

MEMBER COUNTRY: Ukraine

National Report to SCAR for year: 2008 - 2009

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Activity	Contact Name	Address	Telephone	Fax	Email	web site
ACTION GROUPS						
1) Prediction of Changes in the Physical and Biological Environment of the Antarctic 2) 3) 4) insert others as needed	Dr. Oleksandr Tashyrev	Institute of Biology and Virology Zabolotnogo Str., 154 03680 Kiev D	+38 044 5263279	+38 044 5263279	tach@i.com.ua tach2007@ukr.net	
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A BRIEF SUMMARY OF SCIENTIFIC HIGHLIGHTS:

Geological research

Electronic Atlas of the Antarctic deep structure according to the gravimetric tomography data was created. The Atlas contains information on anomalous density heterogeneities derived by gravimetric tomography method using EGM96 global gravity potential model (geoid). The 3D images of the Antarctic lithosphere are shown by vertical cross-sections and lateral slices on different depths within the area of 30°S. Tectonic setting, intraplate and interplate processes in the Antarctic region are shown on both the global maps and the cross-sections along the Antarctic Plate's boundary by spreading the mid-ocean ridges on more than 40,000 km. The primary connection of the mantle plume below the Ross Sea area with the North America soft mantle domain is distinguished at a depth of 5300 km. New information on propagation of hot material of the Ross plume into the cold oceanic lithosphere was obtained in the Australian-Antarctic Discordance and the Nazca Ridge on several vertical sections. Regional features of the deep structure within the area of Scotia Sea and within the both Pacific and Antarctic mantle upwelling are shown along the 58°S. The pathways for moving the mantle substance from the Weddel subduction zone to the Bransfield Rift system are revealed. The pathways of uprising of soft mantle material in the West Antarctic Rift System are also shown along the meridians 90°W and 170°W.

Atlas includes 61 maps and sections and following topics: Gravimetric Tomography Method and initial data; Interaction of Antarctica with other regions; Modification of the Earth's structure on different depths within the Antarctic lithosphere plate; Deep structure of the Antarctic Plate's boundary zone; Trans Antarctic vertical sections; Cross-sections of Western Antarctica; Detailed structure maps of the West Antarctica; Large-scale structural features of the Scotia Plate.

The geoinformative system today are the equate means of support of geologists' activity with the factual providing and inquiry service function. GIS-technologies application for treatment of magnetometer survey materials in the water area nearby Vernadsky station allowed attaining some success. As a result of measuring during the three field seasons the database had been obtained. The database includes measurements of complete field vector module in more than 40000 points. The closeness of profiles and amounts of measurements varies strongly from season to season. While transferring the data to the platform, GIS materials were presented and analyzed on each level. After that the four seasons' data were linked to form the integrated data array.

Meteorological research

The developed in 1998 method of long-range weather forecast for the moderate latitudes of Northern hemisphere is based on two-month similarity of atmospheric circulation which is well revealed by the traditional method of analogues of one season. That is why the similarity of atmospheric processes in the non-tropical latitudes of Southern hemisphere was also studied by the method of traditional analogue. Taking into account the found out period of quasi-periodicity of regional atmospheric circulation of the Antarctic Peninsula about 60 days in summer and about 70 days in winter the forecast scheme of anomaly of mean monthly temperature of air is developed. The forecast scheme of anomaly of average monthly air temperature for the area of Vernadsky Station is developed with monthly earliness using the equations of linear regression. The anomaly of mean month air temperature of initial month is used in equation of linear regression as predictor. The verification of forecast scheme was carried out on dependent material of several years and showed success of the offered method of forecast of average monthly air temperature for Vernadsky Station. For the improvement of estimation of extreme values of temperature on the Antarctic Peninsula and at Vernadsky Station the scheme of long-range forecast of mean monthly air temperature was complemented by auxiliary equations which allow calculating extreme values. On the whole, it is possible to note that the found out atmospheric circulation conformities of near two-month quasi-periodicity for the moderate latitudes of Southern hemisphere can be basis for development of method of long-range forecast of atmospheric circulation and weather conditions for the Antarctic Continent.

Geophysical research

The most informative geophysical method to study the Earth's deep structure is assumed to be seismic tomography. For the study region we use seismic tomography method based on Backus-Gilbert approximation using the data on earthquake hypocentre and time arrival of P-waves recorded by network of seismic stations. The seismology data are taken from catalogues of International Seismology Center (ISC), from information of IRIS Corporation (Incorporated Research Institutions for Seismology) data of Geological Survey of USA and data coming from AIA seismic station mounted at the Ukrainian Vernadsky Station. The earthquake catalog of the region contains events with magnitude $M \geq 5$.

Oceanographic research

Research results of the seasonal and interannual sea ice variability of different closeness around the Antarctic Continent are submitted. Correlation between variability of the atmospheric circulation indexes South Oscillation (SOI) and Antarctic Oscillation (AAO) and ice conditions are analyzed. Their connection with the air temperature at polar stations in the Antarctic Peninsula Region is considered. The data of sea ice closeness on $1^{\circ} \times 1^{\circ}$ grid from array British Atmospheric Data Centre HadISST ICE are used. It is shown that the seasonal variability of the ice closeness is most pronounced in the Weddel, Lazarev, Sodruzhestvo Seas. The areas of maximal seasonal variability of the sea ice closeness are extended in east direction along movement of the Antarctic Circumpolar current waters. The minimal seasonal variability of the sea ice closeness is observed in the Antarctic coastal areas, where the extensive ice shelves (Larsen, Ronne, Filchner, Ross and Abbot) are located. It is founded that the closest correlation between the SOI and the sea ice closeness era observed in the areas of their maximum interannual variability: direct correlation ($R_{SOI} \sim 0,6$) in the area between 130-150 W and 63-70S, inverse correlation ($R_{SOI} \sim -0,6$) in the Weddel Sea. Significant correlation between the index AAO and the sea closeness ($R_{AAO} \sim -0,6$) is founded to west from the Antarctic Peninsula. The close inverse correlation ($-0,6 \dots -0,8$) between the air temperature at Vernadsky, Bellingshausen, Rothera, Orcadas, Marambio polar stations and sea ice closeness in the region of Vernadsky station is obtained.

Medical research

In extreme conditions the support of a normal working rhythm of a person requires mobilization of additional reserves of a body, especially in conditions of long-term social isolation of a small collective. In such conditions of incomplete renewal of the body functional state on the background of desynchronous phenomena, the development of pre-parthological functional states of overstrain can occur, which can be the basis for disadaptation development. The functional state of the central nervous system (CNS) was estimated on departure to the Vernadsky Station and after returning from the wintering using EEG standard methods. It was revealed that at the end of wintering in the structure of bioelectric activity of the brain cortex significant changes were recorded in the delta range (the capacity increased by 5,6%) and in the alpha range (the capacity decreased by 9,5%). Almost the total decrease of alpha activity (except for the left parietal part) in the right hemisphere was recorded. Thus, over the period of wintering significant changes in the bioelectric activity point to noticeable involvement of the right hemisphere, which is responsible for specifically creative thinking and emotional activity. The received data on the brain bioelectric activity, on the whole, can point to the adaptive decrease of the functional state of the CNS on the background of the great activation of the sympathetic department of the vegetative nervous system in conditions of the chronic stress in the Antarctic region.

Biotechnologies

The biogeographical polygon with the maximal diversity of biotopes is developed in the Antarctic oasis on Galindez Island. With the help of GPS and GIS - methods the 3D model and a topographical map of polygon is constructed. Geochemical researches on studying the contents of 19 elements (metals and nonmetals) in sediments (soil, humus, lake sediments), the molecular-mass characteristic of humic acids of Antarctic soils are carried out. System researches of physiological groups of soil microorganisms of the polygon are carried out. Correlation factors between number and distribution of physiological groups of microorganisms and the contents of humic-like substances in soils are determined. The microbiological counts of psychrotolerant and mesophyllic microorganisms which are characterized as oligotrophic, autochthonic and zymogenic are carried out. It is established, that they are primary factors of humus and soil formation and provide circulation of elements. Quantitative parameters of a homeostasis of microbial populations under influence of a raising gradient toxic Cu^{2+} are received.

Complex biogeographical researches of a zone of Penola Passage are carried out: 60 km from the north to the south (Booth - Lippmann Islands) and 30 km from the West to the east (Cruls Islands - Tuxen Cape). The large-scale microbiological analysis of biotopes (265 samples of soil, mosses, lichens, lake sediments, water, humus) on 19 islands and capes of the continent is carried out. In a zone methylotrophic bacteria are widely occurred. They play an important role in transformation of methanol in a global biogeochemical cycle of carbon and positively influence flora of Antarctic Region due to phytosymbiosis. As a result of system researches the presence of the basic phylum prokaryotes and eukaryotes is revealed: bacteria (Proteobacteria, Firmicutes, Actinobacteria), yeast (Ascomycota) and microscopic fungi (Basidiomycota). In biotopes with high level UV-radiation (vertical rocks) dominate pigment-producing strains which are producers of biologically active substances: melanins, phytohormones, carotenes, etc. Antibiotic-producing (*Pseudomonas*) and melanin-producing strains with anticarcinogenic and antiulcerogenic properties (*Exophiala nigra*) are isolated.

For the first time it is shown, that resistance of chemoorganotrophic microorganisms to very high concentration of toxic metals is the widespread biological phenomenon on an internal island shelf and the western coast of Antarctic peninsula. The Antarctic microorganisms are resistant to a wide spectrum of the most toxic metals (Hg^{2+} , Cu^{2+} , Cd^{2+} , Co^{2+} , Cr(VI) , Ni^{2+}) in a range 500-1000 ppm. Metal resistant microorganisms are present at all terrestrial biotopes (humus, soil, rocky breeds, lake sediments, lichens, mosses, vascular plants). The number of metal resistant microorganisms is 1-5 % of their total amount and makes 10^3 ... 10^6 colony forming units/g of sample. The collection (60 strains) of metal resistant microorganisms is created. Ten strains are polyresistant to high concentration of the most toxic metals (in ppm): Hg^{2+} and Cd^{2+} -500, Co^{2+} -1000, Ni^{2+} -2000, Cu^{2+} -3000, Cr(VI) -60000. The database of a biogeographical zone (30×60 km) and series of 3D-models of polygon, developed by GIS and GPS methods, include concentration of elements specified in stationary sampling points (including toxic metals) and number of physiological groups microorganisms of biogeochemical cycles of elements (including metal resistant). It is proved that metal resistance has a plasmid origin. The system of quantitative criteria of resistance of microorganisms to toxic metals is developed. On the basis of the Antarctic microorganisms which effectively accumulate toxic metals, universal nature protection biotechnologies of sewage treatment from a wide spectrum of metals in any concentration range will be developed.

The complex geoinformation system database, which characterizes structural and functional connections in microbial communities of typical biotopes of Antarctic Region in a zone (30×60 km) of island shelf of passage Penola of the western coast of Antarctic peninsula, is developed.

Physical research

The region of Antarctic Peninsula seems to be an ideal area for investigating the troposphere-to-ionosphere energy transfer as it combines the extremely high cyclone activity with a quiet mid-latitude ionospheric background. Atmospheric gravity waves (AGW) are the principal transportation agent. Using the data of long- term measurements, there were detected coupling effects of quasi-periodical variations in atmospheric pressure with geomagnetic field variations (period about 90 minutes) both at Vernadsky Station and the magnetic-conjugate region. The typical delay time between local variations of preassure and magnetic field (30 minutes) corresponds to the AGW propagation lag toward the dynamo area. Also sporadic E-layers and spread-F are observed more frequently above the atmospheric fronts in winter. The intensified troposphere-ionosphere interaction is increased with reduction of warm-up of the ozonosphere in winter or with ozone hole developing. This leads to the increase of the Brunt-Vaissala frequency in mesosphere, improving conditions for vertical AGW propagation.