RUSSIAN ACADEMY OF SCIENCES

NATIONAL GEOPHYSICAL COMMITTEE

РОССИЙСКАЯ АКАДЕМИЯ НАУК

НАЦИОНАЛЬНЫЙ ГЕОФИЗИЧЕСКИЙ КОМИТЕТ

NATIONAL REPORT

for the

International Association of
Geomagnetism and Aeronomy

of the

International Union of Geodesy and Geophysics

2011–2014

НАЦИОНАЛЬНЫЙ ОТЧЕТ

для

Международной ассоциации
геомагнетизма и аэрономии
Международного
геодезического и геофизического союза

2011–2014

Москва 2015 Moscow

Presented to the XXVI General Assembly of the International Union of Geodesy and Geophysics

К XXVI Генеральной ассамблее Международного геодезического и геофизического союза

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The Report is prepared by the Section of Geomagnetism and Aeronomy of the National Geophysical Committee of Russia to the XXVI General Assembly of the International Union of Geodesy and Geophysics. Some main results of 2011–2014 are presented on the following topics: 1) Internal Earth's magnetic field; 2) Aeronomic Phenomena; 3) Magnetosphere; 4) Solar wind and interplanetary magnetic field; 5) Observations, instruments, surveys and analysis.

Отчет, подготовленный Секцией геомагнетизма и аэрономии Национального геофизического комитета Российской академии наук к XXVI Генеральной ассамблее Международного геодезического и геофизического союза, отражает некоторые основные результаты исследований, выполненных российскими учеными в 2011—2014 гг. по следующим разделам: 1) внутреннее магнитное поле Земли; 2) аэрономия; 3) магнитосфера; 4) солнечный ветер и межпланетное магнитное поле; 5) приборы, обсерватории, службы и анализ данных.

DOI: **10.2205/2015IUGG-RU-IAGA**

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Contents

Foreword

This report containing a review of the activities and scientific researches in 2011–2014 in Russia has been compiled for the presentation to the International Association of Geomagnetism and Aeronomy at the XXVI General Assembly of IUGG.

There are five sections in the report according to the IAGA Divisions I-V. The preparation of this report has been organized by the Section of Geomagnetism and Aeronomy of the National Geophysical Committee of Russia as a collective effort of the team of authors. Only minimal editorial work has been done when putting all these parts together, preserving, thus the diversity in styles and approaches.

The report cannot be considered as comprehensive review of the principal achievements during this period of time in this field of science in Russia. Moreover, some arbitrariness in the choice of the material makes the report far from being complete. Many important results are not mentioned at all. Bearing in mind all these restrictive circumstances we hope that the readers who are interested in this field of science can find useful sources of information in this report.

Conference Activity

Conferences in Russia

There have been many local and international conferences on IAGA subjects, held in Russia for the period 2011–2014. Some major ones are listed below.

- International conference “Artificial Intelligence in the Earth’s Magnetic Field Study. INTERMAGNET Russian Segment”, 2011, Uglich (http://uglich2011.gcras.ru/)
- Scientific conference “Databases, tools and information bases for polar geophysical research (POLAR-2011)”, 2011, Moscow (http://www.izmiran.ru/POLAR2011/)
- Second Scientific conference “Databases, tools and information bases for polar geophysical research (POLAR-2012)”, 2012, Moscow (http://www.izmiran.ru/POLAR2012/)
- International partnership conference “Geophysical Observatories, Multifunctional GIS and Data Mining”, 2013, Kaluga (http://www.kaluga2013.gcras.ru/)
- International scientific and practical conference “Polar Geophysics of Yamal: monitoring, database and information systems in the practice of development of oil and gas industry (POLAR-2014)” , Salekhard (http://www.polar2014.yanao.ru/)
- International Conference “Space Weather Effects on Humans: in Space and on Earth”, 2012, Moscow (http://swh2012.cosmos.ru/)
- Russian Conference on Magnetohydrodynamics, 2012, Perm (http://mhd12.icmm.ru/)
- Seventh International Aerospace Congress (IAC-12), 2012, Moscow (http://www.fund.ru/congress/eng/iac2012.shtml)
- Annual Seminar “Physics of Auroral Phenomena” (http://pgia.ru/seminar/)
- Annual conference “Plasma Physics in the solar system”, 2011–2014, Moscow, (http://solarwind.cosmos.ru/circ2011_2.htm http://plasma2012.cosmos.ru/ http://plasma2013.cosmos.ru/ http://plasma2014.cosmos.ru/)
- International Conference “Problems of Geocosmos”, 2012, 2014, St. Petersburg. (http://geo.phys.spbu.ru/materials_of_a_conference_2012/Conference_Index_2012.html http://geo.phys.spbu.ru/geocosmos/)

Participation in foreign conferences

Members of the Section of Geomagnetism and Aeronomy widely participated in multiple international scientific conferences and congresses. Here is the list of the most significant ones.

- European Planetary Science Congress 2012, Madrid, Spain
- European Geosciences Union General Assembly 2012, Vienna, Austria, 22–27 April 2012
- The International Symposium on Equatorial Aeronomy, Paracas, Peru, 12–17 March 2012
- 21st EM Induction Workshop, Darwin, Australia, July 2012.
- IAGA workshop on geomagnetic observatory instruments, data acquisition and processing, Cadiz, Spain, June, 2012
- The 12th IAGA Scientific Assembly, Merida, Mexico, August 26–31, 2013
- The European Planetary Science Congress (EPSC2013, University College London, 8–13 Sept. 2013
- European Geosciences Union General Assembly 2013 (Vienna, Austria, 07 – 12 April 2013).
- International Congress on Mechanics 25–27 May 2013, Chania, Crete, Greece.
- International Conference on Fluid Mechanics, Heat Transfer and Thermodynamics, Copenhagen, Denmark, June 13–14, 2013.
- The 6th MagNet E Workshop on European geomagnetic repeat station survey, 2013.
- The 3rd Beijing Symposium on Earth and Planetary Interior, 27–30 June 2013.
- 21st ESA Symposium on European Rocket and Balloon Programmes and Related Research, 9–13 June 2013.
- 5th International Symposium on Three-Dimensional Electromagnetics, Sapporo, Japan, May 7–9, 2013

Public activity

For drawing attention to the problems of the influence of magnetic activity on human and environment, there were several reports at the government and parliament level presented:

V. D. Kuznetsov. “Direct and indirect threats of space weather”, pesented at Public chamber of the Russian Federation, the hearings of the Commission of Public chamber of the Russian Federation on science and innovation, together with the Russian Association for the advancement of science on the question "Scientific and innovative approaches to the solution of problems of prevention of emergency situations at the facilities responsible appointment”.

Meeting of the Working group “Risk and security” under the President of the Russian Academy of Sciences.

Meeting of Presidium of the Russian Academy of Sciences (V.D. Kuznetsov's Report “Solar and terrestrial physics and problems of safety of power infrastructure”, 18.01.2011).

Meeting of Advisory Council of the Ministry of Emergency Situations (V.D. Kuznetsov's Report “Influence of space weather on safety of infrastructures”, 14.07.2011).

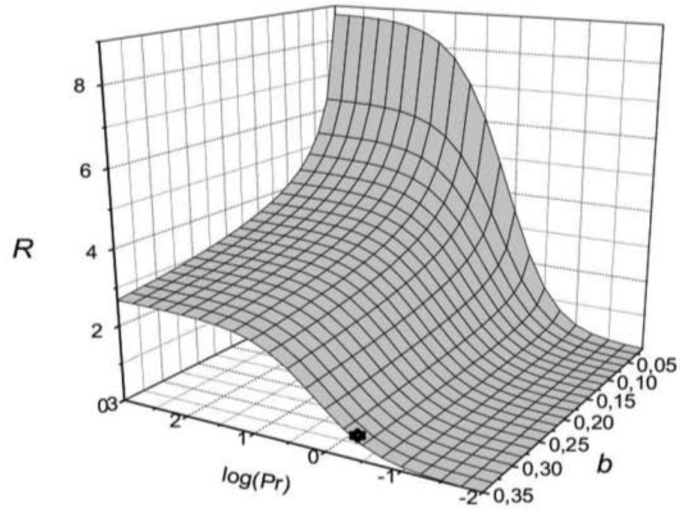
Meeting of the Commission on science and innovations of the Civic chamber of the Russian Federation (V.D. Kuznetsov's Report “Direct and indirect threats of space weather”, 30.11.2012).

Round table “About development of measures for ensuring planetary protection against space threats” (The Federation Council of the Russian Federation, Committee on science, education, culture and information policy; Committee on defense and safety. V.D. Kuznetsov's report “Direct and indirect threats of space weather”, 12.03.2013

Major scientific results

Critical stability of convection in the liquid cores of the Earth's type planets

(IZMIRAN, LIH RAS)



contact: sstarchenko@mail.ru

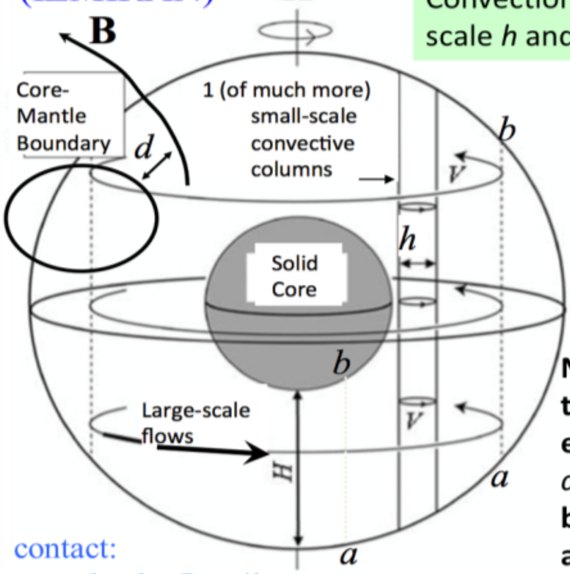
Critical heat and/or compositional convection formations, frequencies and Rayleigh numbers *R* are found asymptotically and numerically for typical planetary Prandtl number Pr and the radius of the solid core *b*.

For the first time, a general analytical solution was obtained in the limit when the radius (=*b*) of the inner edge of the liquid core is small compared to the outer radius (=1) and sources of convection concentrated at the inner boundary. Prior to our work here was only *one* numerical result marked with an asterisk in our 2D graph on the left.

Starchenko S.V., Kotelnikova M.S., Critical stability of almost adiabatic convection in a rapidly rotating thick spherical shell // Journal of Experimental and Theoretical Physics. 2013. V. 116, No. 2. P.338–345.

Power scaling of geodynamo-like systems

(IZMIRAN)



Convection power *F* determines typical hydrodynamic scale *h* and velocity *V* via small Rayleigh number r_a as

$$h = r_a^{1/5} H, V = r_a^{2/5} H\Omega$$

$$r_a \equiv F / \Omega^3 H^2 \sim 10^{-14}$$

$$B = (\mu\rho)^{1/2} (FH)^{1/3} = r_a^{1/3} (\mu\rho)^{1/2} H\Omega$$

Justifications were obtained for scaling law known from numerical simulation

New laws were found for typical magnetic/kinetic energy ratio, magnetic scale *d* and sine *s* of the angle between magnetic field B and velocity V vectors.

$$\frac{B^2/\mu}{\rho V^2} = \frac{d^2}{h^2},$$

$$d = r_a^{2/15} H = F^{2/15} H^{11/15} / \Omega^{2/5} = sH.$$

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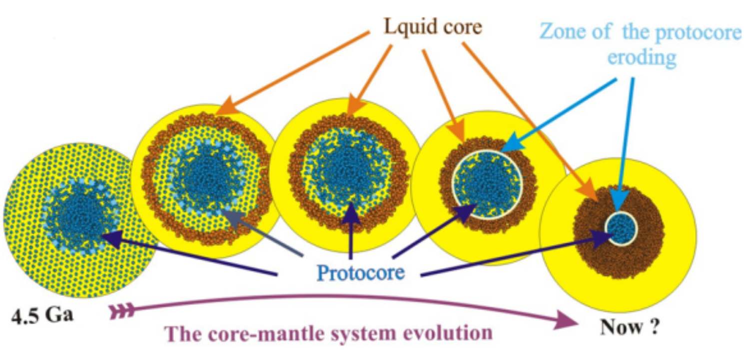
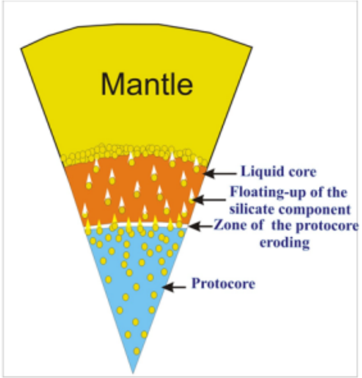
Starchenko S.V., Analytic base of geodynamo-like scaling laws in the planets, geomagnetic periodicities and inversions // Geomagnetism and Aeronomy. 2014. V. 54, No 6. P. 694-701.

Starchenko S.V., Pushkarev Y.D. Magnetohydrodynamic scaling of geodynamo and planetary protocore concept // Magnetohydrodynamics. 2013. V.49, No 1. P.35-42.

Geodynamo and protocore concept

(IZMIRAN and IPGG RAS)





The currently accepted scenario with the inner solid core crystallizing from the liquid core provides us with too small value of geomagnetic field during more than 3 billions years after formation of the liquid core. Since this is inconsistent with the available paleomagnetic records we are suggesting another scenario with a solid protocore that occupied almost all the core of just formatted Earth. This protocore is slowly melted under the surface influence of the overheated liquid core that grows up to its modern size when the solid core is small relic of the protocore. Such protocore concept resolves the problem of the energy source for geodynamo and for plume activity in the mantle. In case of validity of this concept the mantle should be supplemented by silicate material from the protocore with primitive isotope composition of the lead but which can't be the result of the liquid core crystallization. Additional argument to the validity of the concept could be the primitive isotope composition of lead in combination with the primary helium enriched by isotope ^{3}He.

Starchenko S.V., Pushkarev Y.D. Magnetohydrodynamic scaling of geodynamo and planetary protocore concept // Magnetohydrodynamics. 2013. V.49, No 1. P.35-42.

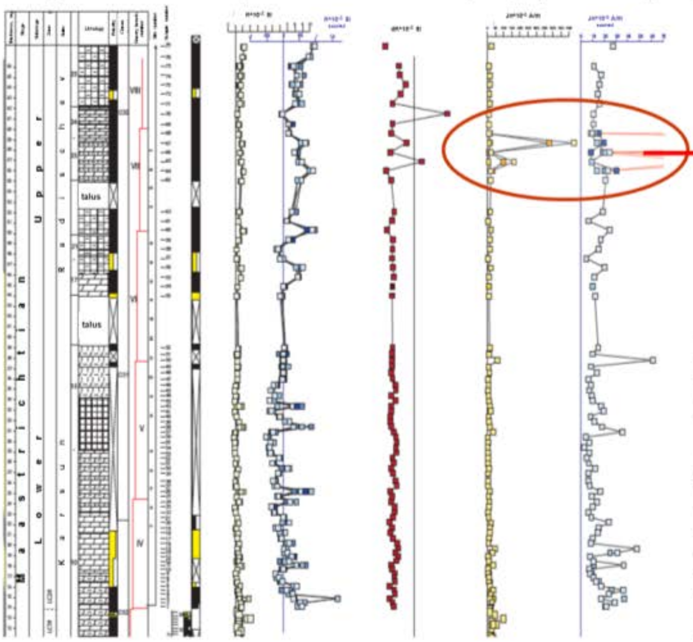
contact:
sstarchenko@mail.ru

Pushkarev Y.D., Starchenko S.V. Solid core as relic of protocore // Geochimica et Cosmochimica Acta. 2010. V.74, Issue 12, Suppl.1. P.A835.

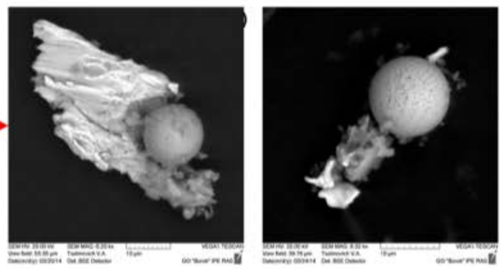
Cosmic material in sedimentary rocks

Rock-magnetic study of sediments of different origin and age, revealed intervals with a high content of cosmic material. Such intervals may indicate the existence of a change in the interaction of the magnetosphere with the near-Earth dust cloud.

· **Upper Cretaceous deposits in "Bolshevik" quarry (Saratov region)**



Cosmic spherules and native iron
(SEM image by and V.A. Tsel'movich)



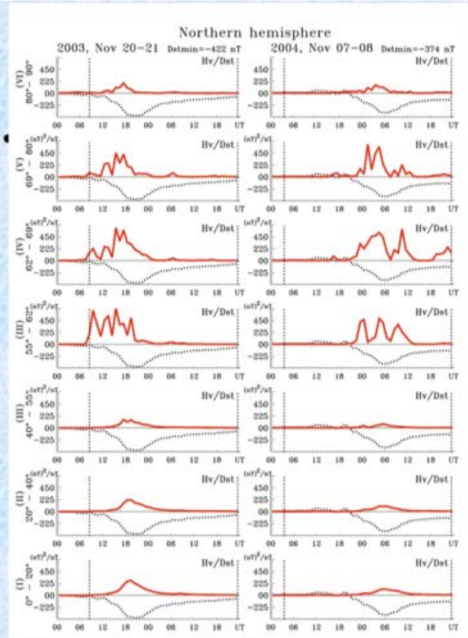
D.M. Pechersky, D.M. Gil'manova, A.Yu. Kazansky, S.K. Krivonogov, D.K. Nurgaliev, and V.A. Tsel'movich
Native iron in Quaternary deposits of the Darhad Basin (northern Mongolia) // Russian Geology and Geophysics , 2013, v. 54, № 12, p. 1923—1941.

Guzhikova A.A., Tsel'movich V.A., Guzhikov A.Yu., Kazansky A.Yu,. Kurazhkovsky A.Y. Rock-magnetic data as a possible indicator of increased concentrations of cosmogenic particles in Maastrichtian "Bolshevik"quarry (Volsk city, Saratov region.) // Cretaceous System in Russia and adjacent countries: problems of stratigraphy and paleogeography. - Sat. Scien. works / eds. E.Yu. Baraboshkin, V.S. Markevitch, E.V. Bugdaeva, M.A. Afonin, M.V. Cherepanova. - Vladivostok: Dal'nauka. 2014. pp 110-113. ISBN 978-5-8044-1479-6 (in Russian)

Usage of 2009 extremely quiet geomagnetic disturbance level for estimation of geomagnetic variations and geomagnetic activity

A big problem in magnetic activity studies is a selection of quit level – level when we consider variable part of magnetic field is absent. 2009 was the most quiet year of solar activity and, respectively, of geomagnetic activity for the whole period of qualitative magnetic measurements. Consider that during quit intervals of 2009 the magnetic activity has possible minimal level, we can use this level as a base level for calculation of a variable part of magnetic field.

Figure shows a distribution of magnetic field energy (Hv, $nT^2/1000$) in selected latitudinal zones of the northern hemisphere for the two magnetic storms: 20-21 November 2003 (left column) and 7 - 8 November 2004 (right). Solid line - the temporal behavior of Hv, dotted - Dst-variation, the vertical dotted lines mark the moments of the beginning of the preliminary phase and the end of the recovery phase of each storm.

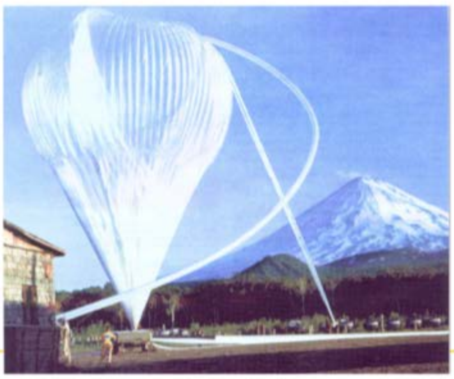


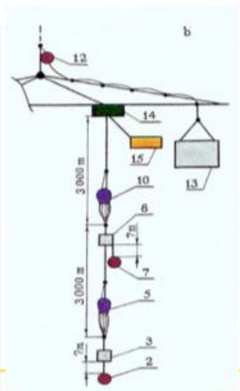
1. Levitin A. E., L.I. Gromova, S. V. Gromov, L.A. Dremukhina. The quantitative assessment of local geomagnetic activity on the basis of measurements of the magnetic observatories counted from the level based on the level of the quiet period of 2009,//Geomagnetism and the Aeronomy. T. 54. No. 3. Page 315-323.
2. 2. Levitin A. E., L.A. Dremukhina, L.I. Gromov, N. G. Ptitsyna. Generation of magnetic indignation in the period of a historical magnetic storm in September, 1859,//Geomagnetism and the Aeronomy. T. 54. No. 3, 324-332

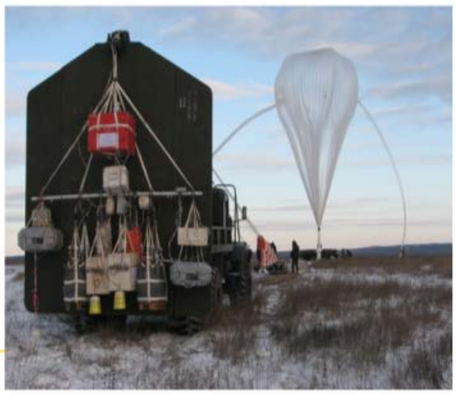
Ballons gradient magnetic measurements in Russia

On the basis of the balloons gradient magnetic data obtained in 2013 it is shown that aero-magnetic survey due to basic reasons incorrectly reproduce a magnetic field of deep sources. It doesn't allow to recalculate correctly magnetic anomalies up from Earth surface. It is shown that the adequate global model of magnetic anomalies in near-earth space developed up too 720 spherical harmonicas (EMM) needs to be built takin into account the data obtained at satellite and stratospheric heights too. Such model can be a basis for the specified studying of a structure and magnetic properties of crust on its deep horizons, to search of minerals on them, etc.

Tsvetkov Yu. P., Brekhov O. M., Bondar T.N., Tsvetkova N. M. The features of a geomagnetic field revealed on gradient magnetic measurements at stratospheric heights//Geomagnetism and the Aeronomy, 2015, volume 55, No. 1, page 1-9.

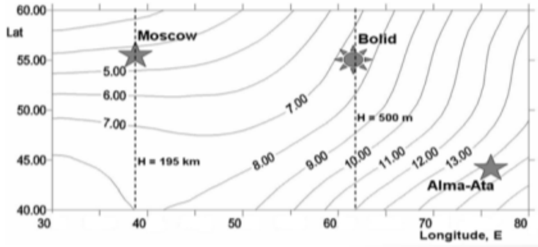




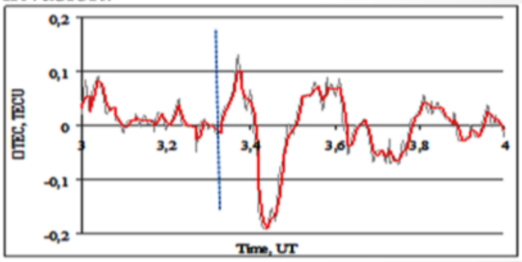


Iomospheric response to the invasion and explosion of Yuzhnouralsk superbolide

Passage through the atmosphere of the South Ural meteoroid that fell near Chelyabinsk February 15, 2013 is well fixed by different ground and satellites observations. The results of the analysis (Y.Y. Ruzhin, V.D. Kuznetsov, V.M. Smirnov) of data showed very weak effect of the bolide explosion in the ionosphere. A comparison of the received signals with known cases of ionospheric effects of ground explosions showed that the existing assessments of TNT (up to 500 kt) for Chelyabinsk event seems overestimated. The absence of effects in the magnetic field at distances of 1500-2000 km from the epicenter also raises the question of overvalued equivalent. A possible alternative - the superposition of cylindrical ballistic wave (due to meteoroid hypersonic movement) and of spherical shock waves because of a few moments of fragmentation (explosions) of superbolides - as the source of the resulting impact on the AGV to ionospheric layers.



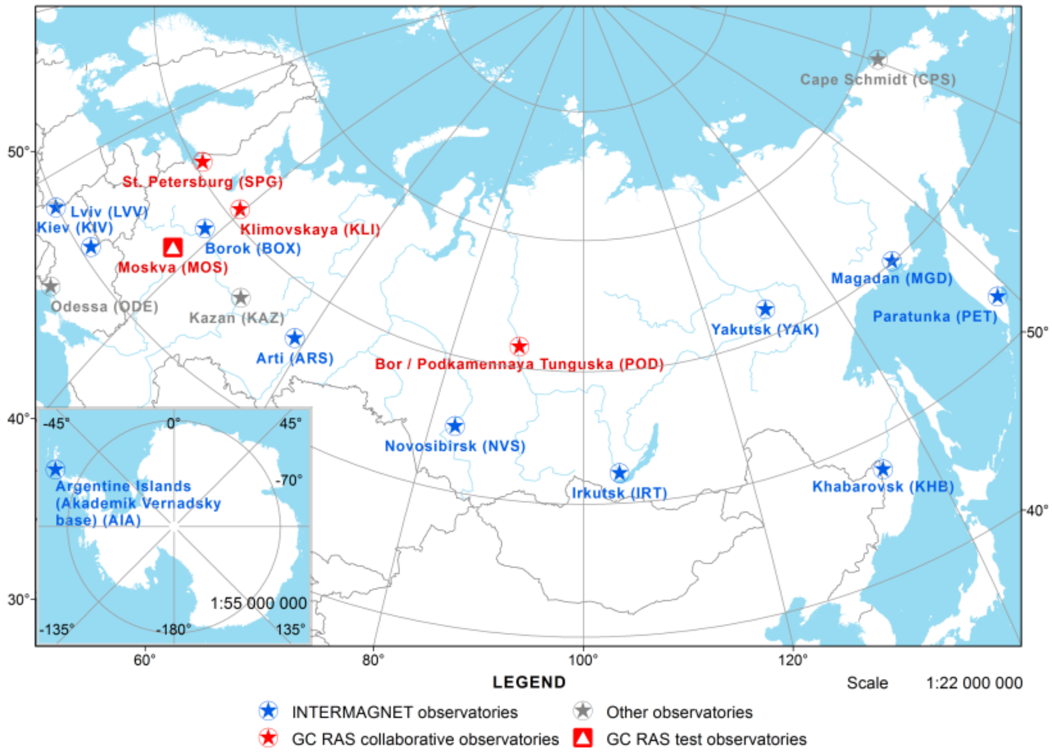
TEC of an ionosphere at the time of invasion.



The most intense ionospheric TEC response recorded in the area of the explosion of the bolide obtained by radio occultation method using a network of GPS satellites .

Russian-Ukrainian Geomagnetic Data Center

In 2012 the inter-regional Geomagnetic Data Center of the Russian-Ukrainian INTERMAGNET segment was launched. It is supported and operated by the Geophysical Center of the Russian Academy of Sciences (Moscow, Russia). As of December 2014 geomagnetic data are transmitted from 18 observatories and stations located in Russia and Ukraine.

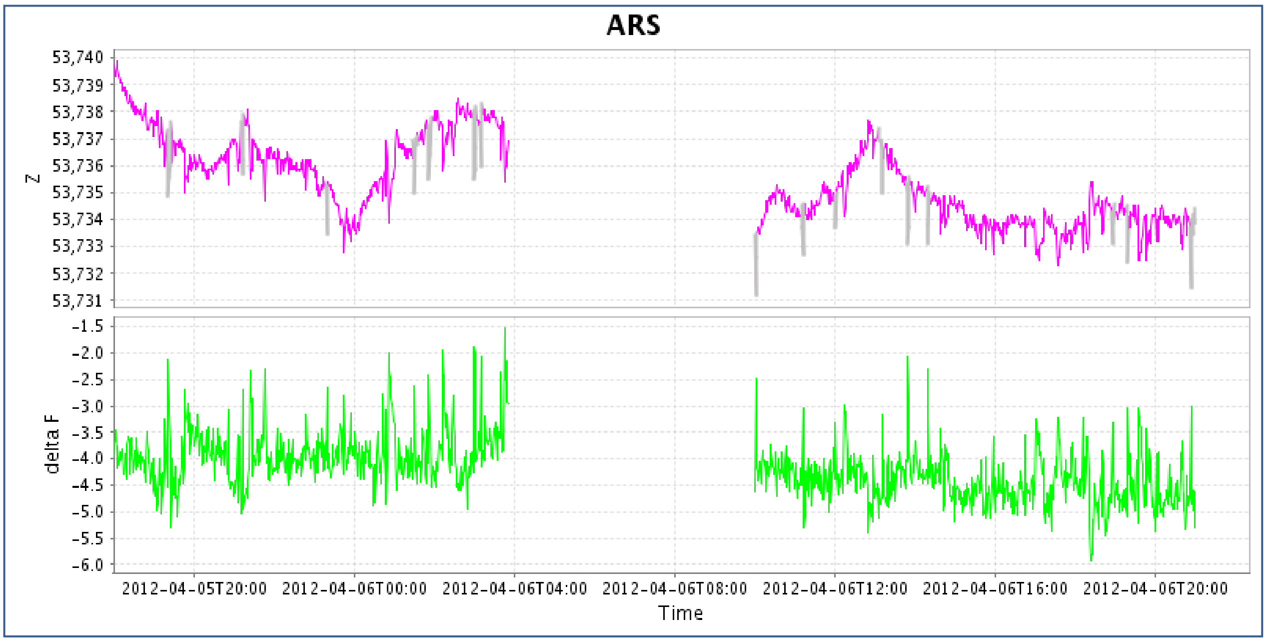


Geomagnetic observatories and stations in Russia and Ukraine, transmitting data to the Geomagnetic Data Center.

The particular feature of the Center is the automated quality control system, which continuously performs recognition of artificial disturbances in incoming magnetograms. Being based on fuzzy logic approach, this quality control system facilitates the preparation of the definitive magnetograms from preliminary records carried out by data experts manually. The results of recognition and incoming data are stored in a relational database managed by DBMS MySQL. In particular, such approach provides higher performance and flexibility of data requests comparing to file storage. It becomes even more relevant with transition of many magnetic observatories from 1-minute to 1-second data registration. The results of anthropogenic disturbance recognition are also stored in the database.

For a user's interaction with the data a set of Java classes and web services have been developed. In 2013 the web-site of the Center was launched (http://geomag.gcras.ru). This web-site provides information on the current observatory network and online services, which include data retrieval in ASCII format (CSV and IAGA-2002), plotting, baseline value calculator, online form for absolute measurements, and other features.

Data download service of the Center web-site.



Magnetogram plots with quality-control results (marked with grey).

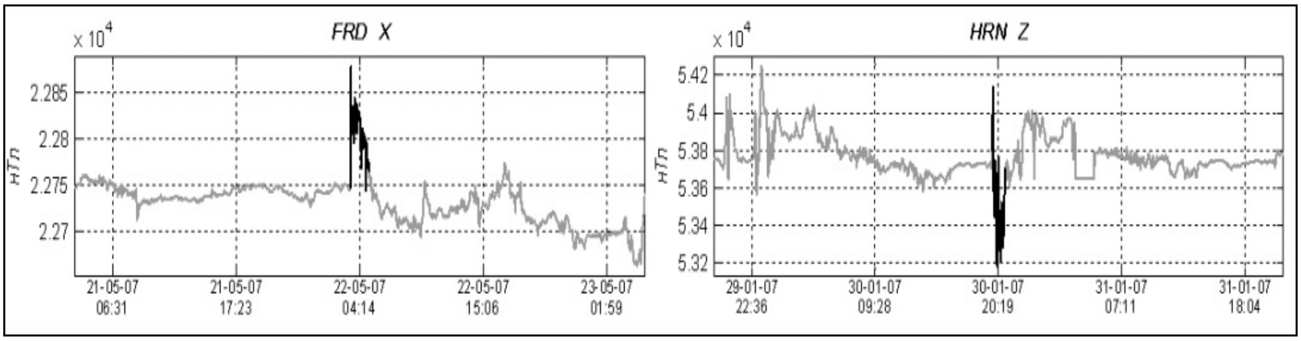
Soloviev, A., M. Dobrovolsky, D. Medvedev, R. Sidorov, Y. Sumaruk, Geomagnetic data center of Russian-Ukrainian INTERMAGNET segment (5.1-5) // Abstract Volume of the IAGA 12th Scientific Assembly (August 26-31, 2013, Merida, Yucatan, Mexico), 2013, p. 254

Soloviev A., Bogoutdinov S., Gvishiani A., Kulchinskiy R., Zlotnicki J. Mathematical Tools for Geomagnetic Data Monitoring and the INTERMAGNET Russian Segment // Data Science Journal, Vol. 12 (2013), p. WDS114-WDS119, DOI: 10.2481/dsj.WDS-019

Gvishiani A., Lukianova R., Soloviev A., Khokhlov A. Survey of Geomagnetic Observations Made in the Northern Sector of Russia and New Methods for Analysing Them // Surveys in Geophysics, 35 (5), 2014 pp. 1123-1154, DOI: 10.1007/s10712-014-9297-8

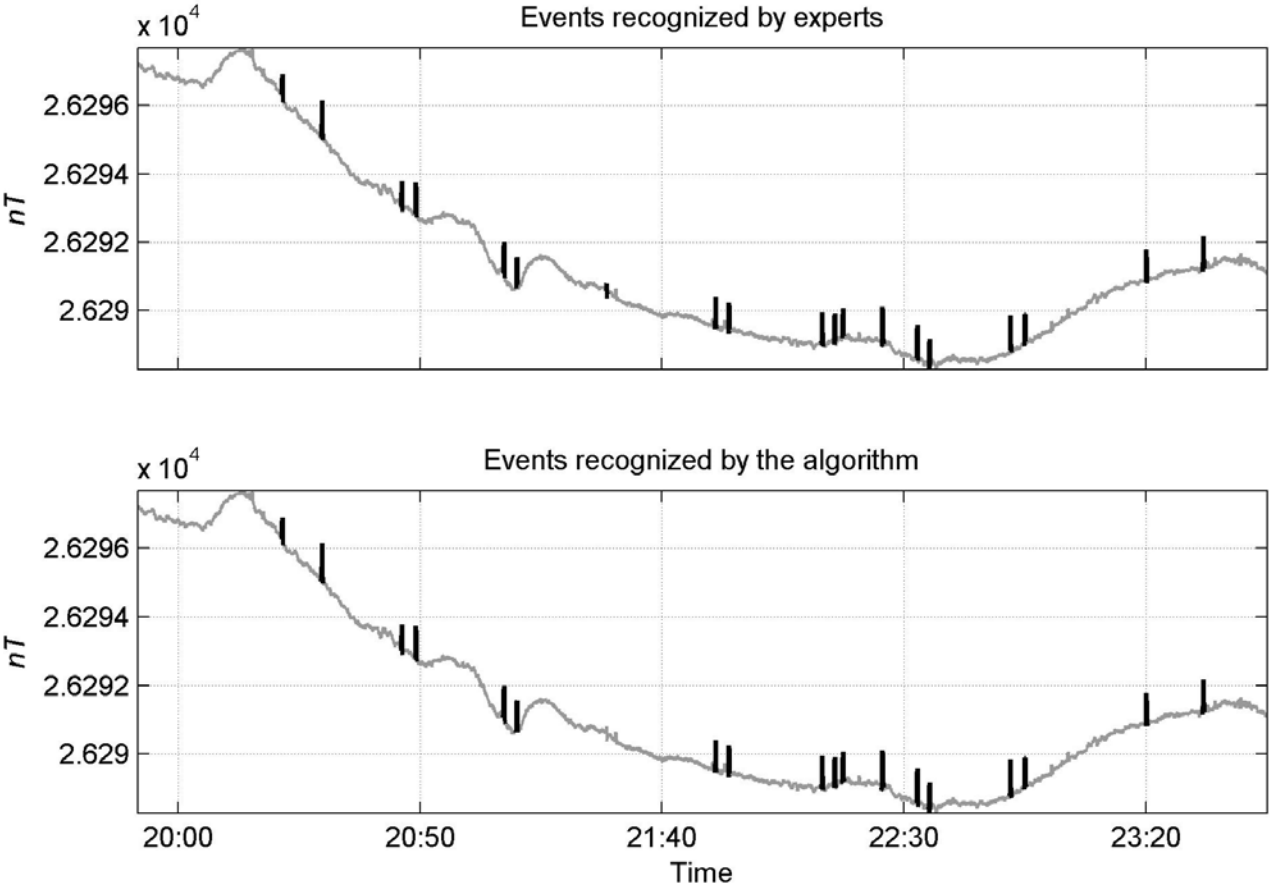
Recognition of disturbances on magnetograms

The recording instruments installed at the INTERMAGNET observatories are exposed to external impacts, which are reflected in the quality of the data. When analyzing the magnetograms, the geophysicist has to recognize the specific anomalies of artificial origin presented on the record and eliminate them. The algorithmic system developed in the Geophysical Center of the Russian Academy of Sciences is intended for recognizing spikes on the magnetograms from the global network INTERMAGNET. Application of this system to analysis of magnetograms allows automating the job of the experts-interpreters on identifying the artificial spikes in the INTERMAGNET data. Relying on the theory of discrete mathematical analysis, based on the morphological analysis of time series using fuzzy logic techniques, a series of algorithms was developed. The SP (from SPIKE) and SPs (from SPIKEsecond for 1 Hz data) algorithms recognize artificial spikes on the records of the geomagnetic field. Initially, this algorithm was trained on the magnetograms of 2007 and 2008, which recorded the quiet geomagnetic field. The algorithm was tested, using data from the following INTERMAGNET observatories: BNG, BOU, DOU, FRD, GUA, HRN, and MMB. The results of training and testing showed that the algorithm is quite efficient. Applying this method to the problem of recognizing spikes on the data forperiods of enhanced geomagnetic activity was a separate task. This analysis showed that the SP algorithm does not exhibit a worse performance if applied to the records of a disturbed geomagnetic field.



Magnetogram plots with recognized spikes (marked with black).

After a learning phase, this algorithm is able to recognize artificial spikes uniformly with low probabilities of target miss and false alarm. In particular, a 94% spike recognition rate and a 6% false alarm rate were achieved as a result of the algorithm application to raw one-second data acquired at the Easter Island magnetic observatory. This capability is critical and opens the possibility to use the SPs algorithm in an operational environment. The SPs algorithm was tested on raw one-second data acquired at the Easter Island magnetic observatory in July and August 2009. The results of comparison between algorithm and manual recognition are shown below.



Comparison between algorithm (bottom) and manual (top) recognition results (X component, 1 July 2009). In both cases recognized spikes are marked with black.

These results were presented at the 23rd International CODATA Conference, held on October 28–31, 2012 in Taipei, Taiwan. The poster presentation "Automated Quality Control of Geophysical Time Series" was given the Best Poster Award.

A.A. Soloviev, S.M. Agayan, A.D. Gvishiani, Sh.R. Bogoutdinov, A. Chulliat, Recognition of Disturbances with Specified Morphology in Time Series: Part 2. Spikes on 1-s Magnetograms // Izvestiya, Physics of the Solid Earth, 2012, Vol. 48, No. 5, pp. 395–409. DOI: 10.1134/S106935131204009X

R.V. Sidorov, A. A. Soloviev, Sh. R. Bogoutdinov, Application of the SP Algorithm to the INTERMAGNET Magnetograms of the Disturbed Geomagnetic Field // Izvestiya, Physics of the Solid Earth, 2012, Vol. 48, No. 5, pp. 410–414. DOI: 10.1134/S1069351312040088

A. Soloviev, A. Chulliat, S. Bogoutdinov, A. Gvishiani, S. Agayan, A. Peltier, B. Heumez. Automated recognition of spikes in 1 Hz data recorded at the Easter Island magnetic observatory // Earth Planets Space, Vol. 64 (No. 9), pp. 743-752, 2012, DOI: 10.5047/eps.2012.03.004

Inclusion of Arti (ARS) geophysical observatory into the INTERMAGNET network

H. and R. Abels Arti geophysical laboratory-observatory is maintained by the Bulashevich Institute of Geophysics, Ural Branch of RAS (IG UB RAS). Regular magnetic observations in the Ural Region of Russia began in 1836 in Ekaterinburg, where a new geophysical observatory was founded. High precision was achieved already in the first years of the observatory's functioning. In 1885–1887 the observation equipment was upgraded. In 1932 due to increasing rate of magnetic disturbances in Ekaterinburg the observatory was relocated to the Kosulino village and changed its name to "Vysokaya Dubrava". It was functioning there up to 1973. In 1969 at the town of Arti (125 km south-west from Ekaterinburg) a new geophysical observatory was established. The observatory has got its current name "Arti" since 1971 after being included into the Soviet network of geomagnetic stations. All changes of the observatory location were preceded by special geomagnetic observations and magnetic variations assessment, which made it possible to ensure the consistency of magnetic observations since 1836.

The Arti observatory began its cooperation with the INTERMAGNET network in 1993, after installation of the digital magneto-variometric station "Quartz-3EM". From this moment new telecommunication and Internet technologies were implemented in the observatory's routine. In 2006 the process of observatory equipment and infrastructure upgrading was initiated. In 2011 the Arti observatory joined the INTERMAGNET network. In 2012 the observatory fluxgate 3T2KP D/I magnetometer was replaced with the MinGeo 010 D/I instrument within the collaboration with the Geophysical Center of RAS.

Arti observatory instruments include:

- Digital magnetic variometric stations Quartz-3EM and Quartz-4, registering D, H, Z values with a sensitivity of 0.1 nT per division;
- POS-1 proton Overhauser magnetometer for total F field registration (random RMS error is less than 0.1 nT);
- POS-3 component-measuring (ZT) magnetometer in a test mode since November 2011;
- MinGeo 010 D/I magnetometer on the Carl Zeiss Theo 010 non-magnetic theodolite.

Arti observatory web-page (http://geomag.gcras.ru/obs-ARS.html).

Kusonsky A.O. Geophysical observatory studies in the Ural Region. Ekaterinburg: RIO UB RAS, 2012. 280 pp.

Inclusion of Paratunka (PET) and Khabarovsk (KHB) geophysical observatories into the INTERMAGNET network

Paratunka and Khabarovsk geophysical observatories are the departments of the Institute of Cosmophysical Researches and Radiowave Propagation, Far Eastern Branch of the Russian Academy of Sciences (IKIR FEB RAS).

Paratunka observatory was founded in 1962 in the town of Paratunka (Kamchatka Region) and started its operation as a complex magneto-ionospheric observatory in 1967. In 2013 after several years of modernization of the observatory equipment and infrastructure, conducted in cooperation with GFZ (Potsdam, Germany), Paratunka was certified as the INTERMAGNET observatory.

Variometer pavilion. **Absolute pavilion.**

The main objectives of Paratunka geophysical observatory include:

- regular long-term observations of various geophysical fields and processes;
- providing metrological characteristics of the registered data, parameter control, verification and calibration of standard equipment;
- geophysical equipment development and testing.

Paratunka observatory instruments include:

- FGE fluxgate vector magnetometer (D, H, Z components).
- GSM-19FD dIdD proton Overhauser magnetometer registering the full magnetic induction vector F and the variations of magnetic declination (dD) and inclination (dI).
- Bartington Mag-01H D/I magnetometer on the Wild-T1 non-magnetic theodolite.

Paratunka observatory web-page (http://geomag.gcras.ru/obs-PET.html).

Khabarovsk geophysical observatory is located near Zabaikal’skoye village (100 km south from Khabarovsk). In 2012–2013 the observatory equipment and infrastructure was upgraded in order to meet the INTERMAGENT requirements. Khabarovsk geophysical observatory was included into the INTERMAGNET network in 2013.

Khabarovsk observatory instruments include:

- Digital magnetic variometric station Quartz-06 registering D, H, Z values;
- GSM-19FD dIdD proton Overhauser magnetometer;
- IZMIRAN fluxgate magnetometer on TT5 non-magnetic theodolite;
- Bartington Mag-01H D/I magnetometer on the Wild-T1 non-magnetic theodolite.

GSM-19FD dIdD magnetometer (sensor).

Wild-T1 theodolite with the Bartington Mag-01H fluxgate sensor.

Khabarovsk observatory web-page (http://geomag.gcras.ru/obs-KHB.html).

Renovation of Saint Petersburg (SPG) geomagnetic observatory

Geomagnetic observatory Saint Petersburg was deployed on the basis of the magnetic station Krasnoye Ozero maintained by the Saint Petersburg branch of the Pushkov Institute of Terrestrial Magnetism, Ionosphere and Radiowave Propagation of the Russian Academy of Sciences (SPbF IZMIRAN). The observatory is located on the shore of Lake Krasnoye 100 km northwest from the city of Saint Petersburg, on a site isolated from industrial anthropogenic noises.

The magnetic station Krasnoye Ozero was founded in the late 1960s as the branch of the Voyeikovo magnetic and meteorological observatory and stopped functioning in 1990s. In June 2012 in terms of collaboration between the Geophysical Center of the Russian Academy of Sciences (GC RAS) and IZMIRAN a full set of observatory equipment of INTERMAGNET standard was installed at the observatory. The GC RAS specialists also performed the aerial magnetic survey of the territory around and between the observatory pavilions, measuring the anomalous magnetic field and the vertical gradient of the total magnetic field. Survey maps showed that the territory of the observatory is clean from any artificial magnetic disturbances. In autumn 2012 the observatory pavilions were renovated, and a new azimuth mark was installed. In June 2013 the GC RAS specialists performed geodetic observations for determining the geodetic azimuth of the azimuth mark and regular absolute measurements have been launched.

In order to maintain the continuity of regular magnetic observations, which started in Saint Petersburg in 1834, the observatory was given the name Geomagnetic Observatory Saint Petersburg with a reserved IAGA-code SPG.

Absolute pavilion.

Variometer pavilion.

Azimuth mark.

Geodetic measurments.

Saint Petersburg observatory instruments include:

- FGE fluxgate vector magnetometer (X, Y, Z components);
- GSM-19 proton Overhauser magnetometer for total F field registration;
- MinGeo 010 D/I magnetometer on the Carl Zeiss Theo 010 non-magnetic theodolite.

Saint Petersburg observatory web-page (http://geomag.gcras.ru/obs-SPG.html).

Gvishiani A.D., Kuznetsov V.D., Kopytenko Yu.A., Sergushin P.A., Soloviev A.A. Magnetometric INTERMAGNET facilities at the magnetic observatory "Krasnoe lake" // Materials of the Partnership Conference "Geophysical observatories, multifunctional GIS and data mining", 30 September - 3 October 2013, Kaluga, Russia, DOI: 10.2205/2013BS012_Kaluga

Kaftan V.I., Krasnoperov R.I. Geodetic observations at geomagnetic observatories // Geomagnetism and Aeronomy. Vol. 55, No. 1, 2015. pp. 118—123.
DOI: 10.1134/S0016793215010065

Construction of a new geomagnetic observatory Klimovskaya (KLI).

Klimovskaya geomagnetic observatory is located in the southern part of Arkhangelsk region on the shore of Lake Svyatoe in picturesque and ecologically clean area free from urban and industrial influence.

Since 2011 Klimovskaya station is being deployed by the Geophysical Center RAS in collaboration with the Institute of Physiology of Natural Adaptations, the Ural Branch of RAS (IPNA UB RAS). The observatory will be installed on the territory of the “Rotkovets” geophysical and biological station, the base for various biological and medical researches of natural systems and human population of the nearest settlements.

In 2011 in collaboration with the Pushkov Institute of Terrestrial Magnetism, Ionosphere and Radiowave Propagation of RAS (IZMIRAN) the Quartz-3 vector magnetomener was installed in a wooden pavilion on the slope to the south from the main building of the station.

In December 2011 the FGE vector magnetometer was temporarily installed in the main building by GC RAS's specialists. Both of these vector magnetometers provide 3-component magnetic field data, and the comparison of their records proves their correct functioning.

In July 2012 the GC RAS's specialists performed a magnetic survey of the anomalous components of the total magnetic field and its vertical gradient on the territory of the station using the GSM-19GW gradientometer. After that the most appropriate sites for absolute and variometer pavilions construction were chosen. Later, in October 2012, these sites were approved by the detailed magnetic survey, and the locations of pillars were marked for the future buildings.

In 2013 the buildings of the pavilions were constructed and equipped with the instruments.

Absolute pavilion.

Variometer pavilion.

In 2014 an azimuth mark was installed and regular absolute measurements started. The significant innovation in the construction of the azimuth mark is the usage of a conventional geodetic mark for angular measurements. This allows attaching a reflector which makes possible periodic geodetic measurements for coordinate and azimuth correction using modern geodetic equipment such as total stations (tacheometers) and GNSS-receivers.

Azimuth mark installation.

Mark with attached reflector.

Due to its location, this observatory in the nearest future is supposed to provide the magnetic records free from any anthropogenic noise.

Klimovskaya observatory instruments include:

- FGE fluxgate vector magnetometer (X, Y, Z components);
- GSM-19 proton Overhauser magnetometer for total F field registration;
- MinGeo 010 D/I magnetometer on the Carl Zeiss Theo 010 non-magnetic theodolite.

Klimovskaya observatory web-page (http://geomag.gcras.ru/obs-KLI.html). Geomagnetic data from the observatory are available via Earth Science DataBase system, launched at the Geophysical Center of RAS (http://esdb.wdcb.ru/).

Geomagnetic data recorded at Geomagnetic Observatory Klimovskaya (IAGA code: KLI). Geophysical Center of the Russian Academy of Sciences. DOI: 10.2205/kli2011

Soloviev, A., Dobrovolsky, M., Kudin, D., & Sidorov, R. Minute values of X, Y, Z components and total intensity F of the Earth's magnetic field from Geomagnetic Observatory Klimovskaya (IAGA code: KLI). Geophysical Center of the Russian Academy of Sciences. DOI: 10.2205/kli2011min

Earth Science DataBase – ESDB

ICSU-World data System, CODATA, DataCite, CrossRef, Force 11 and other organizations join forces and collaborate for the purpose of facilitation of access to high-quality scientific data for researchers and acknowledgement of the scientific data as valuable result of the research that is used during the creation of scientific products and is to be cited as well as other scientific sources of information such as articles, books etc.

In the Geophysical Center of RAS on the basis of the WDC for Solar-Terrestrial Physics (http://www.wdcb.ru/stp/index.en.html) that is the regular member of ICSU-WDS the action for converting of old geomagnetic data into digital form and implementing information technologies for its placement on the WDC website is conducted. This is also important since the old data are not completely protected from natural disaster and human factor. The entire archive of K-indices, data on the magnetic storms and geomagnetic sudden commencements for the period from 1957 to 2005 from the observatories of Russia and other republics of the Former Soviet Union has been processed in such way. Database containing digital geomagnetic data is placed on the WDC website for free access. The ESDB (http://esdb.wdcb.ru/) project is focused on the creation of the modern system of geophysical data registration, publication and DOI assignment used for unique identification of intellectual property.

The system of registration and publication of geophysical data is being developed as a structure for persistent intellectual content identification and management of intellectual content, metadata management, connection of users with content suppliers. Metadata base including detailed description of data itself and information about data producer and data publisher is also formed.

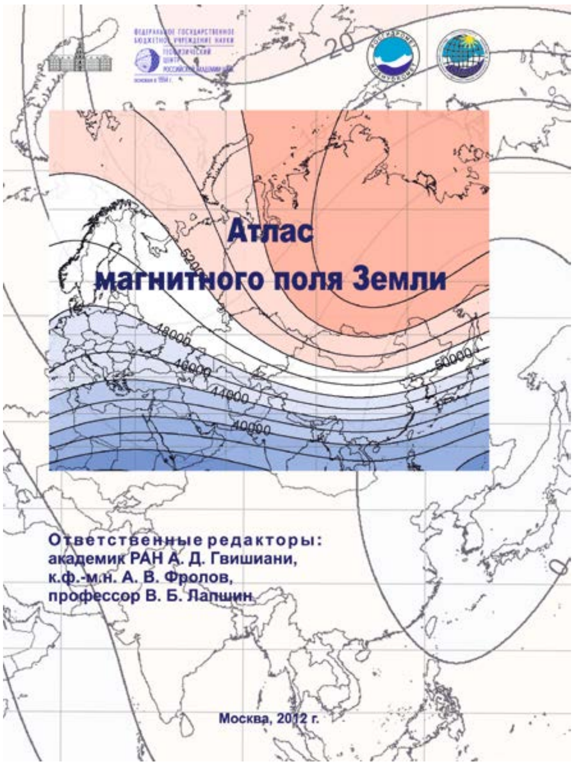
Currently geomagnetic data from the Klimovskaya observatory are published and available via ESDB-service.

Lukianova R. Incorporation of the observatory data into the DOI citation system // Vestn. Otd. nauk Zemle (Herald of the Department of Earth Sciences of RAS), 5, NZ9001 DOI: 10.2205/2013NZ000120 (in Russian)

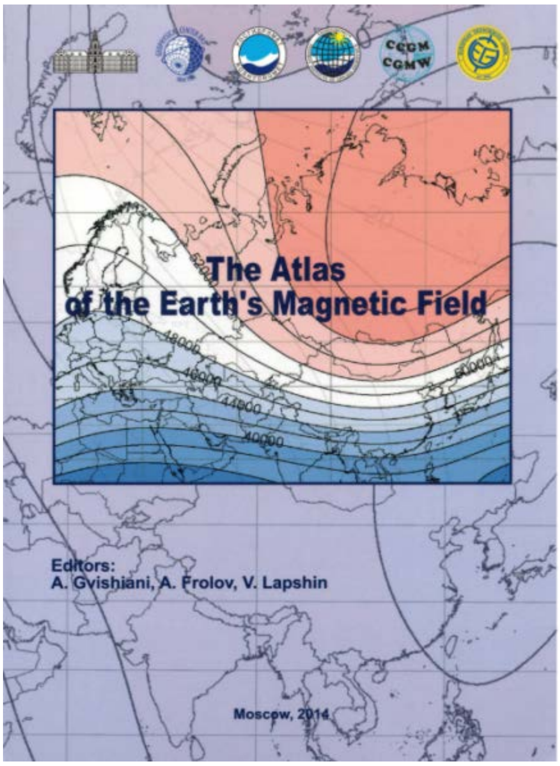
The Atlas of the Earth's Magnetic Field

In 2012–2013 the Atlas of the Earth's Magnetic Field was published. This Atlas represents a unified set of physical, geographic, thematic, and historical materials for a detailed study of the geomagnetic field from 1500 to 2010. The Atlas is intended for a wide range of scientists, teachers, students and experts in applied areas relating to the geosciences, including geologists and geophysicists studying geomagnetism. The Atlas is a unique cartographic product that contains comprehensive and scientifically grounded characteristics of geomagnetic phenomenon, and contains the results of historical and modern studies of the Earth's magnetic field.

Currently the work on the second edition of the Atlas is being carried out



Cover of the Russian version of the Atlas.



Cover of the English version of the Atlas.

Soloviev A., Khokhlov A., Jalkovsky E., Berezko A., Lebedev A., Kharin E., Shestopalov I., Mandea M., Kuznetsov V., Bondar T., Nechitailenko V., Rybkina A., Pyatygina O., Shibaeva A. The Atlas of the Earth's Magnetic Field (Eds.: A. Gvishiani, A. Frolov, V. Lapshin). Publ. GC RAS, Moscow, 2012. 364 pp. DOI: 10.2205/2012Atlas_MPZ (in Russian)

Soloviev A., Khokhlov A., Jalkovsky E., Berezko A., Lebedev A., Kharin E., Shestopalov I., Mandea M., Kuznetsov V., Bondar T., Mabie J., Nisilevich M., Nechitailenko V., Rybkina A., Pyatygina O., Shibaeva A. The Atlas of the Earth's Magnetic Field (Eds.: A. Gvishiani, A. Frolov, V. Lapshin). Publ. GC RAS, Moscow, 2013. 361 pp. DOI: 10.2205/2013BS011_Atlas_MPZ

Magnetic survey of observatory construction sites on the Yamal Peninsula and Sakhalin Island

In 2013–2014 the Geophysical Center of RAS in collaboration with the Schlumberger Company performed a series of expeditions to the areas of exploration of oil and gas on the Yamal Peninsula and Sakhalin Island. During this expedition the magnetic survey of the areas planned for the installation of the INTERMAGNET standard magnetic observatories was performed.

The main goal of the expeditions was to determine the areas suitable for the installation of geomagnetic observatories of the INTERMAGNET standard. The following tasks were performed:

- selection of an area for the magnetic survey, considering terrain features and distance from existing and planned industrial constructions and communications which could be a potential sources of magnetic noises;
- magnetogradiometric survey of the area in several different scales for the detailed study of magnetic anomalies distribution and the selection of suitable areas for observatory pavilion installation and determining their coordinates.

The expedition to the Yamal Peninsula was performed in 2013. The observed area is located in the vicinity of Sabetta shift settlement (Yamal region of the Yamal-Nenets autonomous district) on the coast of the Gulf of Ob (Kara Sea). Magnetic survey included a sequence of three magnetogradiometric measurements with different spatial resolution with spacing of the survey grid: 50, 10, and 2 meters. The survey grid was square and isotropic. For setting out the regular survey grid and coordinate referencing of survey pickets modern geodetic equipment was used – Trimble M3 DR 5" electronic total station and two Javad Maxor GPS receivers for precise coordinate referencing of the survey pickets.

GPS receivers installed at the reference points of the survey grid

The electronic total station at the reference point of the survey grid

Prism reflector on a pole for setting out survey pickets using the electronic total station

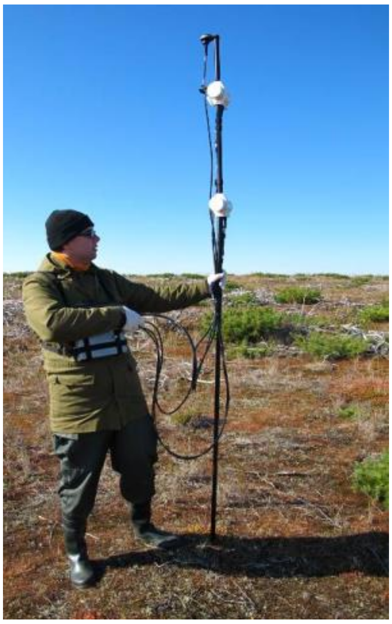
Magnetic gradiometric survey of the pickets marked with wooden sticks

Setting out and magnetic survey were performed in such a way that any possible influence of ferromagnetic elements of the pole man on the measurements would be minimal. For that purpose, a distance between the pole man and the magnetic survey operator was kept so that the influence of noise on the measurements was negligible. During all the survey stages the base magnetometer was installed in 700 m southwest to the center of the first survey area.

All the processing procedures were done on a PC, where the recorded data were imported from the magnetic gradiometer and the base magnetometer. After plotting the maps of the detailed survey area an estimation of optimal places for locating the observatory within it was performed. For this purpose the fields on these maps were classified. As a conclusion, the area observed by the detailed magnetic survey was found suitable for the installation of the magnetic observatory.

In 2014 an expedition to the Sakhalin Island was organized. The expedition included two sited for magnetic survey. The first was located in the vicinity of Pioner temporary shift settlement (Okha city district, Sakhalin region), in the north-east of the Sakhalin Island on the coast of the Okhotsk Sea. This region is located in wooden tundra covered with elfin cedar and its remains, dwarf arctic birch and rare larches.

Magnetic survey included a sequence of 2 magnetogradiometric measurements with different spatial resolution: 10 and 3 m. During the first measurement the field reconnaissance was performed, revealing the common characteristics of the anomalies of total magnetic field, and also detecting the optimal region for a detailed observation. The second survey series was carried out on a grid with a spacing of 3 m. Setting out the regular survey grid was performed by means of the electronic total station.



The electronic total station at the reference point of the survey grid

Prism reflector on a pole for setting out survey pickets using the electronic total station

Magnetic gradiometric survey of the pickets marked with composite rebar sticks.

The second site was selected near the Moskalvo village (Okha city district, Sakhalin region) in the vicinity of a meteorological station on a wetland coast of the Sakhalin Gulf.

As a conclusion, the areas observed by the detailed magnetic survey on both sites were found suitable for the installation of the magnetic observatory.

Krasnoperov R., Sidorov R., Soloviev A. Modern Geodetic Methods for HighAccuracy Survey Coordination on the Example of Magnetic Exploration // Geomagnetism and Aeronomy, 2015, Vol. 55, No. 4, pp. 548–555. DOI: 10.1134/S0016793215040076

Recognition of Pc3 geomagnetic pulsations on magnetograms

An algorithm is developed for recognizing Pc3 geomagnetic pulsations in the magnetic data with 1-s sampling. This algorithm uses the concept of fuzzy bounds, which is part of the algorithmic approach of the Discrete Mathematical Analysis (DMA). During the processing, the algorithm calculates the generalized variance of the covariance matrix for the three-component signal in the selected time window. The length of the window in the analysis of the dynamics of the polarization ellipsoid is determined by estimating the averaged apparent period in the moving window. The algorithm enables one to simultaneously analyze the data from a few observatories in order to study the correlations in the polarization of the magnetic signal between the observatories and to recognize the daytime Pc3 pulsations more accurately. Due to the short periods of the pulsations (20–50 s), manual recognition of the target pulsations in the initial magnetograms is inefficient. Using the algorithm an ana lysis of sampled 1-s observational data on geomagnetic pulsations within the Pc3 range in the initial phase of a moderate magnetic storm (April 5–7, 2010) at the network of longitudinally spaced near-equatorial and low-latitude INTERMAGNET observatories was carried out for the first time. The obtained results were compared with magnetic observations at the midlatitude and subauroral observatories, as well as with observations at six Australian observatories located at low and middle latitudes. Two time intervals were studied in detail: the SC of the storm and the onset of a great global substorm. A hypothesis is proposed that the excitation of the discussed bursts of geomagnetic Pc3 pulsations occurred due to an inside-magnetospheric mechanism and not to generation at the front of protons reflected from the magnetopause. Daytime Pc3 pulsations can be a result of the development of a resonance at midlatitudes. Evening bursts of Pc3 pulsations can be harmonics of

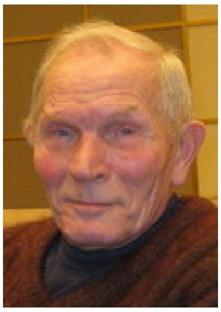
Pi2 oscillations of the plasmaspheric cavity mode resonance; oscillations are caused by a pressure pulse at dipolization or a current disruption in the tail of the magnetosphere during the onset of a substorm.

Kleimenova N.G., Zelinskii N.R., Kozyreva O.V., Malysheva L.M., Solov'ev A.A., Sh.R. Bogoutdinov, Pc3 Geomagnetic Pulsations at Near-Equatorial Latitudes at the Initial Phase of the Magnetic Storm of April 5, 2010 // Geomagnetism and Aeronomy, 2013, Vol. 53, No. 3, pp. 313–320. DOI: 10.1134/S0016793213030092

Zelinskiy N.R., Kleimenova N.G., O. V. Kozyreva, S. M. Agayan, Sh. R. Bogoutdinov, A. A. Soloviev (2014), Algorithm for recognizing Pc3 geomagnetic pulsations in 1-s data from INTERMAGNET equatorial observatories, Izvestiya, Physics of the Solid Earth, Vol. 50, N 2, pp. 240-248. DOI: 10.1134/S106935131402013X

Obituary

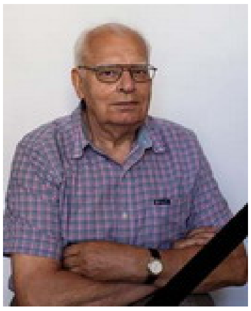
With a great sadness we announce that in 2013 two prominent geophysicists and IAGA activists, Dr. Oleg M. Raspov and Dr. Evgeny P. Kharin, passed away.



Evgeny Petrovich Kharin
(1933–2013)

He was Director of the World Data Center for Solar-Terrestrial Physics for 42 years based at the Geophysical Center of the Russian Academy of Sciences. Through his extensive experience of working with geophysical data, he developed international systems of collecting and storing data on the Earth's magnetic field, the ionospheric phenomena of solar activity, and cosmic rays. Of particular note is his contribution to the long series of observations of geomagnetic variations and geomagnetic indices, which are included in the international Space Physics Interactive Data Resource (SPIDR). Under his leadership and with his direct involvement, international projects were undertaken to save historic magnetograms, and to prepare for and collect data and information from the International Polar Year 2007–2008 (for which he was awarded Diplomas by the Russian Academy of Sciences and the Organizing Committee). Latterly, he took an active role in developing the national node for Russian INTERMAGNET data collection.

In 2013 Dr. Evgeny Kharin for his significant contributions to accumulation, retention and dissemination of data on the Earth's magnetic field required for fundamental scientific research was awarded with IAGA Long Service Award.



Oleg Mikhailovich Raspopov
(1931–2013)

Oleg Mikhailovich worked at the Leningrad State University (magnetic pulsation study), then was the director of Polar Geophysical Institute (Apatity, Murmansk) and deputy director of St. Petersburg department of IZMIRAN.