Anatoly SOLOVIEV

Degrees

- D.Sc. in physics and mathematics (Schmidt Institute of Physics of the Earth of the Russian Academy of Sciences, 2014);
- Ph.D. in physics and mathematics (Schmidt Institute of Physics of the Earth of the Russian Academy of Sciences, 2005).

Academic titles

- Corresponding member of the Russian Academy of Sciences (2016);
- Professor of the Russian Academy of Sciences (2015).

Education

- In 2002-2005, Post-graduate study at the Schmidt Institute of Physics of the Earth of the Russian Academy of Sciences;
- In 1996-2002, Higher education in Applied Mathematics at the Moscow State Institute of Steel and Alloys.

Positions in Russia

- Since 2019, Director of the Geophysical Center of the Russian Academy of Sciences;
- In 2018-2019, Acting Director of the Geophysical Center of the Russian Academy of Sciences;
- Since 2014, Deputy Director for Science of the Geophysical Center of the Russian Academy of Sciences;
- Since 2010, Head of Laboratory of geoinformatics and geomagnetic studies of the Geophysical Center of the Russian Academy of Sciences;
- In 2005-2010, Leading researcher of the Geophysical Center of the Russian Academy of Sciences;
- In 1999-2005, Researcher of the Schmidt Institute of Physics of the Earth of the Russian Academy of Sciences.

Scientific interests include

- Mathematical methods of data mining in geophysical applications:

- clustering in multi-dimensional data sets,
- morphological analysis and recognition of anomalies in time series;
- Geoinformation systems for geoscience data storage and analysis;
- Geomagnetic field studies using methods of geoinformatics;
- Systems of high quality observations of geomagnetic field.

Main scientific results

The algorithm "Crystal", designed to detect areas of increased density in multidimensional data sets, was developed. It can be considered a post-clustering algorithm, as classical algorithms of cluster analysis are focused on the clustering - the simultaneous combination of high density and separation. At the same time, "Crystal" solves the problems associated only with the first property. The formal foundation of "Crystal" is a fuzzy measure of proximity in the initial data array. In combination with the Euler deconvolution method the developed method allows the geometric characteristics and the modules of direction of magnetic moment vector of anomalies generating bodies with high resolution to be determined. It was confirmed by the successful application of the method to examine and clarify the geological structure of the Hoggar region (Algeria) according to the aeromagnetic survey. In particular, it was shown for the first time that tectonically similar areas, comprising the Hoggar massif, are characterized by the common direction of rock magnetization. A map, illustrating and predicting the depths of the crystalline basement roof was constructed, complementing the available geological data.

The Atlas of the Earth's Magnetic Field was developed and published, which reflects the evolution of the geomagnetic field from 1500 to 2010. The Atlas contains both the results of the latest achievements in modeling and mapping the magnetic field, and the results of direct geomagnetic observations and modeling in historical epochs. The Atlas is intended for a wide audience, including scientists, teachers, students and experts of applied Earth sciences. It is a unique cartographic product with the most comprehensive and scientifically sound characteristics of the charted phenomenon of geomagnetism.

For the first time an automated algorithmic system for the recognition of anthropogenic anomalous events in geomagnetic records using fuzzy logic and pattern recognition was developed. Due to its efficiency and accuracy, this system is comparable with the corresponding methods used by hand in the INTERMAGNET program. An algorithm learning system was optimized and a formalized method of evaluating the performance of algorithms for recognition of anomalous anthropogenic events on magnetograms during periods of quiet magnetic field and increased magnetic activity was developed. With the help of the developed algorithmic system the automated recognition of anthropogenic anomalies on the one-second magnetic data was carried out and the quality criteria applicable to second and half-second data were developed. The application of algorithmic system to recognition of anthropogenic anomalies in continuous mode

allows the definitive (verified) data to be obtained in near real time. The latter gives an opportunity to address the challenges in the field of operational modeling and space physics.

A new approach to modelling secular variation of the geomagnetic field and recognition of secular acceleration pulses using observatory data solely has been elaborated. Using this approach several unstudied pulses have been revealed, which contributes to understanding dynamic processes in the Earth's liquid processes. Efficiency of the obtained results gives strong grounds for the method application to studies of secular acceleration pulses over historic epochs.

The system of high quality ground-based observations of the Earth's magnetic field on the territory of the Russian Federation and near-abroad countries was significantly developed. New geomagnetic observatories of the highest INTERMAGNET standard have been deployed in Moscow region ("Mikhnevo"), Arkhangelsk region ("Klimovskaya"), Leningrad region ("Saint Petersburg"), Murmansk region ("White Sea"), Republic of Armenia ("Gyulagarak"). The Trans-Regional analytical center for the collection and processing of geomagnetic data (http://mag.gcras.ru/) was established on the basis of GC RAS. Due to a number of parameters, the center exceeds its foreign counterparts through the adoption of methods of automated analysis of incoming data and quasi real-time calculation of complete values of magnetic field components.

A method for detecting and monitoring geomagnetic activity based on the totality of ground-based observations of the Earth's magnetic field using discrete mathematical analysis (DMA) and GIS technologies was developed. While recognizing the activity the method allows monitoring the dynamics of magnetic storm expansion over the globe in real time. Evaluation of geomagnetic activity in different regions of the Earth is given in a single scale, while its local specificity is taken into account. The method does not require the identification of magnetically quiet days to determine Sq-variations. The developed measure of anomaly helps to analyze the subtle internal structure of magnetic storms, the dynamics of their development, both across the globe and within regions. The method was tested on the example of two strong geomagnetic storms observed during the 23rd solar cycle, based on the entire global network of INTERMAGNET magnetic observatories with 1-minute sampling rate.

Basing on DMA the algorithmic detection of anomalous events in the time series of variations of the bottom water pressure, recorded by the worldwide network of bottom sensors of the hydrostatic pressure in the open ocean, was developed. The established system is capable to detect events in the accumulated data, not included into the available global catalogs of earthquakes and tsunamis because of their small magnitude. The method was used in solving the problem of recognition of the time segments corresponding to signals from underwater earthquakes (P-waves) and tsunami waves on the records of observations of DART-2 (Deep-ocean Assessment and Reporting of Tsunamis) system.

A multidisciplinary intellectual GIS "Data on Earth Sciences for the Territory of Russia and Neighboring Countries" was established (http://gis.gcras.ru/), continuously updated with new geospatial geological and geophysical data.

Currently the analytical components of GIS based on mathematical methods of data mining are being developed.

A technology has been developed for modeling the current field in the polar ionosphere with the identification of vortex current structures using ground-based data in quasi-real time. A modified phenomenological model of a coronal mass ejection is proposed that satisfies all Maxwell's equations.

An interactive GIS has been developed for short-term forecasting of the intensity of auroras and the position of the auroral oval in real time. The influence of space weather on the reliability of the functioning of industrial infrastructure in the Russian Arctic has been studied in detail.

Comprehensive studies of geomagnetic storm diagnostics based on observations of secondary cosmic rays have been carried out.

A digital climate atlas of the dynamics of the main hydrometeorological parameters of the Russian Arctic for 1950–2021 has been created.

For the first time, an expert GIS-oriented database has been created to assess seismic hazard on the territory of the Russian Federation.

Positions in national and international committees and organizations

National positions:

Since 2023, member of the RAS Scientific Council "Environment and Transport". Since 2022, member of Interdepartmental Scientific and Technical Commission on Heliogeophysics under the Presidium of the Russian Academy of Sciences. Since 2021, member of the Working Group in the field of education and science under the Commission of the President of the Russian Federation on state awards. Since 2020, member of RAS Scientific Council on Arctic and Antarctic Studies. Since 2017, member of the Commission on Personnel Affairs of the Council for Science and Education under the President of the Russian Federation. Since 2015, member of the RAS Working Group for evaluation and selection of scientific journals for RSCI (Russian Science Citation Index) collection. In 2017-2022, member of the Scientific Publishing Board of the Russian Academy of Sciences. In 2013-2017 Division vice-chair of the expert group on "Rational use of natural resources" of Scientific Coordination Council for Federal Special Purpose Program of the Ministry of Education and Science, in 2015-2017 member of the Council for the creation of unified system of information management for scientific research of the Federal Agency of Scientific Organizations.

International positions:

Since 2018, member of the RAS National committee of the Committee on Data of the International Council for Science (CODATA). Since 2018, member of the National committee of the International Programme "Future Earth" under the Presidium of the Russian Academy of Sciences. Since 2017, Russian National

correspondent to International Association of Geomagnetism and Aeronomy of the International Union of Geodesy and Geophysics. In 2015-2023, Chair of Interdivisional Commission on History of the International Association of Geomagnetism and Aeronomy of the International Union of Geodesy and Geophysics. In 2020-2023, IUGG Liaison Officer to the ISC Committee on Data for Science and Technology (CODATA), in 2014-2018 Chair of the CODATA Task Group "Earth and Space Science Data Interoperability", in 2017-2023 Vice chair of Commission on Data and Information of the International Union of Geodesy and Geophysics. In 2010-2016, visiting professor at Paris Institute of Physics of the Earth (IPGP, France). In 2008 and 2010, visiting researcher at NOAA National Geophysical Data Center (Boulder, Colorado, USA). In 2004, visiting researcher at the Laboratory of Volcanology of Clermont-Ferrand University (France).

Scientific editorship:

Since 2015 member of Data Science Journal editorial board, since 2016 member of Russian Journal of Earth Sciences editorial board, since 2017 member of Izvestiya, Atmospheric and Oceanic Physics journal editorial board, since 2017 editor-in-chief of the Geoinformatics Research Papers journal. Since 2020, member of the editorial board of the journal "Geology and Geophysics of the South of Russia". Since 2022, member of the editorial board of the journal "Izvestiya, Physics of the Solid Earth".

Publications

List of scientific publications include more than 190 papers in Russian and foreign scientific journals, 5 books, more than 150 abstracts from Russian and international scientific conferences and over 40 certificates of intellectual property registration.

Awards

1. RAS prize named after B. B. Golitsyn for a series of works on "System geoinformation analysis of geophysical data for identifying zones of increased seismic hazard, studying lithospheric structures and recognizing geomagnetic field anomalies" (2024);
2. Medal of the Order "For Merit to the Fatherland" II class (2024);
3. Medal "300 years of the Russian Academy of Sciences" (2024);
4. Letter of gratitude from the Ministry of Transport of the Russian Federation (2024);
5. Medal of the Ministry of Science and Higher Education of the Russian Federation "For contribution to the implementation of state policy in the field of scientific and technological development" (2021);

6. Diploma di Merito and Gold Medal for Exceptional Achievements from EU Scientific-Industrial Chamber (2016).