

MEMBER COUNTRY: UKRAINE
National Report to SCAR For year : 2017

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Scientific Research Program						
AAA 1) 2) 3) 4)						
AntEco 1) 2) 3) 4)						
AnT-ERA 1) 2) 3) 4)						
AntClim21 1) 2) 3) 4)						
PAIS 1) 2) 3) 4)						
SERCE 1) 2) 3) 4)						

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Other Groups (optional)						
SOOS						

During the reporting period, the State Institution National Antarctic Scientific Center of Ukraine conducted fundamental and applied research in accordance with the State Special-Purpose Research Program in Antarctica for 2011—2020.

The main directions of research - biological, medical-physiological, geological and geophysical, hydrometeorological, geospace, development and introduction of new technologies - were carried out using the primary data, materials and samples obtained during the 21st (wintering) and 22nd (season) Ukrainian Antarctic Expeditions on the following topics:

1. Study of the structure and functioning of typical Antarctic ecosystems - the rationale for creation of biogeographic landfills

(Project Manager - Andriy Utevskiy, PhD in Biology, V.N. Karazin Kharkiv National University).

The aim of the work is to develop new information layers of the three-dimensional GIS model of the Argentine Islands, reflecting the interrelationships between terrestrial ecosystems and marine ecosystems adjacent areas of the bottom of the water area of the Argentine Islands, and the development of a new biogeographical landfill project.

A new marine biogeographical polygon with a three-dimensional GIS model of the Argentine Islands water area was substantiated and described.

The obtained data will be used for the development of Management Plans for Marine Protected Areas (MPA in accordance with the methodology developed by the State Institution National Antarctic Scientific Center.

2. Study of penguin breeding colonies, chronology and their reproduction success in the CCAMLR Subarea 48.1 using CEMP camera network (Project Manager – Ihor Dykyy, PhD in Biology, Ivan Franko Lviv National University).

The aim of the work is to study quantitative and qualitative changes in ecosystems under the influence of climatic factors, in particular the impact on nesting behavior, nutrition and reproduction of penguins as key species of the Antarctic ecosystem. The object of the study was the breeding colonies of *Pygoscelis papua* and *Pygoscelis adeliae* penguins. The subject of the study was the chronology of reproduction and reproductive success of the population of *Pygoscelis papua* and *Pygoscelis adeliae* penguins. For the research modern methods of photo and video fixation were used applying automatic cameras for monitoring and recording penguin behavior; processing of the results was carried with the help of software.

32140 photographs taken by automatic cameras during the 21st UAE summer season were processed, entered into a common database and adjusted to the format of CEMP protocols. It was found that at the beginning of the 21st century due to climatic changes there was a significant expansion of *P. papua* breeding colonies south of the Petermann Island. It has been established that krill is the main component of the diet of *P. papua* and *P. adeliae* in the spring-summer period in the area of Argentine Islands archipelago. These species should be used as "species-indicators" of krill abundance and distribution in this region, while establishing its reserves. A qualitative model of possible changes in ecosystem elements (penguins) of the Argentine Islands based on krill is developed. The received schemes of daily and seasonal movements of 15 *P. papua* individuals due to the installed ARGOS satellite transmitters in the summer season 2016/2017 indicate that the feeding areas of this species are partially overlapping with the main areas of *Euphausia superba* fishery near the coast of the Antarctic Peninsula.

The research data will be taken into account by the CCAMLR Committee during the allocation of quotas and expansion of the trigger level of krill fishery in CCAMLR Subarea 48.1 for domestic fish industrial companies Proteus, Prydunayska Nyva and INTERPROMFLOT Ltd.

3. Complex adaptability of the unique aboriginal cereals *Deschampsia Antarctica* in nature and culture in vitro (Project Manager – Viktor Kunakh, Doctor of Biological Sciences, Institute of Molecular Biology and Genetics NAS of Ukraine).

The aim of the work is to replenish a series of data of dynamics of complex adaptability values, estimated by the value of the composite latent index of adaptability (CLIA) in *Deschampsia antarctica* plants collected in six natural populations in the dynamics of 5 seasons (taking into account the material obtained during the last 22 UAE); search for mathematical dependencies between the integral index of the size of the genome and other studied indicators of the adaptation of *D. antarctica* obtained from seeds collected in Marine Antarctica which were cultivated under standardized conditions in vitro. For research, primary data, materials and samples obtained during the wintering and season in the 20th, 21st and 22nd Ukrainian Antarctic expeditions were processed. On the basis of the material of five southern summer seasons the dynamics of the complex adaptability of six populations of *D. antarctica* Desv. at Galindez Island. The individuality of the calculated complex latency indicator of adaptability is shown not only depending on the micro conditions of growth but also on the weather conditions of the research season. The studied populations by the nature of the dynamics trend of complex adaptability are joined into groups in which the indicator value passes through the maximum (D1, D12) or the minimum (D2, D4) or fluctuates (D3, D5).

It is assumed that with increasing the number of points of the dynamics it will turn out that the corresponding trends are oscillating with different period and phase of oscillations for different populations. On the basis of the material of eleven genotypes obtained in laboratory conditions in the form of micro clones, the dynamic state of hereditary information realized on the basis of the composite latent index of adaptability (CLIA) was investigated. The latter is determined on the basis of five series of data, in particular genome size, synthesis of proteins in leaves, secondary compounds, morphometric characteristics and biological activity of secondary metabolites in extracts from plant leaves that were approximately at the same stage of development. The analysis of probabilistic schemes of networks of interaction of characteristics dependent on external

conditions, obtained on the basis of the analysis of the fine CLIA structure showed that the figures formed by probabilistic connections have a complex structure, which each of the genotypes uses individually. The individuality of the use of interaction networks can be connected with the realization of the states of dynamic hereditary memory specified by a certain set of conditions in which seeds were formed and matured in nature.

4. Bioinformatic search and cloning of the genes of the transcription factor family of CBF / DREBs *Deschampsia antarctica* involved in the signaling pathways for a response to abiotic stress (Project Manager Igor Andreiev, Institute of Molecular Biology and Genetics NAS of Ukraine).

The aim of the work is to search and characterize genes and DNA sequences that determine the resistance of *Deschampsia antarctica* to extreme environmental factors, to establish connection between the determined molecular genetic characteristics and peculiarities of the conditions of existence of Antarctic organisms.

Methods of bioinformatic analysis and molecular biology, samples of plant material of *D. antarctica* collected in Ukrainian Antarctic expeditions, as well as primary data of genome and transcription of *D. Antarctica* presented in GenBank database are used.

For the first time for *D. antarctica*, a nucleotide sequence of three genes encoding stress-induced transcription factors DaCBFIIIc, DaDREB2A and DaDREB2B involved in regulating gene expression responses to abiotic stresses has been identified *in silico*. With the help of bioinformatic analysis of the sequences of the genome and transcripts, the intron-exon structure of these genes has been determined. For the DaDREB2B gene, an additional reading frame is shown, that is absent in related cereal species, which by alternative splicing of mRNA allows producing another isoform of this transcription factor, which can be one of the manifestations of species adaptation to extreme environmental conditions.

5. Estimation of flow of biogenic elements and greenhouse gases in terrestrial ecosystems of coastal Antarctica (Project Manager – Nataliya Zaimenko, M.M. Gryshko Botanic Garden NAS of Ukraine).

The aim of the work is to substantiate the influence of the temperature factor and vector flows of biogenic elements on the Carbon balance in the coastal Antarctic biogeocoenoses.

Quantitative assessment of the biogeochemical Carbon flux in coastal Antarctic ecosystems is extremely important in view of their vulnerability, in particular to global climate change.

A significant feature of the terrestrial ecosystems of the Coastal Antarctic is their close relationship with marine ecosystems, in particular through the biogeochemical cycles of Carbon and Calcium.

Based on the results of the research, a scheme of vector flows of nutrient elements from the ocean to the land with the participation of seabirds was constructed. Particular attention is paid to the flows of chemical elements which are part of the Antarctic limpet shells and, first of all, of Calcium, Carbon, and Oxygen. An important role of Antarctic limpet shells as the source of Calcium for the terrestrial ecosystems of the Coastal Antarctica is substantiated. Based on studies on the organic matter content of the soil (in particular, water-soluble carbohydrates) and the rate of CO₂ assimilation by Antarctic plants, a conceptual model of reservoirs and Carbon fluxes in terrestrial ecosystems of the coastal Antarctica was constructed. Two problem elements that are difficult to estimate quantitatively were revealed: the flow of elements from land to the ocean, as well as the pool and the effect of alco-chemicals on the synthesis processes for the absorption of greenhouse gases. Further research aimed at clarifying this model and quantifying its components will allow predicting the possible consequences of climate warming for these ecosystems and adjusting environmental measures aimed at their conservation and restoration.

6. Spectrum of lytic phage activity and phage-bacteria relationships in Antarctica soils (Project Manager – Iryna Budzanivska, Doctor of Biological Sciences, Educational and Scientific Center "Institute of Biology and Medicine" of Taras Shevchenko National University of Kyiv).

The purpose of the work is to create a collection and to determine the biological characteristics of viruses of bacteria isolated from different biotopes of the Antarctic Peninsula, including the root soil (rhizosphere) of higher Antarctic plants, and the study of the nature of the interaction in the "virus-host" system.

A collection of bacteriophages isolated from the rhizosphere of Antarctic plants *Deschampsia antarctica* and *Colobanthus quitensis* with the identified morphological and biological properties is obtained, the characteristic of interaction in the "bacteriophage-bacteria" system is given, the spectrum of lithic activity of bacteriophages and the efficiency of reproduction on sensitive strains of bacteria are determined; recommendations and suggestions on the prospects of development on the basis of isolated bacteriophages of drugs directed against bacteriosis of plants have been developed. The research results have been implemented in the educational process of the Educational and Scientific Center "Institute of Biology and Medicine" of Taras Shevchenko National University of Kyiv.

7. Biological characteristics of Antarctic microorganisms - producers of biologically active compounds promising for biotechnology, medicine and environmental technologies (Project Manager – Tetiana Beregova, Doctor of Biological Sciences, Educational and Scientific Center "Institute of Biology and Medicine" of Taras Shevchenko National University of Kyiv).

From the Antarctic samples, microscopic fungi and bacteria that are capable of producing important biologically active compounds have been isolated. This is a manifestation of an active strategy of adaptation of microorganisms to the extreme conditions of Antarctica. Biologically active compounds of microorganisms are promising for use in the biotechnological industry, medical and food industries, agriculture and environmental technologies.

Changes in the species composition of microscopic fungi from samples of the 18-21th UAE, which indirectly confirms data on climate changes, have been revealed. Since Antarctica is one of the main regions of the planet undergoing global climate change, changes in microbiocenoses that are determined by microbiological monitoring can be an objective predictor (risk predictor) for climatic changes in the polar regions of the Earth. It has been established that under the action of biologically active compounds of Antarctic bacterial antagonists, phytopathogenic fungi - pathogenic agents of wheat "spectacled spotting" disease - lose their ability to grow. The positive effect of isolates of Antarctic bacterial antagonists on the formation of plant immunity, their systemic stability, and the adaptive potential of winter wheat has been revealed.

In seedlings and seeds of Myronivskaya 808 and Renan winter wheat, infected with the pathogenic agents of spectacled spotting, the treatment by suspension of Antarctic bacteria led to inhibition of the development of oxidative processes, exhibited a protective action, and induced the activity of utilizers of active forms of oxygen (superoxide dismutase (SOD) and catalase. The use of bacteria to increase the plant's resistance to diseases and increase the yield of crops is considered as a direction related to environmentally friendly technologies of food production.

It has been established that the optimum medium for the synthesis of lipids, important fatty acids, by Antarctic fungi is potato squash (potato starch production waste). It is known that lipids of fungi are used to create medicines, in technical fields for the production of biodiesel, with the use of agricultural waste and food industry. The molecular-genetic features of the producer of melanin, the cultured liquid of which has a powerful antifungal and antibacterial effect, are shown. It has been determined that the introduction of copper ions into the medium (as inductors) provides effective regulation of expression and increase the production of lactase enzymes three times as much.

It has been established that test cultures of Antarctic filamentous fungi from samples from 18th-21st UAE are able to accumulate toxic metals and show positive chemotropic reactions, that is, to grow towards environments with a high content of toxic metals (Ag, Cr, Cu, Pb).

The obtained results indicate a high degree of metal resistance of investigated microorganisms, which is promising for their application in environmental technologies. According to the results of the research, a collection of technologically promising strains of microorganisms has been replenished with new types (strains) of filamentous fungi, yeast and bacteria - producers of BAS and metal-resistant microorganisms

8. Peptides derived from the Antarctic scallop *Adamussium colbecki*, as a potential means of correcting metabolic disorders of the body caused by the development of obesity (Project Manager – Oleksiy Savchuk, Doctor of Biological Sciences, Educational and Scientific Center "Institute of Biology and Medicine" of Taras Shevchenko National University of Kyiv).

The aim of this work is to investigate the effects of peptides derived from the Antarctic region hydrobionts on the development of experimental obesity induced by the consumption of high-calorie feed. In the course of the research, the conditions for enzymatic hydrolysis of proteins of tissues of hydrobionts of the Antarctic region were selected, which made it possible to obtain a solution of peptides in the molecular weight range from 5 to 0.5 kDa. It was shown that the introduction of a peptide solution to animals that were on a high-calorie diet caused a decrease in the amount of feed consumed per day and was accompanied by a less pronounced weight gain and a decrease in body mass index compared with the rats, that were only on a high-calorie diet.

The revealed changes were accompanied by normalization of the resistin content in adipose tissue and a decrease in the content of resistin and ghrelin in the blood serum compared with the results for obesity. It is shown that the use of a solution of peptides determines the normalization of glucose concentration, the content of glycosylated hemoglobin and insulin, which are considered as informative markers of the development of insulin resistance. The effect of peptides on the functioning of the peripheral serotonergic system has been established, which is revealed in the normalization of monoamine oxidase activity, a decrease in the serotonin content and an increase in the tryptophan content. The application of a solution of peptides contributed to the normalization of the total prooxidant-antioxidant balance, influenced the cytokine profile, namely, after their introduction, a decrease in the concentration of pro-inflammatory cytokines IL-1 β , IL-6, IFN- γ , TNF- α below the control indicators and an increase in the concentration of anti-inflammatory cytokine IL -10 was observed. The obtained results substantiate the expediency of using these peptides to create on their basis pharmacological preparations of prophylactic and therapeutic action, biologically active additives or functional foods.

9. Study of the morbidity structure, mechanisms of development of pathological conditions and improvement of methods for the prevention and rehabilitation of Antarctic wintering members (Project Manager – Yevgen Moiseienko, Doctor of Medical Sciences, State Institution National Antarctic Scientific Center).

The aim of the work is to improve the psychophysiological selection of Antarctic winterers, to develop new methods for the prevention of morbidity and to assess the quality of adaptation of Antarctic expedition participants during their long stay in Antarctica, substantiation of methods of rehabilitation and restoration of functional reserves of the body, as well as the development of methodological recommendations for the correction of psychophysiological disorders through the operational evaluation of the psycho-physiological status and application of bioregulation technology. As a result of research, additional indicators for assessing the psychophysical state were identified to improve the selection of Antarctic wintering members; a method has been developed to prevent morbidity and preserve the health of wintering members.

A new method of polychromic bioregulation has been developed and practically applied to correct violations of the psychophysiological status of Antarctic wintering members, based on the principle of biological feedback.

New data on changes in the morpho-functional status of platelets under the influence of hypoxic loading, based on the allelic polymorphism of the HIF-1 α gene have been obtained, which indicate that the allelic polymorphism of the HIF-1 α gene influences hypoxic induced changes in the

ultrastructure, as well as the function of blood cells, and therefore the type of changes can serve as an evaluative marker for the formation of adaptive reactions of the Antarctic wintering members organism in response to a hypoxic stimulus.

10. Subglacial and geotectonic studies of structural and geomorphological characteristics of the Antarctic Peninsula (Project Manager – Petro Gozhyk, Academician of the NAS of Ukraine, Director of the Institute of Geological Sciences NAS of Ukraine).

The aim of the work is to create a database and to build the relief of the visible and subglacial surface, as well as the characteristics of the ice cover thickness of the ridge zone of the Antarctic Peninsula massif, construction of a tomographic model of the deep structure along the mountain ridge and in the cross section of the Antarctic Peninsula and the adjacent shelf in the area of Antarctic Akademik Vernadsky station.

The Antarctic Peninsula, like most of the continent, is hidden under the ice sheet and is inaccessible for direct geological research. Therefore, to create cartographic data and a model of the deep structure of the region, modern and most informative technologies were used in the work, in particular, a new database of topographical designation BEDMAP2 with the Matlab-based software package as well as well-known foreign software complexes ArcGIS, ENVI, Surfer, Grafer. In addition to the characteristics of the surface of the Antarctic Peninsula, the gravitational tomography software developed by the Institute of Geological Sciences of the NAS of Ukraine was used to restore the geological structure of the region using the data of the modern model of the Earth geoid.

This made it possible to reconstruct the geodynamics processes at depths of up to 5,300 km., to obtain cartographic data and models, and a section of the earth structure along the crest of the entire Antarctic Peninsula from south to north. It is shown that the surface relief corresponds to the subglacial geological environment (the thickness of the ice cover reaches 1600 m here). The obtained data are extremely important for establishing the deep structure of the Earth's crust, its main structural elements and their evolution, and provided the basis for the search of minerals in the region.

11. Stress-strain state of rocks as a reflection of the tectonic evolution of Western Antarctica as a result of the integration of tectonophysical and petromagnetic studies in Vernadsky station region (Project Manager – Tamara Yegorova, Doctor of Geological Sciences, S.I. Subbotin Institute of Geophysics NAS of Ukraine).

The aim of the work is to create an evolutionary geotectonic model of the Western Antarctica based on the results of field geological, structural and tectonophysical studies at the geological and geophysical polygon of Antarctic Akademik Vernadsky station and analytical studies of the magnetic texture of rocks.

As a result of the conducted research, it was shown that active tectonic processes in the area of Antarctic Akademik Vernadsky station were manifested in the complex evolution of individual microplates, clearly reflected in the anomalies of geophysical fields.

Scientists have identified the main stages of the development of the oceanic proto-Pacific plate, its interaction with the Antarctic plate, the formation of the main tectonic structures of the continental margin of Western Antarctica. A general scheme of geodynamic evolution of the region is constructed and it is shown how the results of various tectonic processes are reflected in the geophysical fields - wave, gravitational and magnetic. The latter clearly reflect the spatial-temporal relationships of the deep structure of the lithosphere and the tectonic evolution of the region. To understand the tectonic processes that led to the formation of modern geological situation of Vernadsky station region, modern methods investigating the stress-strain state of rocks reflecting the main stages of tectonic evolution throughout the Mesozoic – Cenozoic were involved.

For the first time, complex tectonophysical, geological, structural, and petromagnetic studies of anisotropy of magnetic susceptibility were carried out in the station area. As a result, new data were obtained on the parameters of paleo-stress and strain fields, which is the basis for

determining the nature and direction of the driving forces that cause the formation of geological structures in the region. This is necessary for creation, verification and refinement of geodynamic models, which are the basis for further tectonic, seismoprognotistic, engineering and geological studies and the compilation of various cartographic documents. The presented geotectonic models of various groups of islands of the geological and geophysical test site of the UAS region reflect the main stages of the tectonic evolution of the area and include the following elements: tables, maps, charts and diagrams of tectonophysical measurements and geological structural observations, magnetic parameters of the main rock complexes.

The analysis of tectonic structures and the reconstruction of geodynamic conditions allows us improving the criteria for regional forecasting and the conditions and areas of mineral resource formation not only in Western Antarctica, where active geological processes took place in the recent geological past, but also on the territory of Ukraine, where the processes ended much earlier (in the Proterozoic- Paleozoic).

12. Investigation of the relationship between changes and redistribution of the angular momentum of the Earth, the Antarctic tectonic plate, the atmosphere and the ocean according to the data of permanent GNSS measurements made on the geodetic test site in the area of Ukrainian Antarctic Akademik Vernadsky station and on the territory of Antarctica (Project Manager – Kornyliy Tretiak, Doctor of Technical Sciences, National University Lviv Polytechnic).

The aim of the work is to study the results of long-term GNSS observations at permanent stations located on the territory of the Antarctic tectonic plate; to determine changes in its rotational parameters and angular momentum, to calculate changes in the angular momentum of the Earth, oceanic and atmospheric masses, and to establish the relationship between these parameters.

According to the research results, an improved algorithm for determining the parameters of the Euler pole and the angular velocity of rotation of the tectonic plate, taking into account the continuity and irregularity of the time series of daily solutions of the spatial location of permanent GNSS stations is presented.

According to the results of daily solutions of 28 permanent GNSS stations of Antarctica for the period (1996-2014), the position of the Euler's middle pole and the angular velocity of rotation of the plate, and their annual changes were determined. The annual parameters of the inertia tensor and angular momentum of the Antarctic tectonic plate are determined. The annual changes in the angular momentum of the Earth and the tensors of the moment of inertia and magnitude of the angular momentum of oceanic and atmospheric masses for the period (1996-2014) are calculated using the data of the Earth's rotation service and geophysical observations. It has been established that practically throughout the entire observation period, an increase in the angular momentum of the Antarctic tectonic plate corresponds to a decrease in the angular momentum of the Earth and the atmosphere, indicating that the angular momentum is maintained. An increase in the angular momentum of the Antarctic tectonic plate corresponds to an increase in the angular momentum of the ocean. Explanation of this relationship requires additional research.

13. Integrated magneto variation and tectonic-magnetic monitoring of modern geodynamics of the Earth's crust on the western slope of the Antarctic Peninsula (Project Manager – Valentyn Maksymchuk, Doctor of Physical and Mathematical Sciences, Director of the Carpathian Branch of S.I. Subbotin Institute of Geophysics NAS of Ukraine).

The aim of the work is to develop a methodology for complex magneto variation and tectonic-magnetic observations for monitoring of modern seismotectonic processes in the area of the Ukrainian Antarctic Akademik Vernadsky station.

The task of the work is to investigate the time-varying parameters of electromagnetic induction (Wiese vector) and construct an interpretative model of tectonic-magnetic anomalies along the Barchans-Rasmussen profile.

The work is based on the results of tectonic-magnetic and magneto-varied observations at the UAS Akademik Vernadsky and the Antarctic tectonic-magnetic test site obtained in recent years. The use of magnetovariational soundings for investigation of modern geodynamic processes is based on the hypothesis of changes in the electrical resistivity of rocks under the influence of tectonic stresses and the possibilities of the method for their detection. Tectonomagnetic anomalies of various duration and intensity were detected based on the results of tectonomagnetic monitoring investigations in the Vernadsky station area. It is established that the nature of tectonic anomalies is associated with the response of the geological environment to changes in tectonic stresses in the earth's crust. According to the results of the interpretation of the tectonomagnetic anomalies, it was established that the Penola Strait fault is an important tectonic element in the region. It divides two different tectonic blocks of the crust. According to the calculations, stretching tectonic stresses reach here several bar/year, which is consistent with the data of geodetic observations.

14. Investigation of material composition and ore-bearing of magmatic formations of the western coast of the Antarctic Peninsula near the Ukrainian Antarctic station to determine its mineral resource potential (Project Manager Sergiy Shnyukov, Doctor of Geological Studies, Educational and Scientific Institute “Institute of Geology” of Taras Shevchenko National University of Kyiv).

The aim of the work is to find out the features of material composition of magmatic formations in the area of the Antarctic Akademik Vernadsky station and assess their ore-generating potential.

The work is aimed at solving the problem of insufficient knowledge of the leading magmatic complexes and mineral resource potential of the western coast of the Antarctic Peninsula and the adjacent island archipelagoes. The object of the study was the magmatic formations that make the west coast of the Antarctic Peninsula near the Antarctic Akademik Vernadsky station. The subject of the research is the material composition of intrusive and effusive magmatic formations of Vernadsky station area, as well as ore mineralization spatially associated with them. Based on the latest data on the petrographic diversity of the studied rocks, their geographic distribution, geological conditions of occurrence and natural associations, a new Scheme for the disintegration of magmatic formations of Vernadsky station area has been developed. The mineralogical-petrographic and geochemical features of isolated stratified volcanogenic and non-stratified intrusive-magmatic formations identified in the research process are quite sufficient for their field or laboratory identification and may be recommended for further regional geological studies in the region. According to geochemical modeling data, the theoretical possibility of hydrothermal mineralization is predicted that is genetically associated with the volcanic series of the Antarctic Peninsula and the Argentine Islands archipelago. The nature of the regional metamorphic transformations of VSAP - greenstone degeneration may in future complicate the detection of low-temperature hydrothermal-metasomatic accompanying mineralization. The results of the mineralogical and petrographic study of stratified intrusions indicate the presence of hidden stratification in them, which can later be used to elucidate the features of their geological structure and to identify bottom deposits of Fe-Ti-V ores. The worked out methodology and predictive-search criteria can be successfully used in the practice of exploration works in other regions of the Earth, which are geologically similar to the orogenic belt of the Antarctic Peninsula.

At present the results of scientific and technical work have been introduced into the educational process of Educational and Scientific Institute “Institute of Geology” of Taras Shevchenko National University of Kyiv.

The new data on the material composition and ore content of magmatic formations in Vernadsky station area, conclusions about their mineral resource potential, as well as recommendations for forecasting and research work aimed at assessing the mineral resource base of the region can have both fundamental scientific and applied applications

15. Atmospheric processes in the Southern Hemisphere troposphere and the development of long-term weather prediction for the Antarctic Peninsula (Project Manager – Vazira Martazinova, Doctor of Physical and Mathematical Sciences, Ukrainian Hydrometeorological Institute of the State Service of Emergences of Ukraine and NAS of Ukraine).

The aim of the work is to investigate changes in the current regional climate of the Antarctic Peninsula and above the Antarctic Akademik Vernadsky station during the period of global warming, to study the peculiarities of atmospheric circulation in the Southern Polar Region, to develop methods for forecasting the temperature of seasonal weather for the Antarctic Peninsula.

A comparative assessment of the current state of the climate in the region of the Antarctic Peninsula has been carried out. A characteristic feature of air temperature changes is the tendency for relative cooling in all seasons of the year, including Vernadsky station. An analysis of ground wind is performed according to the station data, certain inhomogeneity in the long-term series and their reasons are determined. Comparison of measurements of the main meteorological values by the data of automated weather stations is carried out. A multi-year change in precipitation has been analyzed with a tendency to increase in most months, and anomaly of precipitation in 2017 is analyzed separately. The dependence of the variability of weather conditions on the predominant phase of the El Niño phenomenon - the Southern Oscillation was confirmed.

The modern character of synoptic processes over the sector of the western Antarctic and the Antarctic Peninsula, including those causing anomalous weather conditions, has been studied. The effect of atmospheric circulation on the state of the ozone layer is shown using a model of changes in atmospheric circulation in the Northern and Southern Hemispheres. It is assumed that in the coming years we should expect an increase in the total ozone content above Akademik Vernadsky station, which is associated with the general nature of the ozone layer above the Southern Hemisphere. Based on the revealed patterns of atmospheric circulation of the Southern Hemisphere, as well as the connection with the El Niño phenomenon, methods have been developed for predicting the temperature of seasonal weather for the Antarctic Peninsula.

16. Modeling the formation and propagation of deep water in the Weddell Sea and studying the influence of geomagnetic activity on atmospheric processes of the troposphere over the Antarctic Peninsula (Project Manager – Volodymyr Maderych, Doctor of Physical and Mathematical Sciences, Institute of Problems of Mathematical Machines and Systems NAS of Ukraine).

The aim of the work is to study using the hydrodynamic modeling the influence of the bottom topography of the shelf and the continental slope of the Weddell Sea, as well as regional flows to the transfer of the deep waters formed on the sea shelf, and also the study of the influence of geomagnetic activity on the change of the pressure field and the associated weather conditions of the Antarctic Peninsula.

Calculations using a three-dimensional model of complete elements with high resolution showed the importance of the existing system of canyon-ridges in the area of the Filchner Trough, partially directing the flow of dense waters to the continental slope of the Weddell Sea.

It was shown for the first time that even in the absence of currents caused by other factors than the source of dense waters beneath the Filchner glacier, the formed water mass is moving along the continental slope of the Weddell Sea in the direction of the Antarctic Peninsula and further into deep-water passages into the Atlantic Ocean. Mutual spectral analysis of surface temperature of the air, atmospheric pressure over the Antarctic Peninsula and the geomagnetic activity index allowed establishing the existence of a close correlation between periodic components in the time series of the studied values.

17. Model of influence of geophysical factors on the air temperature in Antarctica (Project Manager – Volodymyr Bakhmutov, Doctor of Geological Sciences, S.I Subbotin Institute of Geophysics NAS of Ukraine).

The aim of the work is to determine the geophysical factors that influence the long-term changes in the Antarctic environment, in particular the increase in temperature in the West Antarctica.

Construction of the model of cause-and-effect relationships of various geophysical parameters (including those obtained at the Antarctic Akademik Vernadsky Station), which reflect the dynamics of processes in the upper troposphere / lower atmosphere in the Antarctic region and can affect the radiation balance of the Earth.

The object of the study is the factors influencing surface temperature changes in Antarctica; the subject is the space-time structure and cause-and-effect relationships of various geophysical parameters that may affect the surface air temperature in Antarctica.

As a result of the work, maps of the distribution of the module of a complete geomagnetic field vector F and maps of its age variation for each decade for the period 1900 – 2010; maps of the 55-year average values of the total intensity of the geomagnetic field, its secular variations, surface temperature, total ozone and its anomalies, the ratio of ozone mixing at three levels near the tropopause were built.

The maps of the distribution of correlation coefficients were built: secular variation and surface temperature; secular variations and total ozone; between the galactic cosmic-ray flux and the total ozone; between the complete vector of the geomagnetic field intensity and the galactic cosmic rays flux; between solar protons and the total ozone; between the complete vector of the geomagnetic field intensity and the flux of solar protons with the energy $E > 10 \text{ MeV}$; between the total ozone and solar proton fluxes at three levels near the tropopause; the total ozone and the air surface temperature. Also maps of the time shift distribution between the above-mentioned correlated parameters were constructed.

According to the results of the map analysis, a model was constructed that adequately explains the peculiarities of changes in the current temperature in Antarctica — simultaneous “warming” of the western sector and “cooling” of the central and eastern sectors. The model is based on a chain of cause-and-effect relationships: the geomagnetic field - the solar proton flux - the ozone concentration - the temperature and humidity near the tropopause - the surface air temperature. The lower intensity of the geomagnetic field in Western Antarctica results in systematically low ozone concentration and the increased humidity at the tropopause, which helps to keep the Earth’s long-wave radiation in the troposphere due to the greenhouse effect and an increase in surface temperature. The higher intensity of the geomagnetic field and the concentration of ozone in Central and Eastern Antarctica cause an increase in temperature and a decrease in humidity at the tropopause level that does not prevent the propagation of a long-wave radiation from the Earth upwards and contributes to cooling of the lower troposphere.

So, a new explanation for one of the paradoxes of the current climate - simultaneous warming of the West and cooling of the Central and East Antarctica is proposed. The differences of the proposed model from the previous ones are that the latter were based on the internal climate variability, the reasons for which are also not completely clarified. The consideration of the geomagnetic field as a factor of influence on processes near the tropopause allows (according to the chain of changes in geophysical factors) to adequately explain the peculiarities of a long-term climate change in Antarctica.

18. Investigations of atmospheric and space weather systems by analyzing planetary thunderstorm activity and energy transport mechanisms from the Earth's surface to the geospace (Project Manager – Oleksandr Koloskov, Doctor of Physical and Mathematical Sciences, Institute of Radio Astronomy NAS of Ukraine).

The purpose of the work is to detect plasma and field disturbances in the near-Earth space, to identify the nature and sources of geospace disturbances, to control global thunderstorm activity and temperature on a planetary scale.

The main problem to be solved is the study of the interaction of the Earth’s plasma shell (ionosphere and magnetosphere) with energy flows from the Sun (from top to bottom) and from the surface and troposphere (from bottom to top), which determine the state and disturbances of space weather. The object of the study is space weather, the structural components of which are the ionosphere and the Earth's magnetosphere.

As a result of the studies, an improved model for plasma transfer to the ionospheric heights due to neutral winds was developed and introduced, and a new original technique was developed for the coherent processing of data from the ultra-low-frequency interferometer to identify high-

power lightnings. The proper functioning of the layout of the new digital ionosonde, which allows determining not only the position of the ionospheric layers, but also their velocity, has been confirmed. Moreover, it is ten times cheaper than its foreign counterparts. Thanks to this development, geophysicists can now study geospace not only above the station, but also at a distance of thousands of kilometers from it.

19. Investigation of the morphology of mobile ionospheric disturbances using Antarctic and mid- latitude systems of formation of strong electromagnetic fields (Project Manager – Dmytro Kotov, PhD in Physics and Mathematics, Institute of the Ionosphere of the National Technical University “Kharkiv Polytechnic Institute”).

The purpose of the work is to obtain new information about the differences in the morphology of mobile ionospheric disturbances (MID) over Antarctica and Ukraine during periods of powerful geospace storms using the Akademik Vernadsky ion probe and the incoherent scattering radar and ion probe of the Institute of the Ionosphere (Kharkov).

To evaluate MID parameters, methods of system spectral analysis and statistical analysis, as well as algorithms for optimal detection and optimal estimation of signal parameters were used. As a result of the studies, significant differences were observed in the MID periods for high and medium latitudes. The periods of wave processes over Antarctica are on average 50-100% longer than wave periods over Ukraine. During the severe geospace storm on November 14, 2012, the phase and group velocity of internal gravitational waves, as well as the wavelength, increased significantly over Ukraine. The results of this work are extremely important for fundamental studies of solar-terrestrial communications and the near-Earth environment, as well as for solving applied problems related to the influence of wave processes in the ionospheric plasma on modern communications and spacecraft.

20. Development and optimization of architectural solutions for the physical infrastructure of the Antarctic data storage as an integral heterogeneous environment for storage of the Antarctic research results (Project Manager – Mykhailo Ilchenko, Doctor of Technical Sciences, Academician of the NAS of Ukraine, National Technical University of Ukraine “Igor Sikorsky Kyiv Polytechnic Institute”).

The aim of the work is to improve the architectural solutions of the physical infrastructure of the Antarctic data storage as an integral heterogeneous environment of the National Center for Antarctic Data (NCAD), ensuring reliable storage of Antarctic research results and guaranteed access to them in the global environment, which will allow working with relevant data at the international level. The analysis and selection of hardware elements for their inclusion in the heterogeneous infrastructure of a distributed storage of Antarctic data (based on an analysis of the requirements for hardware elements and their parameters) was conducted as well as analysis of architectural solutions, topologies and Cloud technologies, hardware organization technologies for the physical implementation of the Antarctic data storage, taking into account the ArcGIS Online cloud environment was carried out. Architectural solutions have been created and a model of infrastructure (physical and virtual) distributed Antarctic data storage developed, configuration of infrastructure elements of the distributed Antarctic data storage and deployment of the software environment (appropriate software, modules, operating systems, etc.) for the functioning of the heterogeneous (physical and virtual) infrastructure of the distributed Antarctic data storage was carried out.

The documentation for commissioning and maintaining the system (program, methodology and test reports regarding the collection, storage, processing and transmission of Antarctic research data, NCAD operating procedures, operating and maintenance instructions for NCAD using ArcGIS Online has been developed.

21. Development of visualization subsystems and decision-making on the state of the object in the automated fuel leakage prevention system at the Ukrainian Antarctic Akademik Vernadsky station (Project Manager – Nadiya Burau, Doctor of Technical Sciences, National Technical University of Ukraine “Igor Sikorsky Kyiv Polytechnic Institute”).

Experimental and development activities has been carried out to create a software-hardware complex for monitoring the functional state of the fuel tank and the automated system for preventing fuel leaks at the Antarctic Akademik Vernadsky station.

Developed: subsystem for visualization of measurement data based on the developed algorithmic and software for visualization of measurement of stresses and spatial position of the reservoir; methodological, algorithmic and software for predicting the growth of the level of deformation under the conditions of operational loads; a subsystem for decision-making about the current state of an object based on a developed neural network state classifier. The range of values of the parameter of influence of the neural network is established to ensure error-free classification of certain states of the object is determined. The results can be used in the development of modern intelligent monitoring systems for complex spatial objects that are operated in hard-to-reach places under the complex effects of loads.

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