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Міжнародне співробітництво: суспільно-географічні та політико-правові аспекти освоєння Антарктики

International Co-Operation: Socio-Economic, Political and Legal Issues of Antarctic Exploration

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Thirty years of Ukrainian Antarctic Research: Assessing the National Antarctic Program's institutional achievements within the Antarctic Treaty System

Abstract. Ukraine made a significant contribution to the study of the Antarctic. People from Ukraine were part of the expeditions that discovered and explored the Antarctic and conquered the South Pole in the XIX – beginning of the XX century. From the end of the 1950s to the beginning of the 1990s, Ukrainian researchers and engineers made valuable efforts to establish and develop Soviet Antarctic expeditions. With the acquisition of independence, the difficult and ambitious path of studying the Antarctic under the flag of Ukraine began. This article provides a historical overview of the main institutional achievements in the development of Ukrainian Antarctic research from 1993 to the present. Also, it outlines the current state, challenges, and prospects for further developing Ukraine's National Antarctic Program within the Antarctic Treaty System. The gradual development of the State Special-Purpose Antarctic Research Programs is noted, and the main results are presented. The scientific potential and contribution to international scientific cooperation of Ukraine's key Antarctic infrastructure facilities are revealed – Vernadsky station as a multi-purpose observatory for monitoring geophysical processes and the impact of climate change on the Antarctic ecosystems, and the ice-capable research vessel *Noosfera*. It is shown that the environmental protection initiatives and measures developed by Ukraine to regulate tourist activities are an important contribution to the development of the international legal regime of Antarctica.

Keywords: Antarctic infrastructure, Antarctic science, research vessel *Noosfera*, scientific output, Vernadsky station

1 Introduction

Ukraine has travelled a long and thorny path from participating in the early expeditions of the heroic era of Antarctic exploration to acquiring its own scientific station.

The latest documentary research (Prydatko-Dolin, 2019) confirms that Ivan Zavadovskiy, a naval officer of the Russian Empire's fleet, was originally from the Ukrainian nobility. As second-in-command of the sloop *Vostok*, he participated in the South Polar expedition of Fabian Gottlieb von Bellingshausen (1819–1821), which, according to Soviet historiography, discovered Antarctica. In light of this, Zavadovskiy Island, an ice-covered island in the West Ice Shelf in East Antarctica (66°43′00″ S, 86°24′00″ E), was named after him.

One of the first well-documented Ukrainian explorers in Antarctica is Anton Omelchenko, a participant in Robert Falcon Scott's expedition

to the South Pole in 1911–1912 (Rich, 1996). For a long time, Ukraine actively participated in large-scale comprehensive research within Soviet Antarctic expeditions. Due to domestically produced snow trucks, numerous research and supply inland traverses, including to the South Pole and the Pole of Inaccessibility, were successfully conducted in the fifties and sixties (1957–1967) (Rybachuk, 2010).

After gaining independence, Ukraine established its own Antarctic research programs, continuing the proud traditions of Ukrainian explorers of polar territories. Since 1994, Ukraine has joined the Commission for the Conservation of Antarctic Marine Living Resources, and since 2004, participated in Antarctic Treaty Consultative meetings as a Consultative Party, contributing to Antarctic international cooperation and environmental protection.

Following established international practice, Antarctic Parties' national agencies responsible for planning and conducting Antarctic operations in support of science are referred to as National Antarctic Programs. These vary in structure and departmental subordination. In this regard, the thirtieth anniversary of establishing the relevant Ukrainian institution – the Ukrainian Antarctic Center – in 1993 provides a good opportunity to consider Ukrainian contributions to Antarctic research and the role of Ukraine within the Antarctic Treaty System.

The authors are starting a series of publications on the outcomes of Ukraine's 30-year activity in the Antarctic and highlighting the main results in different scientific and technical activity fields. Following earlier comprehensive "state-of-the-nation"-style articles, e.g., on Brazil's (Stefenon et al., 2013), South Africa's (Ansorge et al., 2017), New Zealand's (Morten, 2017), Portugal's (Xavier et al., 2018), and China's engagement (Zhang & Haward, 2022), this paper is devoted to a historical overview of the main institutional achievements in the development of Antarctic research in Ukraine from 1993 to the present day. An assessment of the current state, challenges, and prospects of further developing Ukraine's National Antarctic Program, and contribution to the Antarctic Treaty System is also provided.

2 Independent Ukraine in Antarctica: institutional base formation

The formation of the institutional base of systematic Antarctic research in Ukraine began in 1992 with Ukraine's accession to the Antarctic Treaty.

After the collapse of the Soviet Union in 1991, the Russian Federation left all Soviet Antarctic stations under its jurisdiction even though according to the Agreement on the distribution of all abroad property of the former USSR of July 6, 1992, 16.37% of the assets of the USSR should have been moved to Ukraine (legislation of Ukraine: https://zakon.rada.gov.ua/laws/show/997_022?lang=en). That Agreement recognizes scientific stations to be properties eligible for such distribution. In 1992, Ukraine attempted to obtain one of the former Soviet Antarctic stations – the request of the National Academy of Sciences of Ukraine was sent to the Ministry of Foreign Affairs of Russia. However, the Russian Federation rejected this request, stating that all six operational former Soviet Union stations formed an indivisible infrastructure complex of the now-Russian Antarctic Expedition.

Nevertheless, the Ukrainian government entrusted the National Academy of Science of Ukraine to elaborate a scientific research program in Antarctica. Less than a year later, the National Academy of Science of Ukraine established the Ukrainian Antarctic Center as an independent research institution on June 9, 1993.

At the same time, having built the new Rothera station, the United Kingdom decided to transfer its Faraday station to another state, and after negotiations between the governments of the United Kingdom and Ukraine, a Memorandum of Understanding (MOU) was signed between the British Antarctic Survey and the Ukrainian Antarctic Center in July 1995. On February 6, 1996, the British Faraday station was transferred to Ukraine free of charge, subject to the continuation of long-term

geophysical observations for the next ten years. It was renamed in honor of Volodymyr Vernadsky, one of the founders and the first president of the Academy of Sciences of Ukraine in 1918.

As Hemmings (2011) noted, for Ukraine, acquiring its own Antarctic station is another expression of its independence and desire for closer integration into the international scientific community. Gaining its own Antarctic station was such an extraordinary event for Ukraine that the first staff of the Ukrainian Antarctic Expedition, led by Dr Gennady Milinevsky, was transferred from the United Kingdom to Argentina by plane of the President of Ukraine.

Ukrainian Antarctic Center, led by Prof. Petro Gozhik at the beginning, was reassigned to the Ministry of Education and Science in 1999. Considering the nationwide and international importance of complex research in Antarctica, it was granted the status of a National Scientific Center by the Decree of the President of Ukraine in 2004. Nowadays, the State Institution National Antarctic Scientific Center (SI NASC) is the only funding institution in Ukraine responsible for the preparation and implementation of the Antarctic research programs, coordination of Ukraine's participation in international research in Antarctica, maintenance and further development of Ukrainian Antarctic Akademik Vernadsky station (hereinafter Vernadsky station), as well as preparing and carrying out marine expeditions in the Southern Ocean.

3 State Special-Purpose Antarctic Research Programs

The Ukrainian government and all presidents of Ukraine have shown a strong commitment to Antarctic programs even in very difficult periods, considering that their unique scientific outputs do affect the political capabilities of the country.

Ukraine has had three State Special-Purpose Antarctic Research Programs adopted by the Decrees of the Government of Ukraine. The first one (1996–2000) was only part of the Marine Research Program, but the second (2002–2010) and the third (2011–2020, extended until the end of 2023 in 2021, extended until the end of 2025 in 2023) Programs were approved as independent research Programs.

The first State Special-Purpose Antarctic Research Program (1996–2000) was focused on the research areas stipulated in the MOU on Faraday station transfer as obligatory to continue. This Program was also devoted to organizing the station's effective technical supply and acquiring the Antarctic expedition experience.

Within the second State Special-Purpose Antarctic Research Program (2002–2010), Ukrainian scientists were focused on expanding the spectrum of research and developing new research areas.

During that period, the complex of oceanographic and bioresource research was initiated. In addition, there were established nuclear physics research of the Earth and atmosphere, environmental and biodiversity research in the Vernadsky station area, and medical and physiological studies of geomagnetic, meteorological, change of time zones and seasons, and isolation factors that influence the health of the winterers (Gozhik et al., 2015).

The complex approach and wide range of research subject areas envisaged by the Program led to the involvement of researchers from the leading Ukrainian research institutions. The international recognition of the scientific results of the first State Special-Purpose Antarctic Research Program played a significant role in 2004 when Ukraine's application to acquire the status of a Constitutive Party to the Antarctic Treaty was approved.

The third State Special-Purpose Antarctic Research Program (2011–2025) was approved by the Government of Ukraine in 2010. From the beginning, scientific directions within the third State Special-Purpose Antarctic Research Program were formulated according to priorities articulated by the Scientific Committee on Antarctic Research.

The Program envisaged a complex of fundamental and applied research, as follows:

• *Geological and geophysical research* – on the study of the geological structure of the West

Antarctic, assessment of its mineral resource potential; creation of dynamic models of the state of the natural environment under the influence of natural and anthropogenic factors;

• *Hydrometeorological research* – on the study of the atmospheric processes, changes in the troposphere and stratosphere of the Southern Hemisphere, monitoring of the ozone hole over Antarctica, weather forecasting, and climate change analysis of the Antarctic Peninsula;

• *Oceanographic research* – on determining the trends of climatic variability of the oceanographic sites of the Southern Ocean, forecasting areas of increased biological productivity and industrial significance;

• *Geospace research* – on the study of the interaction of atmospheric and space weather systems, monitoring of global thunderstorm activity as an indicator of global climate changes, reproduction of technogenic influence on the Earth's electromagnetic climate;

• *Biological research* – on the study of adaptive variability and forecasting ecosystem transformations under the influence of global climate change, in particular, research on biodiversity and adaptation of components of terrestrial and marine ecosystems of the West Antarctic to climate change; determining the ecological interrelationships of the components and processes in ecosystems; identification of beneficial properties and biologically active substances in Antarctic organisms; forecasting and minimization of anthropogenic impact on terrestrial and marine ecosystems of the Antarctic;

• *Medical and physiological research* – on human adaptation to extreme Antarctic conditions, improvement of expedition participants selection methods, human body functions' adaptive changes, control and optimization of winterers activities during the long stay at Vernadsky station;

• *Development and implementation of novel technologies* – on proper functioning of the Vernadsky station's software and hardware complexes, creating an information system and technologies for automating collection, preservation, and transmission of Antarctic research results.

Although the third State Special-Purpose Antarctic Research Program has not yet been completed, its main preliminary outcomes can already be outlined with certain indicators. In particular, the wide diversity of the Program and development of the main research teams resulted in significantly increased publication activity.

A significant omission of the first and the second Programs was that most of their results were published in local scientific journals in Ukrainian, which gave them few chances to reach other countries' scientific communities. During the third Program, the Ukrainian Antarctic Journal, published by the SI NASC, changed its policy to publish articles in English only and began to index them in the Scopus database.

The flagship achievements of the third Program, as will be shown below, include strengthening the scientific role and capabilities of Vernadsky station in the study of the impact of climate change on the Antarctic Peninsula ecosystems, the restoration of marine expeditions in Antarctica, and the significant strengthening of the biological and ecological direction of the Program, which gave a certain boost to Ukraine's activity within international collaboration with Antarctic Treaty System organizations.

In addition to scientific deliverables, the third State Special-Purpose Antarctic Research Program also contained complex environmental protection measures in international cooperation within Antarctic Treaty System organizations, in particular, developing and implementing the instruments of the special environmental management and regulation of ongoing and planned multiple activities within the area around Vernadsky station.

Moreover, the third State Special-Purpose Antarctic Research Program prescribed the first complex modernization of Vernadsky station per the recommendations of the international inspections to ensure the guaranteed period of safe operation of the station is extended by the next 10–15 years.

The experience of all three State Special-Purpose Antarctic Research Programs' implementation has proven the efficiency of a Program-based

integrated approach to coordinated planning of research projects and operations on expeditions, logistic support, and station technical maintenance in the long-term horizon of up to 10 years. For instance, planning operational activities for up to 10 years has opened opportunities for planning long-term scientific experiments, especially regarding climate change and biodiversity research.

4 Scientific potential of Vernadsky station

The organization of Ukrainian Antarctic expeditions at Vernadsky station is one of the main tasks of the SI NASC. As a rule, 12–14 winterers work at the station, which ensures continuous operation of the station and conducting of scientific research and monitoring. In addition, up to 20 scientists of various specialties – geologists, geophysicists, meteorologists, physicists, radiophysicists, biologists, ecologists, and doctors – take part in seasonal expeditions yearly. After almost thirty years of organizing expeditions, more than five hundred Ukrainian scientists and specialists have visited the station, among whom more than fifty have repeatedly participated in expeditions.

Vernadsky station is located on Galindez Island of the Argentine Islands on the west coast of the Antarctic Peninsula – one of the climate "hot spots" in Antarctica, where the rate of increase in the average annual temperature is the fastest and the processes of glacier destruction and ecosystem changes are the most noticeable. Therefore, Vernadsky station is an essential reference point for long-term research of the natural environment in the Antarctic, primarily for the assessment and forecast of climatic changes. It is part of the World Meteorological Organization Global Climate Observing System (GCOS), Region VII – Stations in the Antarctic, station index 89063.

Since its establishment by the UK in 1947, and to date, the station has accumulated one of the longest continuous series of meteorological data in the Antarctic. This series continues (Pishniak et al., 2021; Gorodetskaya et al., 2023). Daily SYNOP (surface synoptic observations) actual weather data is sent to the World Meteorological Organization, sea level measurement data is sent to the Intergovernmental Oceanographic Commission of UNESCO, and precipitation samples for isotopic analysis are sent to the International Atomic Energy Agency.

In the 1980s, British researchers discovered the "ozone hole" through observations at Halley and Faraday stations, the unique research that Ukrainian scientists are continuing and developing (Zalizovski, 2011; Grytsai et al., 2018; 2022; Milinevsky et al., 2020; Wang et al., 2021). For almost thirty years, the infrastructure for studying various geospheres and their interaction has been created and constantly updated at the station. In recent years, software and hardware complexes have been modernized for monitoring observations (geomagnetic, tectonomagnetic, and magnet variation observations, ice sheet dynamics monitoring, electromagnetic sounding, seismoacoustic monitoring, and meteorological and oceanographic observations).

The geophysical observatory at the station makes it possible to study processes in various layers of the Earth – from the tectonosphere to the geospace. It is represented by five unique polygons – electromagnetic, tectonomagnetic, paleomagnetic, geodynamic, and glaciological.

The Geomagnetic Observatory "Argentine Islands" is part of the INTERMAGNET worldwide network of observatories (code AIA). The time series of geomagnetic observations at Vernadsky station is the longest in the Antarctic region, which is extremely important for understanding the nature of the Earth's geomagnetic field. Data from geomagnetic observations are used to build international magnetic models (IGRF models), updated every five years and without which the relevance of these models decreases dramatically (Kilifarska et al., 2016; Sumaruk et al., 2022).

The tectonomagnetic polygon covers the Argentine Islands and partly the western coast of the Antarctic Peninsula. At its 24 stationary points, geomagnetic observations are carried out with a certain periodicity; in particular, the dynamics of

the local magnetic field are studied, which allows the study of the complex nature of tectonic processes to estimate the magnitude and directions of changes in geodynamic stresses in the Earth's crust. According to the results of magnetovariation probes at the test site, the peculiarities of the geoelectrical structure of the Earth's crust and upper mantle and their connection with seismotectonic processes in the tectonosphere of the western slope of the Antarctic Peninsula are being investigated (Maksymchuk et al., 2018).

The seismic station "Argentine Islands", which has the code AIA in the International Register of Seismological Stations (IRSS), is included in several seismological networks, in particular the Global Seismographic Network (GSN), which is part of the IRIS (Incorporated Research Institutions for Seismology) consortium. AIA station data are used in the real-time monitoring system of global and regional seismic activity, particularly in the International Seismological Network of the Antarctic Peninsula, an international monitoring system for detecting and identifying nuclear explosions prohibited by the Comprehensive Nuclear-Test-Ban Treaty. The complex provides an opportunity to study local and global seismicity, volcanic eruptions, tsunamis, atmospheric and cryogenic processes, in particular, monitoring of the ice cover of the water area, the destruction of nearby glaciers, the formation of icebergs, and the onset of avalanches, which are indicators of climate change. The mentioned studies, in turn, can contribute to global monitoring of these events, which, for instance, is critical in increasing the resolution of warnings for seismic and tsunami risk (Liashchuk et al., 2021).

For studying geodynamic processes, in particular, the tectonic fault of the Penola Strait, the Antarctic Peninsula, and Antarctica as a whole, seasonal high-precision global navigation satellite system (GNSS) observations are carried out at the points of the geodynamic testing ground of the Argentine Islands, as well as continuous observations at the ASAV GNSS station (Savchyn et al., 2021a; 2021b).

During seasonal work in the station area, comprehensive work is carried out to determine the quantitative parameters of island glaciers, which are sensitive indicators of long-term temperature trends (Savchyn et al., 2021b). In 2018, a study of the stratification of island glaciers near Vernadsky station using ground-penetrating radars, particularly VIY3-300, was launched (Chernov et al., 2018).

An important component of the Vernadsky station research complex is the electromagnetic sensing system of the Earth's plasma environment. It includes installations for remote sensing of the ionosphere and ultrasensitive magnetometric sensors for diagnosing the properties of global electromagnetic resonators.

The set of measuring devices operating at Vernadsky station is unique in terms of frequency range width and sensitivity. An important feature of this system is the continuity of measurements, which makes it possible to track the near-Earth plasma environment's behaviour in real time and to carry out a systematic retrospective analysis of daily, seasonal, and interannual regularities.

The location of the Vernadsky station research complex has unique properties for conducting geospatial research. First, the absence of local thunderstorm activity and remoteness from industrially developed areas ensures a low level of electromagnetic interference, which makes it possible to study rather subtle effects that are impossible to study in other regions. These include global electromagnetic resonators formed due to the spatial-temporal distribution of the near-Earth plasma and magnetic field. Ukrainian scientists proposed to use these global resonators as space weather indicators (Koloskov et al., 2008). Sixteen years of global thunderstorm observations with unique Ukrainian facilities for monitoring in the ultra-low frequency range (UHF-complex), implemented at Vernadsky station and in the Arctic, as well as original methods of signal processing, allowed to collect and analyze more than 65 million super-powerful lightnings and to investigate their distribution over the planet (Koloskov et al., 2020).

Another feature of the location of Vernadsky station is the maximum difference between geographic and geomagnetic coordinates on the planet. Such coincidence of geophysical conditions forms the ionospheric anomaly, the so-called Weddell Sea anomaly. Long-term systematic observations of plasma dynamics at the heights of the upper ionosphere made it possible for the first time to trace the behaviour of the anomaly during a full eleven-year cycle of solar activity and to reproduce the mechanisms of interaction of the ionospheric-magnetospheric plasma with the system of neutral winds at the heights of the thermosphere. Studies of this effect have made it possible to improve the modern global model of the upper ionosphere, which is used to predict the errors of global satellite navigation systems and other ground-space-based systems (Zalizovski et al., 2021).

In addition, Vernadsky station is important for biological research, first of all, to study the origin and biodiversity of terrestrial and marine ecosystems of the Antarctic, their adaptive variability, and forecasting ecosystem transformations under the influence of climate change.

For 20 years, several biogeographic monitoring sites have been created on the islands and island shelf in the station's area and the coast of the Antarctic Peninsula. Research at these sites is characterized by a comprehensive approach to studying the typical terrestrial and marine ecosystems and their components (viruses, microorganisms, components of vegetation, terrestrial and marine invertebrates, and vertebrates) in climate change conditions.

In particular, to build a correlation model of adaptability indicators and climatic factors, a long-term study of dynamic changes and success of Antarctic hairgrass populations – a unique indicator species of Antarctic terrestrial ecosystems, which grows at ten monitoring sites on Galindez Island (Maritime Antarctic) – was conducted. Research is conducted in cooperation with many foreign research groups from the USA, the UK, and Poland (Parnikoza et al., 2009; 2018; Miryuta et al., 2017; 2019).

Moreover, since 2019, new terrestrial microclimatic monitoring sites of typical Antarctic ecosystems have been established and systematically explored during seasonal and year-round expeditions (Savenets et al., 2023).

Molecular genetic and population studies have shown the possibility of using individual representatives of the West Antarctic fauna and flora as model objects for monitoring observations of adaptations of Antarctic ecosystems against the background of climate change. Among them are *Belgica antarctica* Jacobs (Diptera, Chironomidae), one of the two endemic insect species of the Antarctic Peninsula, and two species of vascular plants – Antarctic hairgrass and Antarctic pearlwort. Annual monitoring studies of the specified species of terrestrial invertebrates and vascular plants at different levels (from molecular to population) can shed light on their adaptation mechanisms and successful strategies in harsh Antarctic conditions (Rabokon et al., 2019; Michailova et al., 2021; Andreev et al., 2022; Kozeretska et al., 2022).

Research on microorganisms associated with Antarctic vascular plants is also effective and promising. As it is known, the microbiome of a plant plays an important role in its development and adaptation to the environment growth and, therefore, can contribute to the survival of the plant in the harsh conditions of the Antarctic (Podolich et al., 2021; Yerkhova et al., 2022). At the same time, the study of living organisms from the point of view of their commercial value as resources of valuable compounds and genes for biotechnology is promising (Kondratiuk et al., 2017; Tistechok et al., 2021; Ivannikov et al., 2022; Komplikevych et al., 2023; Raksha et al., 2023).

For more than 25 years, wintering biologists have been monitoring penguin nesting colonies on Galindez and Petermann Islands, regularly observing the seasonal migrations of penguins and seals, studying the dynamics of Antarctic avifauna and theriofauna populations, and establishing cenotic relationships of the region's biota. Given present concerns about avian influenza reaching the sub-Antarctic region (Dewar et al., 2023),

such monitoring can significantly contribute to a better understanding of avian influenza's movement, spread, and impacts on wildlife colonies through the Antarctic Peninsula.

Thanks to the favourable location of the archipelago, the Argentine Islands play the role of a kind of refuge for marine species of birds and pinnipeds. The avifauna of the Argentine Islands and neighbouring areas (adjacent water areas, the Yalour Islands, and Petermann Island) includes 27 species of seabirds. One of them is the Gentoo penguin (*Pygoscelis papua* Forster, JR) – an important key indicator species of the Antarctic krill shrimp population, which is practically the basis of the trophic pyramid of the Antarctic ecosystem.

Ukrainian scientists have begun research on underwater ecosystems around Vernadsky station. From 2013 to 2016, four underwater monitoring sites were established to model the transformation of benthic ecosystems under climate change conditions. To monitor these sites, Ukrainian scientists use the original technology they developed, allowing spatial analysis and presentation of the results of underwater biodiversity research based on GIS technologies (Utevsky et al., 2016).

In 2019, the study of cetaceans of the Southern Ocean began in the area of the station in cooperation with researchers of the Institute of Marine Sciences, University of California, Santa Cruz, USA, and the South Pacific Whale Research Consortium (Savenko, 2020; Marcondes et al., 2021).

Long-term ecological and parasitological monitoring of Antarctic marine and coastal ecosystems has also been introduced in the station area, which will allow to study the speed and directions of ecological changes in Antarctic marine ecosystems in the future (A. Utevsky & S. Utevsky, 2018; Kuzmina et al., 2020).

In order to determine the impact of climate change on the biological and hydrochemical parameters of the marine ecosystem, in 2019, monitoring observation stations were organized in the waters of Galindez Island (Argentine Islands), and a long-term marine research program was launched (Pavlovska et al., 2020; 2022).

Moreover, in addition to scientific importance, Vernadsky station also performs a specific representative and outreach function. The station emerged as a significant tourist destination after it was transferred from the UK to Ukraine in 1996. Subsequently, there has been a notable rise in the frequency of visits from both cruise ships and yachts (Fedchuk, 2013). The presence next to the station of historical monument No. 62 Base F (Wordie House) – a museum of an early British base of the first half of the XX century, supervised by the station staff, gives tourists a unique opportunity to see the development of scientific research from the era of heroic exploration of the Antarctic to the complex research of today.

The high flow of tourists at Vernadsky station also determines the high risk of human intervention in the ecosystem of this area, which creates an additional field for research, the results of which formed the basis of the scientific justification for the introduction of restrictions on the flow of tourists within the Argentine Islands (Yevchun et al., 2021).

As part of bilateral scientific cooperations, scientists from the UK, France, the USA, the Czech Republic, Poland, Latvia, and Turkey conducted research during seasonal expeditions at the station.

Ukraine actively invites potential partners for scientific and technical cooperation at Vernadsky station. It positions the possibilities of conducting scientific research at the station as a guide for other states just starting to develop national Antarctic programs.

In 2016, a joint Ukrainian-Turkish Antarctic expedition was organized, which brought important experience for both Parties. For Ukraine, it was not just an exchange of individual scientists but hosting a well-organized team of 13 Turkish scientists from various institutions involved in Antarctic research at the station. In turn, Turkey started organizing annual national expeditions in the following years.

Such an experience may be of interest to other non-Consultative Parties to the Antarctic Treaty, which do not have their own Antarctic sta-

tions but are striving to conduct "substantial scientific research activity" in Antarctica (in accordance with Article IX of the Antarctic Treaty) as a prerequisite for the attainment of their Consultative status (ATCM, 2016; 2021).

5 Antarctic Marine Expeditions

Until 2021, the main method of delivering expeditions to the station was chartering supply or tourist vessels from Chile or Argentina, except for a few years. Only four expeditions were carried out by sea from the ports of Ukraine to Vernadsky station by the forces of Ukraine's own scientific fleet, which remained from the time of the Soviet Union, as part of the implementation of the first State Special-Purpose Antarctic Research Program: in 1997 and 1998 – on the research vessel *Ernst Krenkel*; in 2000 and 2002 – on the research vessel *Gorizont*.

During these marine expeditions, Ukrainian scientists conducted a complex of oceanographic and bioresource research in the Southern Ocean, covering traditional krill fishing areas. The obtained results made it possible, on the one hand, to confirm the prospects of industrial krill production in the Atlantic part of Antarctica and, on the other hand, to supplement the understanding of the region's pelagic ecosystem and the mechanisms of forecasting the volume of biological resources.

Within the framework of the second and the third State Special-Purpose Antarctic Research Programs, scientists carried out only incidental oceanographic research in the area of the Drake Passage during the delivery of expeditions by chartered vessel.

Since oceanographic research in the Southern Ocean region was carried out by the National Antarctic Scientific Center in partnership with the Marine Hydrophysical Institute of the National Academy of Sciences of Ukraine (Sevastopol, Crimea), this work was suspended in 2014 due to the annexation of Crimea by the Russian Federation. Ukraine's loss of control over one of the key centers of marine research in Ukraine destroyed scientific relations. It cut the country's access to its scientific archives, laboratory, and instrument base of Southern Ocean research.

The direction of marine research within the framework of the third State Special-Purpose Antarctic Research Program of Ukraine required rethinking and re-establishment, considering the available infrastructure and personnel potential. A non-standard solution belonging to the public-private arrangements was found.

In 2018, in order to resume marine research, the Ukrainian fishing company INTERPROMFLOT granted permission to equip its own fishing vessel, *More Sodruzhestva*, with modern measuring systems to carry out oceanological, bioresource, and geophysical observations during fishing in the waters of the Southern Ocean (Komorin et al., 2022).

Thanks to this public-private partnership, Ukraine could resume marine research in the Southern Ocean in the area of scientific interests of Ukraine – CCAMLR Area 48. In particular, monitoring of the physicochemical fields of the Southern Ocean was resumed to determine trends in their climate variability, forecasting zones of increased biological productivity and industrial importance in CCAMLR Area 48 statistical reporting.

In 2021, the National Antarctic Scientific Center, under the political leadership of the President of Ukraine Volodymyr Zelensky, purchased from the UK the ice-class research vessel *James Clark Ross*, which was re-registered under the flag of Ukraine under the name *Noosfera*.

With the acquisition of the RV *Noosfera*, Ukraine has resumed regular marine scientific expeditions in Antarctica. The RV *Noosfera* managed to go on its first voyage in January 2022, a month before the Russian Federation launched a large-scale military aggression against Ukraine and blocked the sea routes of communication in the Ukrainian waters of the Black Sea. Despite the difficult wartime circumstances, the vessel successfully completed all tasks related to the logistical support of Vernadsky station and the rotation of the wintering crew of the 26th and 27th Ukrainian Antarctic expeditions (Fedchuk et al., 2022).

A number of planned marine scientific studies were also carried out during this voyage. In particular, mapping and bathymetric profiling of the topography of the seabed in the water areas of the deep-water part of the Southern Ocean in the area of the Argentine Islands, as well as in the waters of the Argentine Islands adjacent to Vernadsky station, were conducted from the board of the RV *Noosfera*; samples of seabed sediments in the ocean were taken in the Penola Strait, from depths of 251 to 300 meters to establish the granulometric, mineral, chemical and microfaunistic composition of seabed sediments (Olshtynska et al., 2023).

Vernadsky station is a well-known center of geospace monitoring observations. In order to expand the possibilities of these studies, a radiophysical observatory was created on board the RV *Noosfera* to conduct constant monitoring and, in particular, ionospheric observations during the vessel's voyages (Zalizovski et al., 2023). Very low-frequency (LF) and high-frequency (HF) ranges antennas and receiving-measuring complexes are deployed on the vessel. The hardware and software components of geospace research systems created on the RV *Noosfera* were identical to the equipment installed at Vernadsky station and synchronized with it.

During the entire voyage of the RV *Noosfera* in January-April 2022 (from Odesa to Punta Arenas, and from Punta Arenas to Vernadsky station and in the opposite direction), the LF complex synchronously with a similar complex on Vernadsky station conducted the reception of lightning discharge signals, for further restoration of the thunderstorm activity characteristics and the ionospheres' D-layer parameters. The results of radiophysical measurements organized on the RV *Noosfera* during its navigation in isolated and hard-to-reach places of the planet are an important addition to the data obtained on the continents. They are used for the analysis and forecasting of space weather.

Since 2022, the RV *Noosfera* has been used to conduct joint Ukrainian-Polish expeditions, particularly providing logistical support for Arctowski Polish Antarctic Station. Ukraine expects to expand the potential of the RV *Noosfera* to conduct joint international scientific and logistical operations.

6 Publication outputs of Ukrainian research in Antarctica and relevant outreach activity

Evaluation of the number of Antarctic-related policy papers and scientific publications from Consultative Parties could demonstrate a nation's level of research and management activities in Antarctica as well as their input in leadership within the Antarctic Treaty System as a whole (Dudeney & Walton, 2012; Gray & Hughes, 2016).

According to the Scopus database, Ukraine confidently ranks in the top 30 countries by the number of scientific publications studying Antarctica and the Southern Ocean.

To investigate the contribution of the National Antarctic Program of Ukraine to global Antarctic research, a relevant comprehensive bibliometric analysis was applied for 1996–2022. The search was based on 94505 records (as of September 2023) retrieved from the Scopus database (research articles, review articles, letters, etc.) with the word fragment "antarc" or 58 of the most mentioned geographical names in the Antarctic in the title, abstract or keywords of the paper. A paper was considered a Ukrainian contribution when at least one of the authors was affiliated with a Ukrainian institution.

Only ten publications were identified for 1996–2001 (the first State Special-Purpose Antarctic Research Program). During 2002–2010 (the second State Special-Purpose Antarctic Research Program), Ukrainian Antarctic-related publications output scored 84 records, resulting in 0.4% of the total Antarctic-related publications output (20868 records).

Since 2011 (the third State Special-Purpose Antarctic Research Program), research activation, first of all in biological and environmental science, triggered a stable increase in publication activity,

achieving 0.8% of the global Antarctic-related publication output for Ukraine in 2011–2022 (337 of 41637 records).

The important goal of the National Antarctic Program of Ukraine is raising public awareness of the problems of environmental protection and conservation of Antarctic ecosystems and global climate changes, which stipulates carrying out outreach activities connected with the Antarctic and Southern Ocean research.

Since 2001, the SI NASC has organized the biannual International Conference on topical issues of Antarctic and Southern Ocean research with the participation of Ukrainian scientists and leading specialists from other countries (http://uac.gov.ua/en/international-cooperation-en/iac/).

In turn, the general public is informed about the activities of the SI NASC and the work of Vernadsky station through the popular online science publication "Expedition XXI" (https://expedicia.org/pro-nas/) and official pages on social media, namely Facebook (https://www.facebook.com/AntarcticCenter) and Instagram (https://www.instagram.com/antarcticcenterua/), where it is highlighted information about current scientific and educational projects, in particular, online lessons about Antarctica, museum expositions and exhibitions, as well as live broadcasts-excursions from Vernadsky station and the research vessel *Noosfera*. Taking into account the request of the target audience (teachers, schoolchildren, students), the activities of the SI NASC on the YouTube channel, where videos about the work of Ukrainian polar explorers and the unique nature of Antarctica, have been significantly intensified. A number of publications aimed at popularizing women's work in Antarctica have also been created.

7 International cooperation within the Antarctic Treaty System

The first organization of the Antarctic Treaty System, which Ukraine joined as an independent state, was the Commission for the Conservation of Antarctic Marine Living Resources, the decision-making body of the Convention on the Conservation of Antarctic Marine Living Resources. Ukraine became a member state to the Convention in 1994 as one of the successor states of the former Soviet Union. Then, the supreme status of a Consultative Party to the Antarctic Treaty was obtained by Ukraine in 2004. At the same time, Ukrainian delegations have taken an active part in the work of the annual Antarctic Treaty Consultative Meetings (ATCM) since 2000 and hosted the 31st ATCM in Kyiv in 2008. Ukrainian scientists have also been participating in the work of three permanent SCAR scientific groups – Life Sciences, GeoSciences, and Physical Sciences – and are members of expert groups to consider research issues in the chosen field of science.

A comprehensive study of the content and number of official documents submitted by the Ukrainian delegation for consideration at the ATCM allows us to draw the following main conclusions.

First, compared to other countries that take an active position in the ATCM, Ukraine provided a relatively small number of documents but focused on the most urgent issues on the ATCM's agenda. In general, for the years 2000–2023, 63 Information and Working papers were submitted for ATCM consideration (30 documents on scientific cooperation and operational issues, 10 documents on legal and institutional issues), as well as at the annual meetings of the main advisory body of the ATCM, the Committee on Environmental Protection (23 documents).

The information papers provided by the delegation of Ukraine mainly highlighted the main results of research carried out at Vernadsky station, measures to modernize the infrastructure and hardware complex of the station itself, and measures for Ukraine's fulfillment of the requirements of the Protocol on Environmental Protection.

Remarkably, 58% of the working papers submitted by Ukraine relate to tourism issues. During the last three decades, tourism has become the largest human activity (by number of people involved) in the region. Therefore, the issues of

safe development and mechanisms for regulating tourism in Antarctica have become one of the priority areas of the strategic work plan of the Antarctic Treaty Consultative Meetings and are going to get more and more politicized as the States Parties to the Antarctic Treaty use tourism as a tool for ensuring their national interests in this region.

As Liggett and Stewart (2017) showed, 83% of documents related to various aspects of Antarctic tourism are provided by only nine states that have asserted territorial claims to declared geographic sectors of the Antarctic (Australia, Argentina, the UK, New Zealand, Norway, Chile, France) or have reserved the right to make such claims in the future (USA and Russia). This distinguishes Ukraine as a country whose share of working papers on tourism activities submitted for ATCM consideration is disproportionately large among the states that have joined the Antarctic Treaty and do not make, support, or recognize any territorial claims.

At the same time, such a position of Ukraine has a clear justification. As a result of the policy introduced by the SI NASC regarding tourist visits to Vernadsky station, it became one of the five most visited stations in Antarctica. To balance the image benefits of organizing tourist visits and effectively controlling such activities at the station, Ukraine was among the first to develop a national policy regarding tourist visits (ATCM, 2011).

In addition, Ukraine's position regarding the development and application of measures to regulate Antarctic tourism is active not only concerning Vernadsky station itself but also for the nearby islands. In particular, to reduce the cumulative environmental impact, Ukraine, together with other interested parties, has developed site-specific visitor guidelines for several islands around the station: Pleneau, Petermann, Winter, Booth, and the Yalour Islands. These islands are highly popular among tourists and, at the same time, are representative areas where Ukrainian scientists have established research sites for long-term monitoring of changes in the environment.

In 2022, the delegation of Ukraine submitted for consideration at the 44th ATCM updated policy regarding tourist visits to Vernadsky station, in which the maximum number of allowed visits by tourist vessels was reduced from one vessel per day to two vessels per week. A travel route was also developed (tourist trail) for visitors from the station to the top of the glacier cap on Galindez Island to reduce the anthropogenic impact directly on the station itself (ATCM, 2022).

This document, in contrast to similar ones approved by the ATCM, contained several innovations. In particular, it covers not only separate places for landing and walking but also adjacent inter-island water areas of the central group of Argentine Islands. Restrictions apply not only to tourist vessels but also to private yachts. In general, the document has a dynamic nature. That is, the policy regarding the regulation of tourist activities at Vernadsky station and its surroundings will be regularly reviewed, considering natural environmental changes and priorities of environmental protection activities.

Thus, taking into account its decades of experience in managing tourist visits to Vernadsky station, Ukraine plays an active role in developing general rules for regulating tourist activities, thereby contributing to international efforts to preserve the nature and ecosystems of Antarctica.

Secondly, it is remarkable that most of the working papers on tourism-related issues were submitted by Ukraine to the ATCMs together with other interested parties (mainly the UK, the USA, and Argentina), which indicates that Ukraine contributes to documents that are of interest to a wide range of countries that have their interests in this area.

Thirdly, in addition to the tourism-related issues, an important priority of Ukraine's activity at the ATCMs is the development of consistent and systematic work on the establishment of effective and comprehensive spatial environmental protection and management around Vernadsky station under the requirements of the Protocol on Environmental Protection to the Antarctic Treaty to ensure a strategic vision of the sustainable development of multiply activities in the

large-scale area around the station (Fedchuk et al., 2020).

Based on the previous comprehensive field ecological studies conducted by Ukrainian scientists, a prior assessment of a new Antarctic Specially Protected Area (ASPA) was developed and submitted for consideration by the ATCM in 2023. The proposed ASPA has an area of 49.5 km^2 of the terrestrial component and about 0.15 km^2 of the marine component and includes, mainly, the Argentine Islands with inter-island waters, the adjacent islands of the Wilhelm Archipelago, and the coastal oases of the Kyiv Peninsula. The total length of the proposed ASPA from north to south is 60 km, and from west to east – 30 km. In contrast to the already approved ASPAs, it is assumed that this one will not be a discrete entity but will form an integral regional ecosystem. Geographically, the proposed multi-site ASPA is divided into six components (subdistricts), each representing a group of islands with a characteristic combination of biotic, abiotic, scientific, and historical values requiring comprehensive protection (ATCM, 2023). The special geographical position of the proposed ASPA, the climate changes recorded within its boundaries, and the rich biodiversity found allow a comprehensive study of the complex ecological processes typical for the entire central part of the western coast of the Antarctic Peninsula.

The adoption by the Parties to the Antarctic Treaty of the ASPA proposed by Ukraine will significantly contribute to applying the continuous ecosystem approach to the definition of the new ASPA. It is assumed that such an approach will make it possible to eliminate the problem of insufficient representativeness of the existing Antarctic protected areas system, which was emphasized by Shaw et al. (2014).

In addition, the presence of a marine component in the proposed ASPA will also contribute to ensuring the effective protection of marine biodiversity. Thus, taking into account the recommendations of the Working Group on Ecosystem Monitoring and Management of the CCAMLR Scientific Committee regarding the need to strengthen the coordination of efforts in the field of spatial planning harmonization, the delegation of Ukraine initiated in 2018 to define the marine component of the proposed ASPA as one of the monitoring scientific areas as part of the large-scale Marine protected area (MPA) in the planning Domain 1 Western part of the Antarctic Peninsula (proposed jointly by Argentina and Chile and currently under consideration by the CCAMLR) to assess the impact of climate change on the distribution of benthic communities and penguin populations (Fedchuk et al., 2020). In turn, the increase in the number of monitoring scientific sites within the planned MPAs will make it possible to respond to criticism from the Russian Federation and China regarding insufficient scientific justification for the designation of new MPAs.

Another direction of Ukraine's international cooperation under the CCAMLR is fishery activity. Ukraine is one of the few countries under whose flag fishing vessels conduct fishing in Antarctica. Due to the loss of traditional fishing areas in the Black and Azov seas, the area of responsibility of the CCAMLR has acquired strategic importance for the development of Ukraine's ocean fishing fleet.

Ukraine's position is characterized by two important political and economic aspects, which are successfully combined. On the one hand, Ukraine has an economic interest in implementing the activities of Ukrainian fishing companies, contributing to the state's food security, employment, and budget. On the other hand, Ukraine implements this interest not only by faithfully following the adopted CCAMLR rules and procedures for the rational use of marine living resources but also by acting as an active participant in studying fishery potential and establishing scientifically based restrictions on the capture of marine resources.

For this purpose, Ukrainian fishery vessels were equipped with special scientific facilities, making it possible to obtain unique and valuable scientific monitoring data on the census of marine living resources during fishing in the CCAMLR area (Ko-

morin et al., 2022). Thanks to such opportunities, Ukrainian scientists participate in the international system of scientific observation on Ukrainian vessels and vessels of other CCAMLR member states. Thus, according to the results of the international acoustic survey of the Antarctic krill (participants of the survey are Norway, China, Chile, the UK, the Republic of Korea, and Ukraine), which took place in 2018–2019 with the participation of the Ukrainian vessel *More Sodruzhestva*, it was found that the specified for the CCAMLR statistical area 48 (Atlantic sector of the Southern Ocean), the allowable catch limit of krill in the amount of 620 000 tons is systematically underutilized (although the amount of krill catch is gradually approaching the allowable level).

Vernadsky station is also an important component of international bioresource research because the success of the reproduction of the colony of penguins in the area of the station is a significant indicator of stocks of the key element of their food base – Antarctic krill. Ukraine became the eighth country to start reporting scientific activities under the CCAMLR Ecosystem Monitoring Program (CEMP) of coastal areas, within the framework of which, since 2016, Vernadsky station's biologists have been involved in researching the success of reproduction of penguins of the species *Pygoscelis adeliae* and *Pygoscelis papua* using a network of automatic surveillance cameras for CEMP's needs (Hinke et al., 2018). Currently, three of the 15 registered CEMP sites are managed by Ukraine.

8 National Antarctic Program during the Russian full-scale military aggression against Ukraine

The impact of Russian full-scale military aggression on the National Antarctic Program of Ukraine was described in Fedchuk et al. (2022). As a result of Russian systematic missile attacks, about 15% of Ukraine's research infrastructure was fully or partly destroyed, including the head office of the National Antarctic Scientific Center, located in Kyiv, and Ukrainian universities and research institutions that are involved in the National Antarctic Program and are essential for research and observation support at Vernadsky station.

In 2021, before the start of the war, the President of Ukraine entrusted the Government to prepare a new State Special-Purpose Antarctic Research Program for 2024–2033 as a follow-up of the current State Special-Purpose Antarctic Research Program, which was to expire in 2023. Due to the aggression of the Russian Federation and the forced sequestration of government expenditures on science, these plans have been suspended. In order to ensure the continuation of the maintenance of the station and long-term environmental monitoring projects, the Government of Ukraine extended the current Program until the end of 2025 at the minimum allowable financial level.

Moreover, many researchers joined the Armed Forces of Ukraine to defend the country, including 15 members of the previous Ukrainian Antarctic Expeditions. Many of them already have injuries of varying degrees of severity.

Nevertheless, Ukraine systematically and consistently integrates into the European research area despite the imposed martial law. Thus, in April 2022 – at the height of Russian full-scale military aggression – the National Antarctic Scientific Center became a member of the European Polar Board – a consortium of research and academic institutions, logistics operators, and other interested organizations of the EU member states, aims to coordinate European strategic priorities of scientific activity in the Arctic and Antarctic by improving the exchange of information, optimizing the use of polar infrastructure and conducting large-scale and multilateral initiatives between its members and international partners.

One of the most promising initiatives resulted from participation of Ukraine in EPB is Ukraine's joining the POLARIN project, which aims to facilitate sharing the international polar infrastructures. This five-year project (for 2024–2029) involves operators of polar research from the EU and polar operators from Chile, Canada, the USA, the

UK, and Ukraine. There are 50 organizations and 79 infrastructure facilities, including research vessels, data repositories, and numerous stations in both Polar Regions – the Arctic and Antarctica (Biebow et al., 2023).

Furthermore, the international scientific community helps Ukrainian scientists to continue Antarctic research during wartime and the state's budget sequestration. First of all, it should be specially noted the assistance in the deployment of members of the 27th Ukrainian Antarctic Expedition kindly provided by the Polish Antarctic Program (the Department of Antarctic Biology, Institute of Biochemistry and Biophysics, Polish Academy of Sciences) in March 2023. In this regard, it should also be noted that Uruguayan and Czech Antarctic Programs offered for Ukrainian Antarctic biologists to carry out research at their Antarctic stations. In addition, the US Antarctic Program (National Science Foundation), the Bulgarian Antarctic Institute, and the Friedrich Schiller University of Jena (Germany) supported sampling or serving autonomic scientific field equipment.

Department of Antarctic Biology (Institute of Biochemistry and Biophysics, Polish Academy of Sciences), Antarctic Ecosystem Research Division (Southwest Fisheries Science Center, the US), and Argentinian Antarctic Institute, for their part, provided organizational and financial support to the CEMP project, where Ukrainian scientists were involved.

Furthermore, since March 2022, a number of research institutions and organizations have provided their facilities and equipment for Ukrainian scientists in the field of Antarctic research. In particular, the British Antarctic Survey provided access to its processing power (server) to perform the Ukrainian part of the work in the framework of the EU multi-partner project PolarRES. Department of Physics, University of New Brunswick (Canada), provides the possibility for a Ukrainian geophysicist to work at the Radio and Space Physics Laboratory to study the ionosphere and space weather of the Canadian Arctic and also continue to work with the relevant data obtained from Vernadsky station for comparative studies. Masaryk University (Brno, the Czech Republic) provided access to the Czech Collection of Microorganisms for experimental studies of endosymbiont bacteria of Antarctic vascular plants. Institute of Nature Conservation and W. Szafer Institute of Botany, Polish Academy of Sciences, provided laboratories and equipment to investigate bryophytes and lichens. Silesian University (Katowice, Poland) allowed a Ukrainian biologist to continue her work on Antarctic environmental spatial protection. The Adam Mickiewicz University (Poznań, Poland) hosts Ukrainian scientists for investigations of Antarctic Tardigrada. The International Institute of Molecular and Cell Biology (Polish Academy of Sciences) also provided its equipment and laboratories, while the US National Center for Atmospheric Research (managed by the University Corporation for Atmospheric Research and funded by the National Science Foundation) offered a fellowship to help scientists work during the war. The Scientific Committee on Antarctic Research (SCAR) founded a special travel grant for a young Ukrainian researcher to the British Antarctic Survey.

9 A vision of the future at a glance

Despite the Russian Federation's aggression against Ukraine and the consequent barriers to implementing future development plans, Ukraine's National Antarctic Program remains among the governmental priorities in science and technology policy.

Extension of the current State Special-Purpose Antarctic Research Program until the end of 2025 demonstrated that Government of Ukraine still cherishes investments made into the National Antarctic Program for the last decade, achieved results, and the importance of the continuation of the Antarctic and Southern Ocean Research.

Further steps defining the future development of the National Antarctic Program of Ukraine will closely correlate with the general situation in

Ukraine, considering the continuation of the war and connected state budget limitations.

However, in an optimistic scenario, it is expected that Ukraine's scientific priorities in the Antarctic will continue to correspond to SCAR's strategic work plan. In particular, they will include the tasks of developing advanced interdisciplinary and internationally significant research projects to solve the current scientific problems relating to Antarctica and the Southern Ocean (SCAR, 2023). In doing so, an important component of the next State Special-Purpose Antarctic Research Program will remain environmental protection activities and regulation of tourism activities to mitigate the growing anthropogenic impact on Antarctic ecosystems.

At the same time, the next State Special-Purpose Antarctic Research Program, thanks to the new capabilities provided by the RV *Noosfera*, will have a significantly wider range of biological, oceanographic, and geophysical research, including bipolar research, to contribute significantly to multi-nationally co-ordinated research and observing system to better understand and preserve the polar environment as a unique and crucially important area for the Earth System.

While the RV *Noosfera* will be serving as a fully-equipped mobile platform for international maritime research and logistics operations, Vernadsky station should also become an international base for conducting research and joint expeditions, and its infrastructure will continue to be modernized by introducing environmentally friendly best practices and state-of-the-art energy-efficient technologies.

10 Conclusions

Ukraine is one of the 30 countries worldwide operating a permanent Antarctica station. Vernadsky station is a dominant narrative in the main aspects of Ukraine's engagement in Antarctic affairs. Its establishment in 1996 and the introduction of original long-term observations were crucial not only for the approval of the National Antarctic Program, the formation of the school of researchers, and the growth of their publication activity but also for membership in international organizations within the Antarctic Treaty System (SCAR and COMNAP), and most importantly – for getting the honorable status of a Consultative Party to the Antarctic Treaty in 2004.

The National Antarctic Program has gone through an evolutionary path from the reproduction and continuation of monitoring meteorological and geophysical observations, initiated at the station by British scientists, to the development of independent scientific directions by the forces of Ukrainian scientists, in particular in biology, the results of which formed the basis of the justification of environment protection initiatives, to preserving unique Antarctic ecosystems.

Since then, the multi-site Antarctic Specially Protected Area and the Guidelines for the most visited sites around Vernadsky station, proposed by Ukraine, have significantly contributed to ensuring environmental protection and further regulation of the growing tourist activity in the Antarctic.

In recent years, Ukraine has intensified its participation in implementing CCAMLR scientific programs, using in the scientific observations the capabilities of the fishery fleet, which emphasizes the status of Ukraine as an important and responsible CCAMLR member.

The experience of all three State Special-Purpose Antarctic Research Programs implementation has proven the efficiency of long-term program-based planning of research projects and supplementary logistics operations. Planning of operational activities for up to 10 years has opened opportunities for planning long-term scientific experiments, especially research regarding climate change and biodiversity.

To continue moving the National Antarctic Program forward, Vernadsky station should operate as an Antarctic science and logistic hub for collaborative research with other parties, mainly with countries that currently do not have their own infrastructure in Antarctica but seek to carry out research activities.

Moreover, after the acquisition of the well-equipped research vessel, the SI NASC has the ambition to be a leading Ukrainian research institution with a bipolar focus and to contribute significantly to a multi-nationally co-ordinated research and long-term scientific monitoring and sustained observations to better understand and preserve polar environments as unique and crucially important areas for the Earth System.

Such cooperation will not only significantly expand the scope of Ukrainian Antarctic research and logistics operations but will also contribute to further strengthening of Ukraine's role in the Antarctic Treaty System for the current decade and beyond.

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Тридцять років досліджень України в Антарктиці: оцінка інституціональних здобутків Національної антарктичної програми в рамках Системи Договору про Антарктику

Реферат. Українці зробили вагомий внесок у вивчення Антарктики. Вихідці з України були у складі експедицій, які відкрили Антарктику та підкорили Південний полюс у XIX – початку XX ст. З кінця 50-х до початку 90-х років XX сторіччя українські дослідники та інженери доклали значних зусиль до становлення та розвитку Радянських антарктичних експедицій. З набуттям незалежності почався складний та амбітний шлях вивчення Антарктики під прапором України. Зазначена стаття дає історичний огляд становлення та розвитку в Україні антарктичних досліджень з 1993 року до теперішнього часу, а також окреслює поточний стан та перспективи подальшого розвитку діяльності України в Антарктиці. З цією метою висвітлено особливості становлення уповноваженої державної установи, відповідальної за здійснення діяльності в Антарктиці. Вказано на поступальний розвиток та наведено основні результати Державних цільових науково-технічних програм проведення досліджень в Антарктиці. Розкрито науковий потенціал та внесок у міжнародне наукове співробітництво ключових об'єктів антарктичної інфраструктури – станції «Академік Вернадський» як багатоцільової обсерваторії для моніторингу геофізичних процесів і впливу зміни клімату на екосистеми Антарктики та науково-дослідницького судна льодового класу «Ноосфера». Показано, що розроблені Україною природоохоронні ініціативи та заходи з регулювання туристичної діяльності є важливими для розбудови міжнародно-правового режиму Антарктики.

Ключові слова: антарктична інфраструктура, антарктична наука, наукові результати, науково-дослідницьке судно «Ноосфера», станція «Академік Вернадський»