

MEMBER COUNTRY: UKRAINE
National Report to SCAR For year : 2020

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Activity	Contact Name	Address	Telephone	Fax	Email	web site
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)						

Activity	Contact Name	Address	Telephone	Fax	Email	web site
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Other Groups (optional)						
SOOS						

The main tasks of the 25th UAE (2020-2021) were to carry out research in the scientific areas of the State Special-Purpose Research Program in Antarctica for 2011-2020. These are geological-geophysical, hydrometeorological, oceanographic, geospatial and biological research. To implement them within the 25th UAE, seasonal research was conducted in two stages. The research involved 16 scientists (3 geologists, 11 biologists and 2 meteorologists).

The first stage of the seasonal expedition included research in the area of the Antarctic Akademik Vernadsky station (February 08 - April 23, 2020). For the first time, our geologists studied the inaccessible part of the Graham Coast of the Antarctic Peninsula east of Waddington Bay, studied the conditions and petrographic composition of the volcanic-sedimentary layer of the territory. They completed 47 geological routes, selected about three hundred geological samples for petrological, mineralogical, geochemical and paleomagnetic studies. In addition, the next 13th cycle of geomagnetic measurements was carried out at the points of the geodynamic landfill in the waters of the Antarctic Akademik Vernadsky station, a gradient magnetic survey of the islands of Skua and the Barchans was carried out to study the anomalous magnetic field and the geological structure of the studied region, and a detailed magnetic survey Forge Island and the East-Barchans.

Started in 2017 studies of internal changes in the glaciers of the Argentine Islands, where the Antarctic Akademik Vernadsky station is located were continued. During the 2020 seasonal expedition, GPR surveys of subglacial and terrestrial bodies of water in the Argentine Islands were launched, as well as more distant island glaciers in a twenty-kilometer radius from the station were studied. During this period, using GPR, a new subglacial lake was discovered on one of the Argentine islands.

During the expedition, new means and methods were introduced for measuring the parameters of the atmosphere, ocean, glaciopause, collecting meso- and micrometeorological information, studying the formation of glacier stratification and their features. The mesometeorological test site is equipped with the 10th logger type mini-meteorological station located within a radius of 20 km from Akademik Vernadsky station.

In the course of further modernization of the station, the Vaisala weather station AWS-310 was adjusted and the actinometric complex Kipp & Zonen was included in its system. MicroRainRadar, MetecMRR-PRO radar for vertical sounding of clouds and precipitation has been

installed. Equipment was replaced at the station's hydrological post: the old automatic tide gauge was dismantled and a new one (including a satellite data transmission system) was installed and delivered by a British Antarctic Service support vessel.

The work was carried out at the request and in accordance with the instructions of the International Oceanographic Commission (IOC). In the course of seasonal biological works, the monitoring observations launched in 2018 to determine the impact of climate change on the biological and hydrochemical parameters of the marine ecosystem at the Vernadsky station were continued. During February - April 2020, regular measurements of physical and hydrochemical parameters of sea water were carried out at 6 monitoring stations in the water area of Galindez island, selection of biological samples (bacterio-, virio- and phytoplankton) was carried out and the concentration of pigments in seawater was determined. 96 seawater samples were taken for analysis of seasonal dynamics of virio- and bacterioplankton groups.

In collaboration with scientists from the United States, Britain, Poland and Turkey, studies of the dynamics of climate change impact on terrestrial ecosystems in the Argentine Islands region were carried out, in particular, the current state of monitoring sites for vascular plants was investigated, and indicators were measured. studied the current state of monitoring sites of vascular plants, measured microclimate indicators (temperature and light) during the summer Antarctic season were carried out, material for biometric, geobotanical and molecular genetic research, analysis of rhizosphere-associated plants of microorganisms was collected. To substantiate the creation of an Antarctic Specially Protected Area (ASPA, "Region of the Argentine Islands and the Kyiv Peninsula"), in particular, its terrestrial part, the scientists have studied the spatial distribution of biodiversity, carried out photographing of the surface of individual components of the specified area using multispectral and monospectral cameras, mapping of different types of vegetation and bird colonies using a drone. About 700 samples of representatives of different taxonomic groups of animals and plants, a collection of marine organisms from depths of 160-275 m were collected and prepared for further analysis. A number of lab works on isolation and cultivation of microorganisms, isolation of DNA of microorganisms have been carried out.

The second stage of the seasonal expedition included research in the Southern Ocean (December 2020 - February 2021), aimed at continuing the bioresource research launched in 2018 and monitoring the physical and chemical fields of the Southern Ocean to identify trends in their climate variability, forecasting areas of increased biological productivity and industrial significance in the fishing area 48 of the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR).

The data obtained during the expedition will be used in the development of scientific recommendations for the rational and inexhaustible use of biological resources (krill and the like), to predict the ecological state, in the formation of environmental measures aimed at preserving the biological resources of the Southern Ocean.

During the 25th UAE wintering the databases of measurements of the Earth's geomagnetic field, its electromagnetic and seismoacoustic monitoring, radon emanation, oceanographic and hydrometeorological observations, ionosphere radiosonde, etc. were replenished. Ukraine fulfilled its obligations to transfer research results to international and domestic data centers, in particular:

2928 operational data on actual SYNOP weather were provided to the World Meteorological Organization (WMO) and the Ukrainian Hydrometeorological Center (UkrHMC);

12 reports on CLIMAT information were provided to WMO and the Central Geophysical Observatory of Ukraine (CGO); 1907 results of measurements of ozone in the atmosphere were provided to WMO and the British Antarctic Survey (BAS); 500,000 sea level measurements were submitted to the International Oceanographic Commission; 24 precipitation samples were submitted to the IAEA for isotope analysis;

12 monthly weather reports in TMS format were submitted to the Central Geophysical Observatory; 359 daily files with geomagnetic measurement data were submitted to INTERMAGNET and 12 monthly files of geomagnetic data were transferred to the ISGI.

As part of the CEMR - CCAMLR Ecosystem Monitoring Program the station was implementing the international project “Establishing a CEMP Camera Network in Subarea 48.1 – CEMP-cameras”. The project implementation period is 5 years (2016-2020). Partner countries: USA, Argentina, Ukraine, Poland and Spain. The results were submitted to CCAMLR to forecast Antarctic bioresources and set quotas for Ukraine for krill catching.

Marine mammals research was conducted at Vernadsky station as part of the Marine Ecosystem Monitoring Program. The features of the seasonal distribution, population structure and behavior of 7 species of cetaceans and 5 species of pinnipeds have been determined. For 6 species of cetaceans and 2 species of pinnipeds, research was carried out using the method of photo-identification by natural features and identification catalogs were arranged in order to further study their numbers, population structure and migrations. For humpback whales, the first stage of identification data analysis was carried out: 133 registrations were found in different years for 45 individuals and two breeding areas were identified, which include whales feeding near the Antarctic Peninsula. Observation data are organized into databases using GIS methods for further analysis.

Within the framework of cooperation with the Environmental Institute (Slovakia), samples were taken to study the global transport and accumulation of persistent organic pollutants in the tissues of Antarctic marine animals, as well as to study the population genetics and trophism of pinnipeds using molecular genetic methods.

Mapping and photographing of nesting and feeding places of birds was carried out. When studying the spatial distribution of birds in different seasons, 10150 photographs were taken with the coordinates of bird encounters.

The current state and species diversity of groups of bone fish parasites of the Argentine archipelago were studied. A total of 250 samples of parasites of fish and other vertebrates were collected and recorded.

In order to search for Antarctic microorganisms - producers of biologically active compounds, samples of various substrates were taken. Geological and Geophysical research. The reproduction of historical climatic data, begun in 2019, continued through a comprehensive study of the material, granulometric, lithological-mineral composition and organic remains of bottom sediments sampled from the water area of the Argentine Islands archipelago and from the freshwater lakes of the islands of the Argentine archipelago, where the stages of activation of outlet glaciers and their reduction, changes in the temperature regime of water and the development of plankton are recorded. In addition, based on the results of GPR studies of island glaciers of the Wilhelm Archipelago along 40 km of the coastline of the Antarctic Peninsula, new data on the structure of small island glaciers sensitive to climate change have been obtained. The data obtained will make it possible to understand the glaciological and geological history of the research region and predict further changes in the structure of glaciers.

As noted above, during the seasonal expedition, geologists explored the inner inaccessible part of the Graham Coast, Antarctic Peninsula east of Waddington Bay, resulting in the first data on the geological structure of this hitherto unexplored area. Their processing gave an idea of local rocks, their origin, occurrence conditions, material composition and mineral resource potential. New materials, together with the results of previous geological and geophysical studies in different parts of the Wilhelm Archipelago, should provide a modern scientific basis for the formation of intrusive-magmatic rocks for further assessment of the mineral resource potential of the area near the Antarctic Akademik Vernadsky station.

At the same time, based on the results of field observations and comprehensive analytical studies of the rocks of the Barchans-Forge Islands, a model was built that reflects the Cenozoic stage of evolution of the Antarctic Peninsula batholith near Vernadsky station.

Hydrometeorological research. The support for monitoring hydrometeorological measurements for weather forecasting and tracking climate changes in the region has been provided. New high-tech equipment was installed, the first data of meteorological and microclimatic landfills

were obtained. National Antarctic Scientific Center has started using the modern Polar WRF atmosphere model for research purposes. All this will reveal new features of the polar atmosphere, and at the same time provide a basis for involvement of Ukraine in international projects.

An important problem is to determine the state and dynamics of the ozone hole by the parameters of planetary waves in the troposphere and stratosphere over the Antarctic Peninsula. It is shown that the ozone hole in 2019 was one of the smallest, and in 2020 - one of the largest and is the longest by lifetime. Earlier, together with Australian scientists, the dynamics of the ozone hole for the current century was modeled. According to modeling data, the ozone hole should disappear by 2050. But due to the asymmetry of ozone distribution revealed by Ukrainian scientists with a minimum over the Antarctic Peninsula and a maximum in the Australian sector of Antarctica, it was determined that the "closure" of the ozone hole will drag on until 2060-2070. A forecast model for early detection of the ozone hole in the spring months for 1–3 months has been developed. The model is useful for determining the conditions for the development of ozone hole anomalies in the atmosphere over Antarctica. The ozone hole dynamics indicator predicts stratospheric anomalies over Antarctica 3-4 months before the development of the ozone hole.

Oceanographic research. According to observations of the physicochemical fields of the Southern Ocean in the summer of 2019 - 2020, an assessment of the variability of the Antarctic frontal zone was obtained and the structure of water masses in the South Atlantic and Southern Ocean was determined. The results of this work will expand knowledge about the Southern Ocean, identify trends in climatic variability of oceanographic fields, predict areas of high biological productivity and industrial significance.

Based on the results of studies in the area of Vernadsky station and satellite data, and using numerous methods, a numerical baroclinic model was built and adapted for the Bellingshausen Sea and the shelf of the Antarctic Peninsula, which can be used to predict currents, temperature, salinity, level, concentration and thickness of ice with a lead time of 1-2 weeks, as well as for forecasting zones of rising and falling waters, assessment of short-term changes in zones of increased biological productivity and industrial significance.

Geospace research. Studies of processes in the Earth-ionosphere system were carried out according to the data of broadband electromagnetic monitoring at Vernadsky station. The state of the ionosphere reflects changes in space weather. High-frequency measuring complexes located at the station make it possible to study processes in the Earth's ionosphere both directly above the station and in the polar regions as a whole. During the reporting period, new methods were developed for reproducing ionospheric characteristics based on data from a digital coherent ionosonde. The regional features of the ionosphere-plasmasphere system have been investigated during the periods of very calm space weather. It is worth noting that the unique duration of continuous recording of ultra-low frequency signals in the interference-free Antarctic region allowed to develop and implement an original algorithm for the counter of super-powerful lightning discharges over the entire planet. Over 16 years of observations, 65 million events have been selected and analyzed. The seasonal and daily dependences of the number of events are reproduced, confirming the belonging of powerful lightning to the three main centers of world thunderstorms. A synchronous measurement mode for the new very low-frequency (VLF) and ultra-low-frequency (ULF) complexes has been provided, which made it possible to improve the accuracy of localizing powerful lightning in the regions of South America and Africa.

Biological research. Based on the results of seasonal monitoring studies of the state of the marine ecosystem in Vernadsky station area, the nature of the relationship between bacterioplankton and phytoplankton groups, their influence on food webs and biogeochemical cycles in the area of the Argentine Islands archipelago was established. For the first time, the study of the role of bacterioplankton groups in biochemical transformations with the formation of substances affecting the climate balance, greenhouse gases, namely dimethyl sulfide (DMS) and nitric

oxide (N₂O), was carried out. Also, new data were obtained on the biodiversity and population structure of background species of benthic groups in the water area of the Argentine Islands.

A long-term study of extremophilic vascular plants of *Colobanthus quitensis* and *Deschampsia antarctica* has been continued. These studies are primarily intended to explain what biochemical, genetic and other mechanisms allow these plants to survive in extreme conditions in order to transfer these properties to cultivated plants in the future.

Metagenomic sequencing was used for the first time to study the diversity of endophytic microbial groups, which will allow to determine the mechanisms of adaptation of microorganisms to extreme conditions, their impact on the biogeochemical cycles of elements, the contribution of microorganisms to the ability of plants to survive in the extreme conditions of Antarctica, as well as to reveal changes in microbial communities in a changing climate.

New data on the genetic polymorphism and genetic structure of island populations of vascular plants, in particular *Colobanthus quitensis* along the west coast of the Antarctic Peninsula, have been obtained. The efficiency and expediency of using the intron length polymorphism of β -tubulin genes in molecular genetic studies of different plant ecotypes has been shown. This area of research is promising for elucidating the historical aspects of the development of terrestrial ecosystems in the region, as well as predicting their future.

Regarding bioprospecting, new data on the biodiversity of actinomycetes associated with moss on Galindez island, in particular their potential as producers of antimicrobial compounds were obtained.

According to the results of PCR screening in the genomes of the studied isolates revealed genes that encode a wide range of enzymes or enzyme complexes involved in the synthesis of a number of antibiotics. In the genomes of the investigated isolates, genes encoding a wide range of enzymes or enzyme complexes involved in the synthesis of a number of antibiotics were found. As a result of de-replicative analysis in the extract of one of the strains, which revealed the widest spectrum of antimicrobial activity, a number of antibiotics were identified, as well as three potentially new compounds. A number of pure cultures of microorganisms resistant to high concentrations of heavy metals and capable of synthesizing biologically active substances, in particular enzymes and exopolysaccharides, as well as exoelectrogenesis, were isolated from Antarctic samples.

Studies from previous years have shown that *Deschampsia antarctica* is promising for search of biologically active compounds (BAC) to fight melanoma (skin cancer). During the reporting period, potential biochemical markers were searched for and high-performance genotypes of BAC-producing plants were identified to create their collections (ex situ/in vitro), which will provide the required amount of biomass with a high content of BAC for both laboratory research and industrial use.

Fractions of natural peptide molecules were obtained from the tissues of hydrobionts of the Antarctic region (South Antarctic Patella, Antarctic krill) and their antioxidant, membrane-protective activity and influence on key factors of the hemostasis system were studied. The results indicate the prospects of using Antarctic region hydrobionts as potential sources for production of biologically active peptides and substantiate the feasibility of further research aimed at studying the structure and effects of these peptides on in vivo and in situ models.

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