The Fourth Turkish Arctic Scientific Expedition (TASE-IV)

Report 06.05.2024, 26.06.2024- 25.07.2024, Jnr. 24/5448

Project Dates: 27.06.2024-25.07.2024

Purpose of Cruise: Investigation of the anthropogenic impacts in a global scale and the effects of global climate change.

Scientist in Charge: Prof. Dr. Burcu Özsoy

Introduction

Polar Research Institute (PRI) was established in 2019 within TÜBİTAK Marmara Research Center to ensure the coordination and logistics of the national polar expeditions. The Institute aims to provide support for R&D and scientific research studies to be conducted in polar regions, to operate Türkiye's polar research infrastructure, to plan and coordinate logistics, to facilitate communication among relevant organizations, to conduct bilateral international collaborations, to develop and implement the national polar strategy in cooperation with stakeholders, to raise awareness of polar regions at national scale. As the umbrella organization for polar research in Türkiye, PRI organizes scientific expeditions to Arctic and Antarctica to provide a better understanding of the past, present and the future of the Earth, and also to investigate the impacts of global climate change and human activities. The first Turkish Arctic Scientific Expedition (TASE-I) was conducted around Svalbard between 13-26 July 2019 onboard MY Anakena. RiS ID was 11301 and Cruise Information was specified as 190620 on Directorate of Fisheries. The 2nd Turkish Arctic Scientific Expedition (TASE-II) was conducted around Svalbard between 13-24 July 2022 onboard R/V PolarXplorer. Cruise information was specified with reference number 22/9853 by the Directorate of Fisheries. The 3rd Turkish Arctic Scientific Expedition (TASE-III) was carried out onboard R/V PolarXplorer between 04 July-02 Aug 2023 in Barents Sea. In 2024, The Fourth Turkish Arctic Scientific Expedition (TASE-IV) took place from June 27 to July 25. In accordance with the permissions obtained under the "Regulations Relating to Foreign Marine Scientific Research in Norway's Internal Waters, Territorial Sea and Exclusive Economic Zone and on the Continental Shelf", the studies were conducted within the Norwegian Territorial Waters, Norwegian Exclusive Economic Zone, the Fisheries Protection Zone around Svalbard, and Territorial Waters. The overall purpose of the scientific research was to investigate the presence and intensity of the

anthropogenic impacts on a global scale, as well as to observe key parameters and effects of global climate change in the Arctic.

Conducted Projects

The following projects were carried out within The Fourth Turkish Arctic Scientific Expedition (TASE-IV):

1. Determination of the Potential for Cold-Active Enzyme Production by Microorganisms in Sea Ice
2. Analysis of Inorganic Substances in Arctic Seawater
3. Detection of Antifouling Compounds in the Aquatic Environment
4. Identification and Toxicity Analysis of Phytoplankton Samples Collected from the Marine Environment Through Single-Cell Isolation
5. Investigation of Plankton and Pigment Composition in the Arctic Summer Period in the North Ice Sea
6. Assessment of Potential Changes in the Unique Water Ecosystem of the Arctic Region with a Focus on the Secure and Sustainable Supply of Critical Raw Materials
7. Shallow Marine Oceanography of the Svalbard Region
8. Dynamics of Arctic Layers and Investigations of Thermocline and Halocline Around Svalbard
9. Determining the Spatial Change of Arctic Biodiversity Using eDNA Metabarcoding and Evaluating with Physicochemical Parameters
10. Biogeochemical Sampling Around the Barents Sea and Svalbard Island
11. High-Accuracy and Sensitivity Determination of Pharmaceutical Active Ingredients and Their Metabolites in Environmental Samples from the Arctic Region Using LC-MS/MS Combined with Next-Generation Preconcentration Methods
12. Phytoplankton in a Changing Ocean
13. Development of Technical Solutions for Observing Changes in Space Radiation in Polar Regions
14. Collection of Marine Meteorological Data in the Arctic Region
15. Investigation of Microbiological Parameters and Enzymatic Activities in the Barents Sea
16. Identification of Microplastic Pollution in the Barents Sea
17. Identification of Organic Pollutants in the Barents Sea

The members of the expeditions and their institutions are given in Table 1.

Table 1. Expedition members, roles and institutions

No	Name	Role	Institution
1	Prof. Dr. Ersan BAŞAR	Expedition Leader	Karadeniz Technical University
2	Cpt. Doğaç Baybars IŞILER	Expedition Co-Leader	TÜBİTAK Marmara Research Center, Polar Research Institute
3	Çetin BİÇER	Researcher	General Directorate of Meteorology
4	Mehmet Kunter İNCİLİ	Researcher	Turkish Naval Forces Department of Navigation Hydrography and Oceanography
5	Dr. Aslıhan NASIF DONDURUR	Researcher	Dokuz Eylül University
6	Bilge DURGUT	Researcher	Middle East Technical University
7	Gülden AÇIL	Researcher	İstanbul University
8	Nursu Aylin KASA	Researcher	İstanbul Medipol University
9	Şebnem COŞKUN	Photo Reporter	Anadolu Ajansı (Turkish News Agency)
10	Petar SAPUNDZHIEW	Researcher	Bulgarian Antarctic Institute
11	Maria Jose NARİÑO VARGAS	Researcher	Chilean Antarctic Institute

The titles and brief information of the conducted projects are given below.

1. Determination of the Potential for Cold-Active Enzyme Production by Microorganisms in Sea Ice

This study aims to determine the ability of bacteria to exhibit biochemical activity under extreme conditions. Cold-active enzymes have great potential for industrial and biotechnological applications due to their ability to catalyze biochemical reactions at low temperatures. These enzymes are being investigated for use in fields such as the food industry, bioremediation, and biofuel production. Sea ice samples were collected from sampling stations and stored in sterile sample containers at -20°C. After being transported to the laboratory, bacterial isolation procedures were carried out on the collected sea ice samples. The capacity of the isolated bacteria to produce cold-active enzymes will be analyzed in the collected samples.

2. *Analysis of Inorganic Substances in Arctic Seawater*

This study aims to help determine the chemical composition of surface seawater, assess water quality, and evaluate environmental conditions during the current season. From each sampling station, a 500 ml surface seawater sample is collected and filtered using a 0.2 µm syringe filter for inorganic substance analysis. To lower the pH and enhance solubility, 0.5 ml of nitric acid (HNO_3) is added. The prepared samples are stored in 100 ml and 50 ml white plastic sample bottles for long-term storage and analysis. The collected samples will be analyzed for metals, anions-cations, nutrients, pH, and conductivity.

3. *Detection of Antifouling Compounds in the Aquatic Environment*

The aim of this project is to investigate the presence and distribution of commonly used antifouling biocides (Irgarol 1051, chlorothalonil, and dichlofluanid) in water samples collected from the Arctic region. The findings of this study will help assess the pollution levels of the selected aquatic environment caused by antifouling compounds. Additionally, an environmental impact assessment will be conducted to determine whether these compounds have potential adverse effects on aquatic organisms. For the detection of antifouling compounds, 500 ml surface water samples were be collected from eight selected stations. To preserve the samples, 1 ml of hexane was be added to each. The collected water samples were transported to the laboratory, extracted using the stir bar extraction method, and analyzed with a GC/MS (Gas Chromatography-Mass Spectrometry) system.

4. *Identification and Toxicity Analysis of Phytoplankton Samples Collected from the Marine Environment Through Single-Cell Isolation*

The aim of this study is to identify phytoplankton species through single-cell isolation based on their morphological characteristics and to analyze the distribution of phytoplankton diversity in the study area. Additionally, the toxicity potential of the isolated species will be tested, with a particular focus on detecting the presence of harmful algal blooms (HABs). Phytoplankton samples were collected from a 30 m water column using a vertical haul method with a 20 µm mesh phytoplankton net. The collected samples were transferred into 70 ml sterile cell culture bottles and filtered through a 200 µm mesh filter to ensure the analysis of phytoplankton species between 20 µm and 200 µm in size. To maintain cell viability and growth, the samples were stored at +4°C under white light conditions, with a 20-hour light and 4-hour dark cycle.

5. *Investigation of Plankton and Pigment Composition in the Arctic Summer Period in the North Ice Sea*

Planktonic organisms respond rapidly to environmental changes due to their short life spans. This study aims to examine the current composition of phytoplankton, zooplankton, and pigments in the Barents Sea and compare the results with previous studies. During fieldwork, sampling was conducted at 6, 10, 24, and 24 stations for zooplankton, phytoplankton, picoplankton, and pigment analysis, respectively. Zooplankton and phytoplankton samples were collected using 200 µm and 20 µm mesh plankton nets, respectively. For pigment analysis, 1-liter surface seawater samples were collected from each station and filtered through GFF filters with a 0.7 µm pore size.

6. *Assessment of Potential Changes in the Unique Water Ecosystem of the Arctic Region with a Focus on the Secure and Sustainable Supply of Critical Raw Materials*

This project aligns with the EU's recently completed framework, titled "Ensuring the Secure and Sustainable Supply of Critical Raw Materials", which aims to regulate similar supply processes. In addition to securing CRM supply, it is essential to consider their potential impacts on terrestrial and aquatic ecosystems. This project aims to understand CRM (Critical Raw Material) concentrations in increasingly fragile aquatic environments. By identifying CRM concentration increases in surface waters and predicting their effects on both biotic and abiotic components of aquatic ecosystems, the project seeks to mitigate negative environmental impacts. At sampling stations, 50 ml surface seawater samples were collected from designated locations for analysis.

7. *Shallow Marine Oceanography of the Svalbard Region*

This project aims to investigate the presence of freshwater inputs along an average 90-meter water column resulting from glacial melt in the open seas around the Svalbard Islands. Additionally, it will explore how these freshwater inputs interact with ocean currents and how they affect the current dynamics. SVP measurements conducted around the Svalbard Islands will help determine temperature, salinity, conductivity, and sound velocity profiles based on water column depth, allowing us to understand water mass movements and mixing processes. These measurements will also enable the study of ocean currents and thermohaline circulation. Furthermore, the data will provide insights into biological productivity and nutrient distribution, offering an opportunity to assess the impacts of

climate change and seasonal variations on water temperature and salinity. The results will also contribute to the calibration of ocean-climate models, laying the groundwork for future predictions.

8. *Dynamics of Arctic Layers and Investigations of Thermocline and Halocline Around Svalbard*

The project aims to identify the thermocline and halocline boundaries in the water mass around the Barents Sea and Svalbard Island. A Sound Velocity Profiler (SVP) device was used for measurements, with data being collected by lowering the device to a depth of at least 80 meters from the stern via a 100-meter cable at each sampling point. The data obtained from the SVP will help determine the thermocline and halocline boundaries in the Barents Sea around Svalbard during the measurement period. In subsequent years, this study will continue regularly to assess how glacial melt in the Arctic region is affecting the oceanography of the water mass around Svalbard.

9. *Determining the Spatial Change of Arctic Biodiversity Using eDNA Metabarcoding and Evaluating with Physicochemical Parameters*

This project aims to analyze the environmental DNA (eDNA), chlorophyll, pigments, and particulate organic matter by filtering seawater samples taken from stations along the TASE-IV expedition route. Additionally, nutrient analysis will be conducted on the collected water samples, and physical and chemical data such as temperature, salinity, depth, and pH will be combined. This will provide insights into how Arctic biodiversity changes in different regions of the Barents Sea in relation to these parameters. The biodiversity data obtained from this project will be compared with existing Arctic bacterial and multicellular species in the literature to investigate the presence and origin of novel alien species in the region. This will help determine the impacts of climate change and Atlantification on biodiversity. Along with the surface and deep seawater samples, filtered seawater, sea ice samples, and sediment samples were collected from the relevant stations for further analysis.

10. Biogeochemical Sampling Around the Barents Sea and Svalbard Island

Seawater samples collected from stations along the TASE-IV expedition route were filtered through various pore sizes for metallic particle analysis. Similarly, seawater obtained by melting sea ice will undergo the same analyses. Size and composition determinations will be made to gather information on the sources of the particles. Additionally, nanoparticles isolated from sediments will be analyzed for size and composition, providing insights into the biogeochemical status of the region. At the relevant stations, surface and deep seawater samples were collected. Some samples were filtered, while others will be stored directly. Sea ice and sediment samples were also collected for further analysis.

11. High-Accuracy and Sensitivity Determination of Pharmaceutical Active Ingredients and Their Metabolites in Environmental Samples from the Arctic Region Using LC-MS/MS Combined with Next-Generation Preconcentration Methods

Pharmaceutical active ingredients, which are significant environmental pollutants, can be transported from their source to remote areas, accumulating in water, soil, and air, potentially harming sensitive ecosystems. Additionally, these substances affect the ecosystem when tourists and scientists visiting polar regions excrete them through urine. As a result, they can threaten the natural habitats in these regions, endangering local species and contributing to biodiversity loss. In this context, the determination of selected analytes in seawater samples from the Arctic region will be conducted using microextraction followed by analysis in the LC-MS/MS system. This will mark the first time that these 10 analytes, along with their metabolites, have been simultaneously determined in Arctic environmental samples. Furthermore, the application of preconcentration techniques for pharmaceutical active ingredients is quite limited in the literature. This project aims to develop next-generation preconcentration techniques, contributing to the literature and enhancing research focus on high-accuracy and high-sensitivity detection of pharmaceutical active ingredients in complex matrices. Environmental samples from relevant locations, including seawater, sea ice, and sediment samples, were collected in 50 ml bottles, with a total of 5 liters of samples being obtained.

12. Phytoplankton in a Changing Ocean

The project focuses on understanding phytoplankton ecology in a changing ocean, with an emphasis on polar regions affected by climate change. These changes include the increasing dominance of small organisms, altering species composition and abundance. Phytoplankton plays a vital role in the carbon cycle, and shifts in their composition may impact higher trophic levels and human health, especially through toxic species. The project aims to quantify phytoplankton toxins, analyze genetic diversity, evaluate biomass distribution, and produce samples for microscopic analysis. Samples were collected three times from the same location using a 20-micron mesh net, from 20 meters to the surface. The water was divided for various analyses, with some preserved in formalin for microscopy and others filtered for genetic analysis. A Secchi disk measured the photic zone depth, and surface water was also collected for chlorophyll, toxin, and genetic analyses.

13. Development of Technical Solutions for Observing Changes in Space Radiation in Polar Regions

The main goal of the project is to develop technical solutions for observing changes in accumulated dose rates and fluxes from primary and secondary cosmic rays. The data collected throughout this project will serve as a resource for improving the reliability and functionality of field-deployed equipment in the harsh environment of the polar regions. This will allow for the creation of a more consistent long-term database for environmental processes, which play a significant role in both local and global changes on our planet. During this project, a series of field-specific experiments was conducted with a Liulin-CNR-VG spectrometer along with a data logger for GPS coordinates and environmental parameters. Along with the collected radiation dose, the effects of temperature, humidity, and mechanical stress on the entire system, including the power supply and protective casing, were analyzed. By conducting a series of procedural experiments, the characteristics of the power budgeting of low-bandwidth Iridium satellite communication for real-time data access was examined. Throughout the expedition route, all relevant satellite data was collected and stored in a digital format.

14. Collection of Marine Meteorological Data in the Arctic Region

The collection of marine meteorological data in the Arctic region was carried out using certified sensors to measure and record air temperature, humidity, wind direction and speed, air pressure, sea water temperature, global solar radiation intensity, and location values with high accuracy according to WMO standards. Throughout the expedition route, all relevant meteorological parameters were collected and stored in a digital format. The project outputs will serve as a primary data source for studies in various fields, especially in climate science and maritime studies, as well as other natural and social sciences.

15. Investigation of Microbiological Parameters and Enzymatic Activities in the Barents Sea

This study aims to understand the microbial roles in organic matter turnover through enzymatic activity measurements, the abundance of heterotrophic bacteria, the structure and dynamics of the phytoplankton community, and the microbial abundance and function of the plastisphere community. The goal is to better understand microbial dynamics in response to climate change in the Barents Sea, providing new insights to improve existing datasets on microbial communities in the region. This research will contribute to ongoing efforts to assess the ecological impacts of climate change on marine environments.

In the Arctic Ocean, the microbiological organisms present in the Barents Sea, including phytoplankton, enzymes, bacteria, and plasmodium, were measured to study the microbiological structure of the Barents Sea. Sea surface water samples were collected in 250ml amber bottles and fixed with Lugol's solution. Additionally, sea water samples from the same locations were stored frozen in glass jars. 1.5ml sea water samples were taken in Eppendorf tubes and stored at room temperature, while 500ml samples of sea surface water were filtered through Whatman GF/F filters and stored frozen.

16. Identification of Microplastic Pollution in the Barents Sea

The scientific goal of the proposed study in the Arctic is to investigate the environmental impact of microlitter, focusing on plastic additives that are released when plastic objects fragment in the environment. These additives can pose risks to both marine organisms and humans, as they may act as endocrine disruptors and affect reproductive health. The 2024 survey aims to analyze the load budget of plastic additives in seawater, quantify and characterize microplastics (<100 μm), and examine their relationship with other environmental parameters. This research will contribute to understanding long-range

transport pathways of pollutants and their ecological consequences, supporting sustainable management of fragile Arctic environments in the context of ongoing climate change. For this purpose, microplastic samples were collected from sea surface water in 2.5-liter containers and through control sampling using filters in Petri dishes.

17. Identification of Organic Pollutants in the Barents Sea

The Arctic ecosystem is vulnerable to pollution from lower latitudes, with contaminants transported through oceanic circulation and migratory wildlife, worsened by climate change and increased human activities. This research aims to assess the distribution of organic micro-pollutants, identify transport routes, and evaluate ecological risks in polar oceans. The study will focus on emerging organic pollutants in seawater, relate contamination to physical and biological parameters, and expand to monitor additional contaminants like pharmaceuticals and sea ice. The goal is to understand human impacts on the Arctic marine environment in the context of climate change and ensure sustainable management. A total of 4 liters of seawater were collected and frozen for analysis.

The coordinates of the sampling points are given in Table 3. In addition, the sampling points are shown on a map in Figure 1.

Table 3. Coordinates of the sampling points and their corresponding dates

Sampling Points	Date	Latitude	Longitude
SP1	1.07.2024	71° 19.693 N	24° 25.751 E
SP2	2.07.2024	70° 36.036 N	32° 27.303 E
SP3	2.07.2024	73° 01.325 N	35° 49.126 E
SP4	3.07.2024	74° 19.704 N	37° 01.030 E
SP6	3.07.2024	74° 41.520 N	36° 56.889 E
SP 7	4.07.2024	77° 14.725 N	37° 36.835 E
SP 7A	4.07.2024	77° 46.700 N	37° 35.475 E
SP 9	4.07.2024	78° 14.710 N	34° 38.438 E
SP10	5.07.2024	79° 14.270 N	34° 51.284 E
SP11	5.07.2024	80° 11.980 N	34° 47.240 E
SP 12	5.07.2024	80° 22.070 N	34° 39.240 E
SP 40	6.07.2024	79° 35.340 N	25° 47.380 E
SP 41	6.07.2024	79° 14.750 N	22° 58.780 E
SP 42	7.07.2024	79° 44.345 N	21° 41.930 E
SP 43	7.07.2024	79° 38.568 N	18° 41.555 E
SP13	8.07.2024	81° 30.050 N	23° 04.850 E

SP14	9.07.2024	81° 00.651 N	14° 13.044 E
SP14A	9.07.2024	80° 25.686 N	10° 41.230 E
SP15	10.07.2024	79° 48.522 N	03° 13.645 E
SP16A	10.07.2024	79° 37.815 N	11° 27.714 E
SP 16	12.07.2024	80° 00.540 N	10° 17.706 E
SP17	12.07.2024	79° 38.690 N	09° 11.720 E
SP18	12.07.2024	79° 04.120 N	09° 32,740 E
SP19	12.07.2024	78° 33.271 N	09° 48.420 E
SP20	13.07.2024	78° 04.230 N	11° 02.158 E
SP21	13.07.2024	77° 59.493 N	12° 03.607 E
SP22	13.07.2024	77° 33.030 N	12° 51.870 E
SP23A	14.07.2024	77° 00.240 N	15° 37.784 E
SP23	14.07.2024	76° 43.400 N	14° 28.570 E
SP24	14.07.2024	76° 12.860 N	16° 34.340 E
SP30	15.07.2024	76° 44.650 N	17° 48.030 E
SP31	15.07.2024	77° 13.530 N	18° 09.910 E
SP33M	15.07.2024	78° 10.610 N	18° 57.870 E
SP31M	15.07.2024	77° 27.060 N	17° 56.810 E
SP32	15.07.2024	78° 07.550 N	19° 33.560 E
SP22A	16.07.2024	77° 29.650 N	14° 41.930 E
SP22B	17.07.2024	77° 31.180 N	15° 53.680 E
SP18A	18.07.2024	79° 21.030 N	11° 43.740 E
SP18B	18.07.2024	79° 18.030 N	12° 07.240 E
SP 18C	18.07.2024	79° 11.890 N	12° 13.010 E
SP18D	19.07.2024	79° 03.070 N	11° 22.970 E
SP18E	19.07.2024	78° 44.980 N	11° 26.020 E
SP20A	19.07.2024	78° 26.820 N	11° 53.550 E
SP20B	19.07.2024	78° 21.800 N	12° 47.730 E
SP20C	20.07.2024	78° 08.560 N	13° 14.530 E
SP21A	20.07.2024	78° 03.640 N	14° 09.820 E
SP21C	21.07.2024	78° 38.990 N	16° 53.250 E
SP21D	22.07.2024	78° 40.470 N	16° 33.150 E
SP21E	23.07.2024	78° 26.410 N	17° 19.400 E
SP21B	23.07.2024	78° 40.810 N	14° 27.430 E
SP 21F	23.07.2024	78° 32.120 N	14° 19.870 E
SP21G	23.07.2024	78° 26.610 N	15° 10.930 E

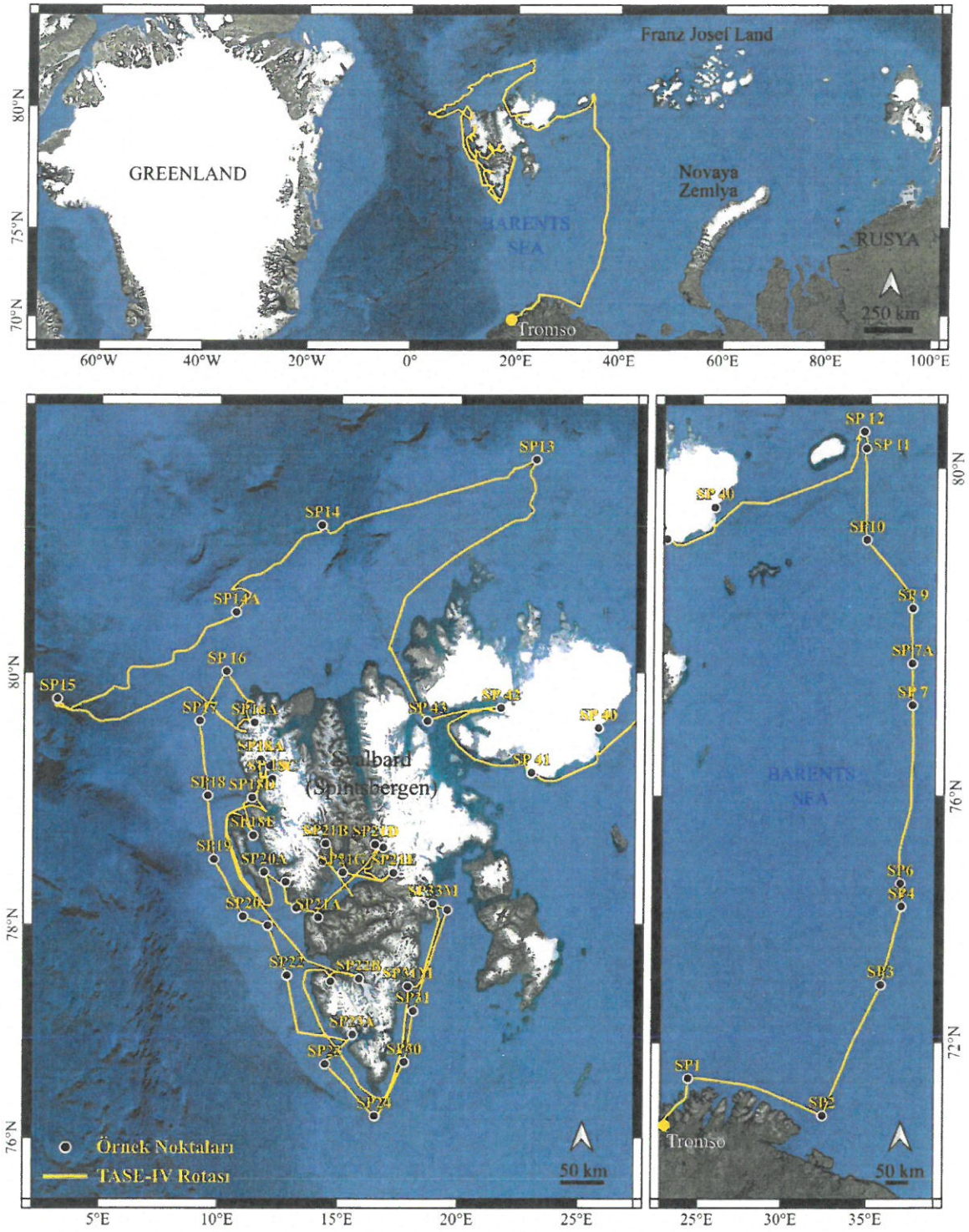

Figure 1. TASE-IV sampling points

Results

SVP (sound velocity profile) measurements were carried out in 23 sampling points during TASE-IV. Station numbers, date, time, SVP depths, wind, and pressure data are presented in Table 4. Data gathered from SVP device are available on demand.

Table 4. SVP Measurement Parameters

Station	Date	Time	SVP Depth (m)	Water Column Depth (m)	Wind Direction (°)	Wind Speed (m/s)	Pressure (hPa)
1	1.07.2024	06:05	91	313	-	-	1007
2	2.07.2024	02:35	104	281	135	2.0	1002
3	3.07.2024	23:05	83	215	090	7.5	1009
4	3.07.2024	09:35	96	211	015	5.0	1009
6	3.07.2024	21:35	95	214	350	4.2	997
7	4.07.2024	09:35	82	187	060	6.7	999
07a	4.07.2024	14:45	87	206	005	5.9	1001
9	4.07.2024	20:00	101	104	050	3.0	1001
10	5.07.2024	03:00	105	218	-	-	1002
11	5.07.2024	10:30	90	242	150	7.0	1002
12	5.07.2024	15:00	89	301	160	8.9	1003
13	8.07.2024	15:30	82	509	160	11.	888
14	9.07.2024	04:30	86	1468	090	7.9	987
15	10.07.2024	08:00	78	2000	210	5.7	1001
16	12.07.2024	09:00	78	430	180	3.5	1009
17	12.07.2024	13:20	96	226	060	4.4	1006
18	12.07.2024	18:30	57	56	120	8.1	1002
19	13.07.2024	23:30	85	120	150	6.8	1001
20	13.07.2024	05:00	84	217	180	1.8	1001
21	13.07.2024	07:30	93	228	150	2.1	1002
22	13.07.2024	11:30	99	136	250	3.7	1003
23	14.07.2024	13:00	89	95	260	6.6	1001
24	14.07.2024	19:30	92	249	290	7.0	1004

Meteorological data measured at each sampling points are given in Table 5.

Table 5. Meteorological data at each sampling points

Sampling Points	Date	Time	Depth (m)	Wind Direction (°)	Wind Speed (m/s)	Air Pressure (hPa)
SP1	1.07.2024	06.05	313	-	-	1007
SP2	2.07.2024	02:35	281	135	2.0	1002
SP3	2.07.2024	23.05	215	090	7.5	1009
SP4	3.07.2024	09.35	211	015	5.0	1009
SP6	3.07.2024	21.35	214	350	4.2	997
SP 7	4.07.2024	09.35	187	060	6.7	999
SP 7A	4.07.2024	14.45	206	005	5.9	1001
SP 9	4.07.2024	20.00	104	050	3.0	1001
SP10	5.07.2024	03.00	218	-		1002
SP11	5.07.2024	10.30	242	150	7.0	1002
SP 12	5.07.2024	15.00	301	160	8.9	1003
SP 40	6.07.2024	14.00	87.5	000	2.7	1004
SP 41	6.07.2024	21.00	51.8	070	3.7	1002
SP 42	7.07.2024	14.15	69	030	8.2	997
SP 43	7.07.2024	18.45	310	330	16	991
SP13	8.07.2024	15.30	509	160	11	988
SP14	9.07.2024	04.30	1468	090	7.9	987
SP14A	9.07.2024	13.45	910	000	5.6	989
SP15	10.07.2024	08.00	~ 2000	210	5.7	1001
SP16A	10.07.2024	11.30	194	090	7.6	1009
SP 16	12.07.2024	09.00	430	180	3.5	1009
SP17	12.07.2024	13.20	226	060	4.4	1006
SP18	12.07.2024	18.30	56	120	8.1	1002
SP19	12.07.2024	23.30	120	150	6.8	1001
SP20	13.07.2024	05.00	217	180	1.8	1001
SP21	13.07.2024	07.30	228	150	2.1	1002
SP22	13.07.2024	11.30	136	250	3.7	1003
SP23A	14.07.2024	07.15	19.6	350	2.0	999
SP23	14.07.2024	13.00	95	260	6.6	1001
SP24	14.07.2024	19.00	249	290	7.0	1004
SP30	15.07.2024	01.00	189	280	12	1006
SP31	15.07.2024	05.15	105	270	7.1	1008
SP33M	15.07.2024	14.30	19.9	300	4.8	1008
SP31M	15.07.2024	22.00	12.9	210	5.3	1010
SP32	15.07.2024	13.00	75	280	5.8	1009
SP22A	16.07.2024	20.30	33.5	035	1.7	1018
SP22B	17.07.2024	13.45	10	280	1.8	1022
SP18A	18.07.2024	18.15	56	030	2.4	1018
SP18B	18.07.2024	22.10	35	210	2.3	1018
SP 18C	18.07.2024	23.40	94	050	2.2	1017
SP18D	19.07.2024	02.30	348	180	10	1015
SP18E	19.07.2024	08.30	15.9	180	11	1014

SP20A	19.07.2024	20.30	13	045	2.0	1015
SP20B	19.07.2024	23.30	11.8	050	2.1	1015
SP20C	20.07.2024	09.15	269	210	2.9	1015
SP21A	20.07.2024	17.00	145	330	4.7	1015
SP21C	21.07.2024	17.30	56	120	1.7	1010
SP21D	22.07.2024	10.45	14.4	159	2.5	1011
SP21E	23.07.2024	10.20	45.4	043	5.8	1012
SP21B	23.07.2024	19.00	23	-	-	1010
SP 21F	23.07.2024	21.00	55	-	-	1010
SP21G	23.07.2024	07.30	259	140	1.5	1009

The meteorological conditions collected during the 4th Turkish Arctic Scientific Expedition (TASE-IV) show a range of moderate to cool weather patterns over the observed period (27 June – 23 July 2024; Table 6). The average temperature was 6.0°C, with fluctuations between a minimum of -1.1°C and a maximum of 19°C, indicating a generally cool climate. The humidity remained high, averaging 88.1%, with levels ranging from a minimum of 48.3% to a maximum of 100%, suggesting that the air remained quite humid, particularly during the high humidity periods.

Atmospheric pressure showed slight variation, with the average pressure recorded at 1005 hPa, ranging from a low of 981 hPa to a high of 1020 hPa, indicating generally stable but slightly fluctuating pressure conditions. Solar radiation showed significant variability, with the average solar radiation being 164 W/m², ranging from a low of 7.8 W/m² on overcast or night-time periods to a high of 829 W/m², indicating strong sunlight during certain times of the day. Additionally, the sea surface temperature varied between -1.6°C and 15.1°C, with an average temperature of 5.3°C, reflecting cooler sea temperatures during the period.

Overall, the data suggests a temperate or coastal climate with high humidity, cool temperatures, and fluctuating solar radiation, reflecting an environment with moderate weather conditions and occasional sunlight.

Table 6. Mean meteorological data collected during the expedition

Date	Temperature (°C)	Relative Humidity (%)	Pressure (hPa)	Solar Radiation (W/m²)	Seawater Temperature (°C)
2024-06-27	11.30	70.42	1014.07	204.24	9.12
2024-06-28	12.14	73.17	1005.55	297.20	9.56
2024-06-29	14.03	77.02	994.05	170.59	8.98
2024-06-30	12.61	75.97	1002.65	102.14	10.04
2024-07-01	7.67	94.60	1005.60	170.23	8.15
2024-07-02	5.17	95.08	998.71	93.15	6.33
2024-07-03	2.24	95.99	998.16	95.17	4.26
2024-07-04	0.84	93.55	1000.65	163.03	1.71
2024-07-05	0.09	95.67	1001.78	193.80	0.34
2024-07-06	2.12	86.47	1002.97	133.66	1.19
2024-07-07	1.98	87.23	995.78	90.81	2.66
2024-07-08	1.87	93.10	986.41	227.38	1.79
2024-07-09	0.80	95.45	992.48	192.22	1.09
2024-07-10	1.68	97.44	1003.05	141.21	1.66
2024-07-11	8.28	77.55	1007.52	118.22	3.80
2024-07-12	6.12	88.75	1004.77	106.30	4.94
2024-07-13	4.74	96.01	1003.06	94.44	4.59
2024-07-14	4.49	96.94	1002.08	113.04	2.80
2024-07-15	6.66	79.37	1008.39	270.75	3.77
2024-07-16	3.78	95.02	1014.46	189.56	3.82
2024-07-17	4.35	97.64	1018.61	207.20	5.30
2024-07-18	7.46	80.28	1016.65	269.84	6.17
2024-07-19	5.45	87.28	1013.49	182.82	6.17
2024-07-20	7.45	80.72	1013.46	282.19	6.93
2024-07-21	7.24	82.45	1010.31	94.11	8.46
2024-07-22	7.67	92.49	1011.78	94.65	7.94
2024-07-23	10.13	85.51	1010.84	146.77	7.10

Conclusion

A series of comprehensive research projects have been conducted to investigate various aspects of the Arctic environment, focusing on microbiology, oceanography, pollution, climate change, and biodiversity. These studies aim to enhance the understanding of ecological processes, environmental risks, and the impacts of climate change on Arctic marine and terrestrial ecosystems. Several projects have examined microbial and enzymatic activities in extreme conditions, including the potential for cold-active enzyme production by microorganisms in sea ice and the microbiological dynamics of the Barents Sea. Additionally, investigations into Arctic phytoplankton ecology, including toxicity assessments and biodiversity studies using environmental DNA (eDNA) metabarcoding, provide insights into shifting biological communities.

Oceanographic studies have analyzed seawater composition, thermocline and halocline dynamics, and the influence of glacial melt on water mass movements in the Svalbard region. Concurrently, biogeochemical sampling has been performed to assess metal particle distribution, critical raw material concentrations, and physicochemical parameters influencing Arctic biodiversity.

Environmental pollution research has focused on identifying and quantifying microplastics, organic pollutants, pharmaceutical residues, and antifouling compounds in Arctic waters. The determination of microplastic pollution and plastic additive release contributes to understanding long-range transport pathways of contaminants and their ecological consequences. Furthermore, the detection of pharmaceutical active ingredients and their metabolites in seawater marks a significant advancement in environmental monitoring.

Meteorological data collection and space radiation monitoring have also been carried out, providing valuable datasets for climate science, maritime studies, and environmental modeling. These data contribute to the calibration of ocean-climate models, facilitating improved predictions of climate change impacts.

Overall, these interdisciplinary research efforts provide critical insights into Arctic environmental changes, supporting sustainable management and conservation initiatives in response to ongoing climate change and human activities. Although the finalization period of the studies may vary (months to years), the reports or scientific publications prepared from these studies will be shared with the relevant authorities of Norway once they are published.

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