy of Sciences, was appointed Head of the IGY Committee. On July 5, 1955, the Council of Ministers of the USSR issued a decree defining the principles of geophysical data exchange with foreign partners, and also obliging industry to manufacture equipment for conducting IGY observations. Another important resolution on organizing and supporting research in Antarctica by the USSR conducted by international community in the course of IGY preparation was issued by the Council of Ministers of the USSR on July 13, 1955.

In 1955, Academician Ivan Bardin, Vice President of the USSR Academy of Sciences, became the Chairman of the IGY Committee. By that time, Academician Bardin had vast experience in managing the entire metallurgical industry of the country. Therefore, he was a worthy candidate for the position of the IGY Committee Chairman, which he held during the IGY (1957–1958) and until 1961. Four distinguished scientists were appointed Deputy Chairmen: Corresponding Member Vladimir Belousov (geotectonist), Corresponding Member Yuri Boulanger (gravimetrist), Professor Nikolay Pushkov (geomagnetist) and Doctor of Science Feophan Davitaya (climatologist). Professor Valeria Troitskaya (space physicist) was appointed Scientific Secretary of the IGY Committee.

The main goals of the IGY Committee were planning and coordination of complex geophysical research conducted under international projects and programs, and a comprehensive scientific approach to the objects under study. Another important task was establishing reliable and long-term data storage and free exchange of the data collected in the course of the IGY. More than 100 scientific organizations of the USSR took part in the IGY implementation. The IGY was the largest international scientific event of the mid-twentieth century. It united scientists from 67 countries, which at that time constituted 2/3 of the countries in the world.

Among the most outstanding results of the IGY, the following should be mentioned. Apparently, the pivotal outcome was the launch of the first artificial Earth satellite “Sputnik-1” on October 4, 1957, which marked the beginning of the space era (Figure 2a). Despite the absence of specific scientific equipment, the basic radio beacon installed onboard made it possible to obtain new knowledge about the ionosphere properties, including the density, distribution of electron density and its influence on the propagation of radio waves. Another important goal accomplished in the course of the IGY was the deployment of the unprecedented observational network of scientific stations in the Soviet Union (Figure 2b). These stations provided measurements covering all the thematic sections within the IGY Committee: Meteorology and Atmospheric Physics, Geomagnetism, Auroras, Solar Activity, Cosmic Rays, Ionosphere, Meteors, Longitudes and Latitudes, Oceanology, Glaciology, Seismology, Gravimetry, Rockets and Artificial Earth Satellites. For handling the vast volume of the observation results collected worldwide from all sections of the IGY program, the World Data Centers (WDCs) were established in the USA (WDC A) and USSR (WDC B) by the National Governments. The WDCs provided the unprecedented mechanism for ensuring data preservation and free access for researchers worldwide. Other important scientific results of the IGY included the empirical support of the radiation belts in the magnetosphere by Academician Sergei Vernov (USSR) and Prof. James Van Allen (USA).

The absolute success of the IGY encouraged the world community to extend the IGY to 1959. The Decree of Presidium of the USSR Academy of Science on October 21, 1958 obliged the Ministry of the Maritime Fleet, Main Directorate of the Hydrometeorological Service under the Council of Ministers of the USSR and other organizations and academies of sciences of the Soviet Union republics to ensure in 1959 the implementation of scientific research according to the plan approved by the IGY Committee. The studies of Antarctica in

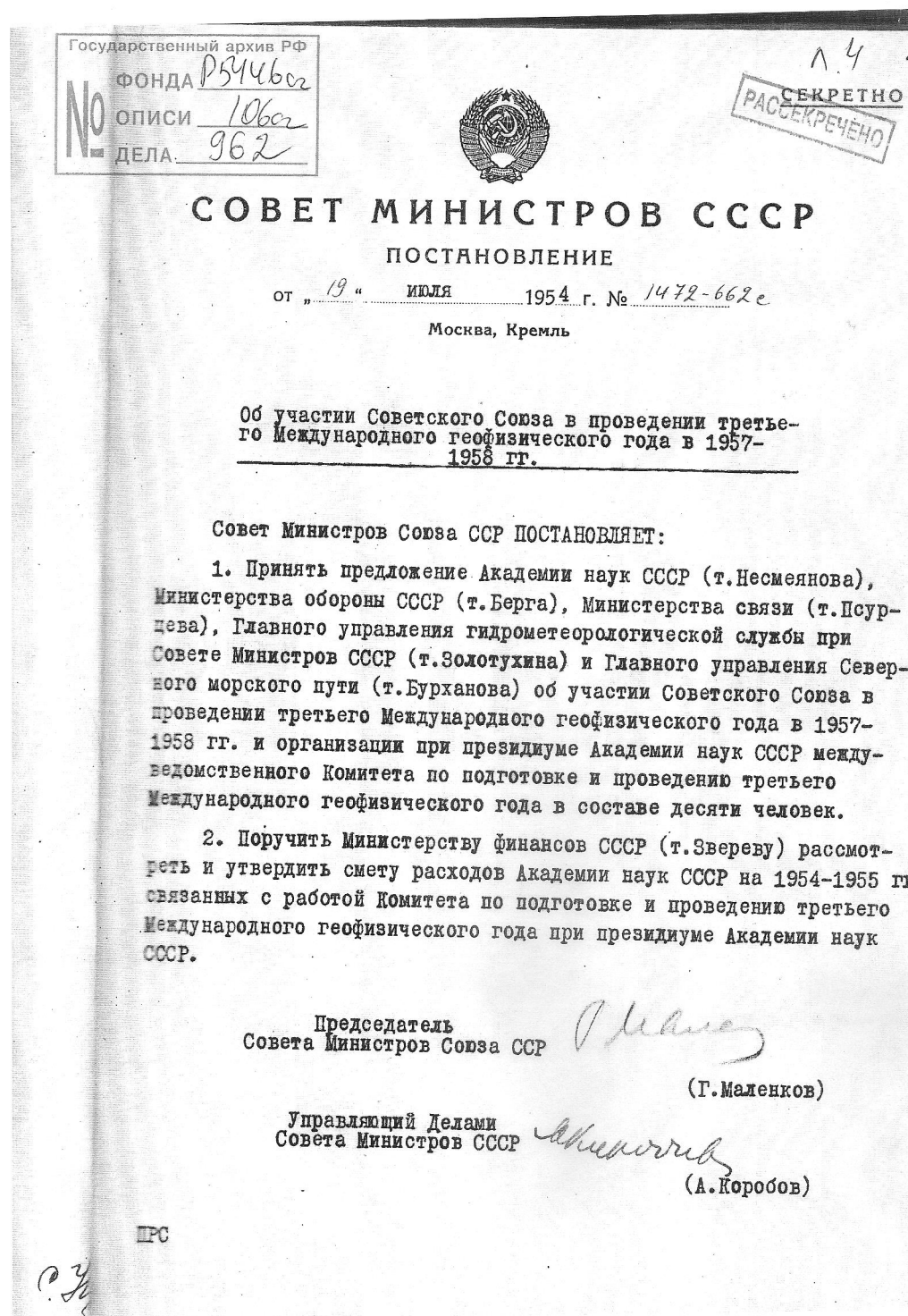


Figure 1. Decree of the Council of Ministers of the USSR on creation of the IPY Committee signed by Prime Minister Georgy Malenkov.

the fields of geophysics, geology and nature, as well as special measures for the processing of materials from Antarctic expeditions and the publication of scientific papers were especially valuable for the scientific community. The Computing Center of the USSR Academy of Sciences was assigned the task of processing the results of observations submitted by the IGY Committee [Lyubovtseva et al., 2020].

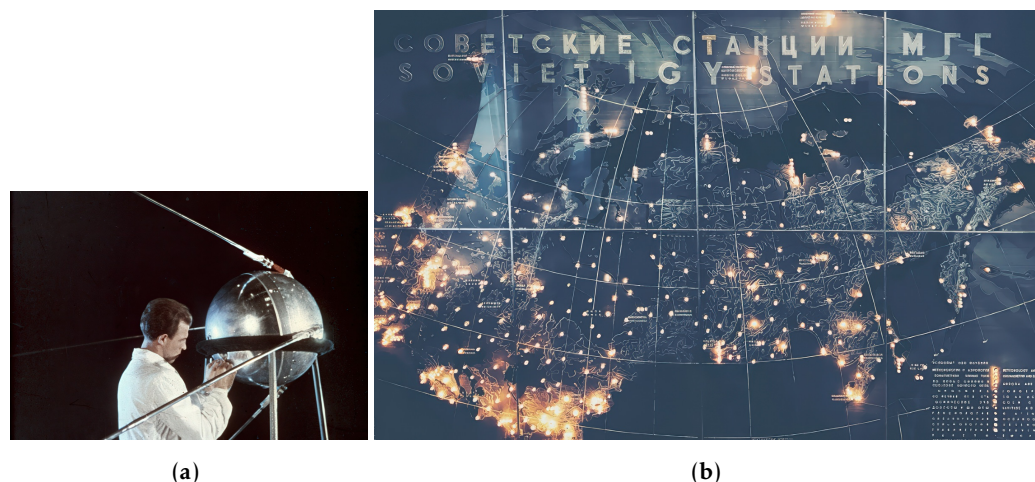


Figure 2. The first artificial Earth Satellite “Sputnik-1” launched on October 4, 1957 (a) and the map of Soviet scientific stations deployed in the course of the IGY, 1957–1958 (b).

To preserve and enhance the legacy of the IGY, the Interdepartmental Geophysical Committee (IGC) under the Presidium of the USSR Academy of Science was created in January 1961. The prescribed goals of the IGC were as follows:

- Coordination and planning of complex geophysical research under international projects and programs;
- Operation of WDC for Solar-Terrestrial Physics and WDC for Solid Earth Physics (since 1971) within the structure of the IGC;
- Ensuring the participation of the USSR in the relevant international organizations of the International Council of Scientific Unions (ICSU) and International Union of Geodesy and Geophysics (IUGG);
- International data exchange on planetary geophysics.

In 1961–1990, the Director of the IGC was Corresponding Member Vladimir Belousov, a well-known geologist and IUGG President (1960–1963). Over 1975–1985, the number of employees increased up to 91 people mainly due to new scientific workers of the WDCs. In 1980, 28 employees were under 30 years of age. An important organizational enhancement of that time was the creation of the temporary laboratory “Atomic and Subatomic Data Center”. The Committee gradually became a full-fledged research institute.

In 1990, a well-known seismologist, Corresponding Member Gennady Sobolev became the Director of the IGC; he held this position until 2005. In June 1992, the IGC was renamed and transformed into the Geophysical Center of the Russian Academy of Sciences (GC RAS) within the structure of the Geoscience Department of the RAS and the name of the institution remains until now. All functions of the IGC were transferred to GC RAS. Additionally, GC RAS became responsible for data collection and exchange between World Data Centers worldwide and became a host for the National Geophysical Committee of IUGG. The research directions of the institute expanded towards seismology, earthquake prediction, geoecology and altimetry.

Geophysical Center RAS in its current status

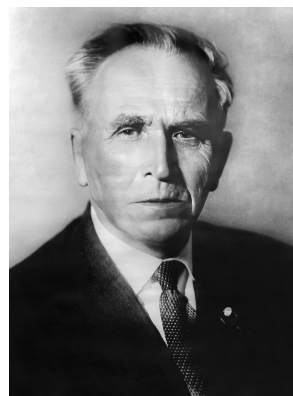
A new era of the GC RAS development started when Academician Alexey Gvishiani became its Director in July 2005. He merged the Center of Geophysical Data Studies and Telematics Applications (CGDS, a department of the Schmidt Institute of Physics of the Earth RAS), which he headed at that time, with GC RAS. The CGDS included a powerful shared computing center, which became a part of the GC RAS facilities. Immediately after that, GC RAS was appointed a National coordinator of the Electronic Geophysical Year (eGY) Programme (2007–2008) initiated by IUGG on the 50th Anniversary of the IGY. Among other initiatives, eGY stimulated creation of international virtual laboratories.

GC RAS significantly expanded cooperation with many foreign institutions and increased its visibility and recognition in Russia and worldwide. The involvement of GC RAS in IUGG, ICSU, CODATA and the International Institute of Applied Systems Analysis (IIASA) was notably strengthened. Being CODATA Vice President (2002–2006), in 2005 Academician Gvishiani became the Chair of the CODATA National Committee in Russia. In 2014, he was elected as Vice Chairman of the IIASA Scientific Council. Later on he became an Acting Chair of the IIASA Council [Gvishiani *et al.*, 2018a,b, 2019a,b].

Under the leadership of Academician Gvishiani and his team, GC RAS became a full-scale multifunctional and multipurpose geophysical institute. The scope of the scientific research areas at the institute became even broader by developing fundamental and applied studies in the field of geophysics, geodynamics, geodesy, geoinformatics, system analysis and related Earth sciences and their information support. GC RAS has intensified field works including geophysical observations using ground based and airborne equipment for both fundamental and applied research. GC RAS has revived and coordinates high-precision geomagnetic observations in Russia. Since 2010, the network of geomagnetic observatories in Russia and near-abroad countries has been significantly expanded. The institute management pays much attention to intensive recruitment of young scientists. Because of the efficient management, GC RAS was classified as a first category institution by the Ministry of Science and Higher Education. Academician Gvishiani's directorship lasted until 2018. Figure 3 depicts portraits of all Chairs and Directors from 1954 to 2018 [Gvishiani *et al.*, 2021, 2020a,b; Lyubovtseva *et al.*, 2019, 2022].



Full member of the
AS of the USSR
Grigory Gamburtsev



Vice President and Full
member of the AS of the
USSR
Ivan Bardin



Correspondent member
of the AS of the USSR
Vladimir Belousov



Correspondent member
of the RAS
Gennady Sobolev



Full member
of the RAS
Alexei Gvishiani

Figure 3. Chairs of IGY Committee, IGC and Directors of GC RAS over 1954–2018.

GC RAS has become a key scientific organization in solving a number of important applied problems for industries. Below we mention some of them. In particular, GC RAS provides the full range of services ensuring the geomagnetic support of high-tech directional drilling process, which is now an essential part of oil and gas production. It includes ground and airborne high-precision geomagnetic surveys, deployment of magnetic observatories, a complete description of static and time-varying magnetic fields in a three-dimensional environment, and a forecast of geomagnetic disturbances. In also involves artificial intelligence methods for real-time multi-criteria recognition of magnetic activity and specific IT infrastructure for handling Big Data, which together form the MAGNUS (Monitoring and Analysis of Geomagnetic aNomalies in Unified System) software-hardware system. This approach provides precision navigation of the drill string, which achieves hitting the target with an error of 3 m at a distance of 15 km from the wellhead. This science-driven result significantly contributes to increasing the efficiency of mineral deposit development. The expansion of GC RAS applications for the oil and gas industry triggered the creation of a new Geophysical Monitoring Sector in 2023, headed by Dr. Dmitry Kudin since that time. Figure 4 shows a map of the oil and gas fields where the relevant GC RAS services are being introduced. The map also shows the network of magnetic observatories maintained by GC RAS and regional research institutions.



Figure 4. Map of oil and gas fields where GC RAS provides geomagnetic support technology for directional drilling, and magnetic observatories in Russia and neighboring countries, which transmit data to Analytical Geomagnetic Data Center at GC RAS.

The applied geodynamics researches of GC RAS are highly demanded by the nuclear industry. The results obtained in the field of studying the modern movements and modeling the stress-strain state of the Earth's crust as well as seismic hazard assessment are used for justification of geoecological safety of highly radioactive waste disposal. In particular, GC RAS is responsible for estimating the stability of the geological environment in the area of construction of the underground research lab in the Nizhnepansk massif for monitoring the disposal of highly radioactive waste (Figure 5). GC RAS does the full package of works, including both field and office research to summarize experimental and theoretical materials.

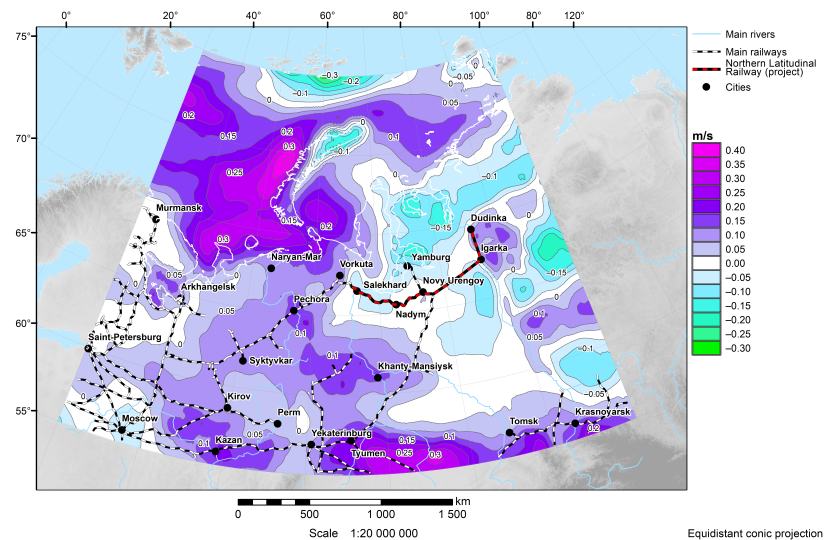


Figure 5. Construction of the underground research lab in the Nizhnekansky massif for monitoring the disposal of highly radioactive waste (<https://strana-rosatom.ru/>).

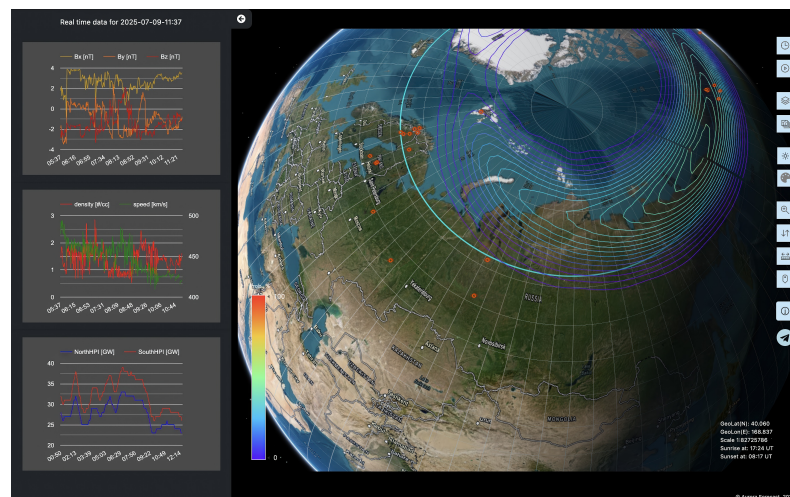
A number of geoinformatics products have been developed for the transport and energy industries. They include electronic atlas on climate change in the Russian Arctic since 1950 and its forecast up to 2100 for the Russian Railways. This atlas contains more than 1000 maps and provides information on spatiotemporal variability of the following hydrometeorological parameters both for vast regions and along railway mainlines: air temperature at the surface, atmospheric precipitation, wind speed at the surface, soil temperature, soil moisture content, air humidity, and snow thickness (Figure 6a). Another product is the online system for the short-term forecast of aurora intensity and auroral oval position (Figure 6b). It allows to predict the locations of excitation of the intense geomagnetically induced currents harmful for railways, power transmission grids and gas pipelines.

GC RAS is the only manufacturer in Russia of the hardware-software system ORBUS for interactive spherical visualizations. It enables visualizing various dynamic global processes of the stars, planets and Earth (natural and anthropogenic) on a sphere up to 1 m radius. This system has been manufactured and installed in several museums, universities, space agencies and other organizations as well as at many exhibitions in Russia and abroad (Figure 7). All the above-mentioned activities stimulated the significant expansion of the fleet of scientific instrumentation.

Since 1998, GC RAS publishes a peer-reviewed “Russian Journal of Earth Sciences” (RJES), which covers all areas of the Earth sciences and interdisciplinary results integrating the achievements of relevant scientific disciplines (<https://rjes.ru/>). Dr. Andrey Grachev (DSc) and Dr. Vitaly Nechitailenko (PhD) greatly contributed to the development of the journal in its infancy. Starting from 2018, the RJES Editor-in-Chief is Academician Alexey Gvishiani. The languages of this fully online journal are English and Russian. For today, authors from more than 10 countries have published more than 800 papers in it (Figure 8). Over the last 10 years, RJES has attracted more than 20,000 readers. The journal is indexed in the following main bibliographic databases: Scopus (Q3), Web Of Science (Q4), “White List” (Q2) and RSCI (Q1). It publishes special issues on request and admits urgent publications, exceeded size and translation service for fee. In his capacity of the head of the GC RAS Electronic Publications Laboratory Dr. Ernest Kedrov is a prominent driving force of the RJES “engine”.



(a)



(b)

Figure 6. Map of the wind speed change between 2010–2021 and 1980–1989 from the Electronic Atlas on Climate for the Russian Arctic [Gvishiani *et al.*, 2023] (a) and short-term forecast of aurora intensity and auroral oval position using the online system <https://aurora-forecast.ru/> (b).

Scientific achievements of GC RAS are regularly highlighted by the President of RAS and Head of RAS Geoscience Division and reported to the Russian Government on a yearly basis. In 2017–2024, these achievements were:

1. Recognition of the secular acceleration pulses of the core geomagnetic field at the core-mantle boundary using magnetic observatory data (2017);
2. Algorithm for sequential recognition of the earthquake prone areas (2017);
3. Creation of the stochastic seismicity model with exponential distribution of the earthquake productivity (2019);
4. Studying the fine structure of geomagnetic disturbances and geomagnetically induced currents in power grids (2019);
5. A new model of the geothermal heat flow for the Arctic (2022);
6. The most complete and representative catalog of earthquakes in the Russian Arctic with a unified magnitude scale (2023);
7. Discovery that the boundary between the North American and Eurasian lithospheric plates represents a broad diffuse zone in Siberia (2024).



(a) (Photo by M. Zakharov)



(b)

Figure 7. Hardware-software system ORBUS installed at the museum of Kazan Federal University (a) and exhibition “Russia” in Moscow (b).

Since 2016, GC RAS organizes annual International and All-Russian Schools of Young Scientists. So far, more than 700 eminent lecturers and young researchers attended these events from more than 14 regions of Russia and abroad (Armenia, France, Germany, Italy, UK, Uzbekistan, ...). Since 2021, a particular emphasis is placed on the study of natural processes in the Arctic (Figure 9).

For the intense knowledge exchange in geosciences, the institute organizes GC RAS Online Scientific Seminar on a biweekly basis since 2016. Prominent Professor Alexey Lushnikov chaired the Seminar in 2016–2021, and afterwards Academician Alexey Gvishiani took over. More than 100 seminar’s online meetings have been held so far where more than 120 reports from Russia and abroad have been made. In total, the Seminar has attracted more than 300 participants, which makes it all-Russian event. A particular attention is paid to involving young scientists. The GC RAS researchers quite often appear in mass media reports and broadcasts. Some screen shots over the last several years along with media sources are given in Figure 10.

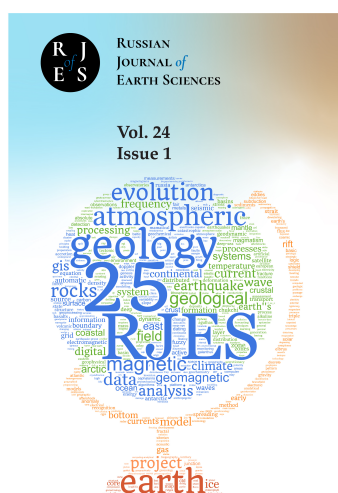


Figure 8. Cover of the 25th Anniversary issue of the RJES.



(a) (Photo by M. Zakharov)



(b)

Figure 9. Attendees of the All-Russian School of Young Scientists “System Analysis of the Natural Process Dynamics in the Russian Arctic” organized by the GC RAS in 2022 (a) and 2023 (b).

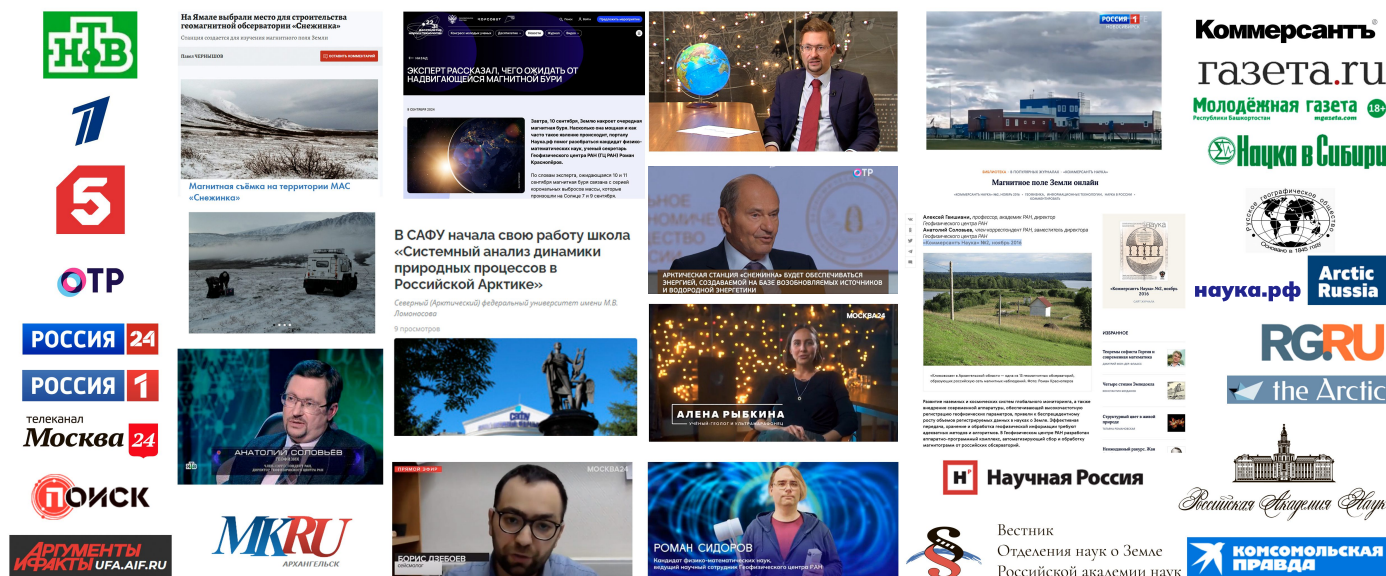


Figure 10. Screen shots of mass media reports and broadcasts featuring the GC RAS staff and media sources.

In 2018, the GC RAS management was renewed [Solovieva and Gvishiani, 2022; Solovieva and Nikitina, 2025]. Anatoly Soloviev, Corresponding Member of RAS, successfully headed the institute during his first term in 2018–2024. In September 2024, he was re-elected and appointed for the second 5-year term. Since 2017, Academician Alexei Gvishiani serves as Chief Scientist and Scientific Council Chair [Kedrov, 2023]. Dr. Boris Dzeboev (DSc) is Deputy Director for Science, Maxim Pasishnichenko is Deputy Director for General Issues and Dr. Roman Krasnoperov (PhD) is Scientific Secretary. The GC RAS management team is shown in Figure 11. The present day organizational structure of the institute is shown in Figure 12. GC RAS possesses a large fleet of modern world-class scientific equipment, which is essential in the activities of all structural divisions.



Figure 11. GC RAS management team as of 2024: Anatoly Soloviev, RAS Corr. Member, Director (2018–2024, re-elected 2024); Alexei Gvishiani, RAS full member, Chief Scientist, Scientific Council Chair; Boris Dzeboev, DSc, Deputy Director for Science; Maxim Pasishnichenko, Deputy Director for General Issues; and Roman Krasnoperov, PhD, Scientific Secretary.

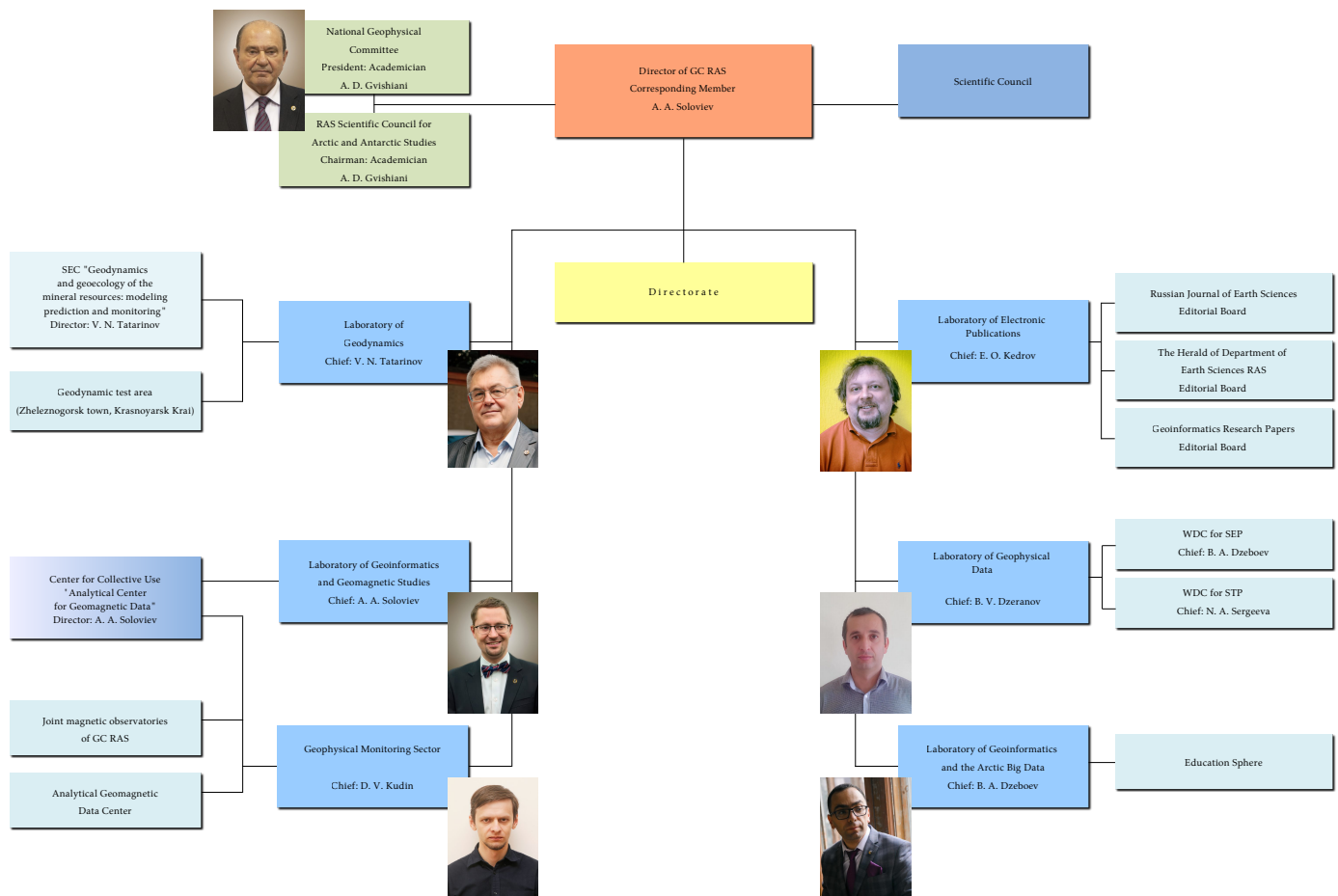


Figure 12. The GC RAS structure and heads of departments.

As of 2024, the GC RAS staff consists of 110 employees including 6 RAS members, 21 DSc's, 27 PhD's and 38 young researchers (up to age 39). Some staff member photos including those taken during field works are given in Figure 13. GC RAS representatives hold important positions in such international organizations as IIASA, IUGG, IAGA and CODATA. A special attention is paid to strengthening cooperation in geophysics and remote sensing with research institutions from the BRICS countries, including those under the China Earthquake Administration and the Ministry of Natural Resources of China, the South African National Space Agency and others. Today, the Geophysical Center of RAS is a new type of prominent research institute that efficiently combines fundamental research with high-priority applied projects.



Figure 13. The GC RAS staff.

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