CRUISE REPORT

CHARCOT

An oceanographic snapshot in the CHanging ARctiC passing thrOugh The "North Pole"

Le Commandant Charcot, Cruise No. CC060924,

September 6th 2024 – September 26th 2024

Nome (Alaska)-Longyearbyen (Svalbard Islands)

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Summary

The Arctic region's rapid warming during the past decades has led to substantial perturbations of atmospheric, ice and ocean physics including a reduction in sea-ice extent and an increase in river discharge. The impact of such changes on physical and mechanical sea-ice properties, ecosystems and biogeochemical cycles remains profoundly understudied especially in the difficult-to-reach central Arctic. Arctic Amplification, Atlantification, Ocean Acidification, deoxygenation and emerging contaminants (e.g. plastics, nanoparticles, PFAS, Rare Earth Elements) are additional stressors altering carbon cycling and ecosystems in the Arctic Ocean today and in the future. Large changes taking place at the central Arctic's ice/ocean/air interface, where water masses and ocean life interact across a range of temporal and spatial scales, are currently poorly documented.

CHARCOT project employed a multidisciplinary approach with an international team to document the current state and ongoing changes of the physical, chemical, biological and biogeochemical systems of the Arctic Ocean. Emphasis of the project was devoted to understanding the major ongoing transformations in water masses, sea-ice, marine ecosystems (pelagic, sea-ice and bioaerosol), carbon cycling and plastisphere. Furthermore, the ship's performance and its structural response were analyzed in the context of environmental conditions.

The overarching goal of the CHARCOT project is to generate a dataset that will lead to a synoptic characterization of the Arctic Ocean including hydrography, sea-ice, carbon cycling and ecosystem functioning, and iconic life. The obtained results will provide a unique baseline that will contribute to track climate change and its impacts as they unfold in the Arctic.

Finally, the social science component includes an ethnographic study of scientific work performed on the Arctic cruise ship. This study contributed to a greater understanding of how scientific knowledge about the Arctic environment is produced today. Furthermore, this research demonstrated the contribution of the Ponant Science initiative and “Le Commandant Charcot” to polar science, while increasing knowledge dissemination and visibility of the CHARCOT Transarctic expedition to a wider audience.

1. Research Programme/Objectives

CHARCOT's overarching goal (Figure 1) is contributing to the evaluation of the current state and major ongoing transformations in water masses (thermohaline and biogeochemical properties), sea-ice, marine ecosystems (pelagic, sea-ice and bioaerosol), carbon cycling, plastisphere by applying a multidisciplinary approach and involving an international team composed of researchers with complementary expertises. The understanding of vessel performance and structural response in the context of peculiar polar environmental conditions, as well ethnographic studies of polar scientific expeditions, are also considered.

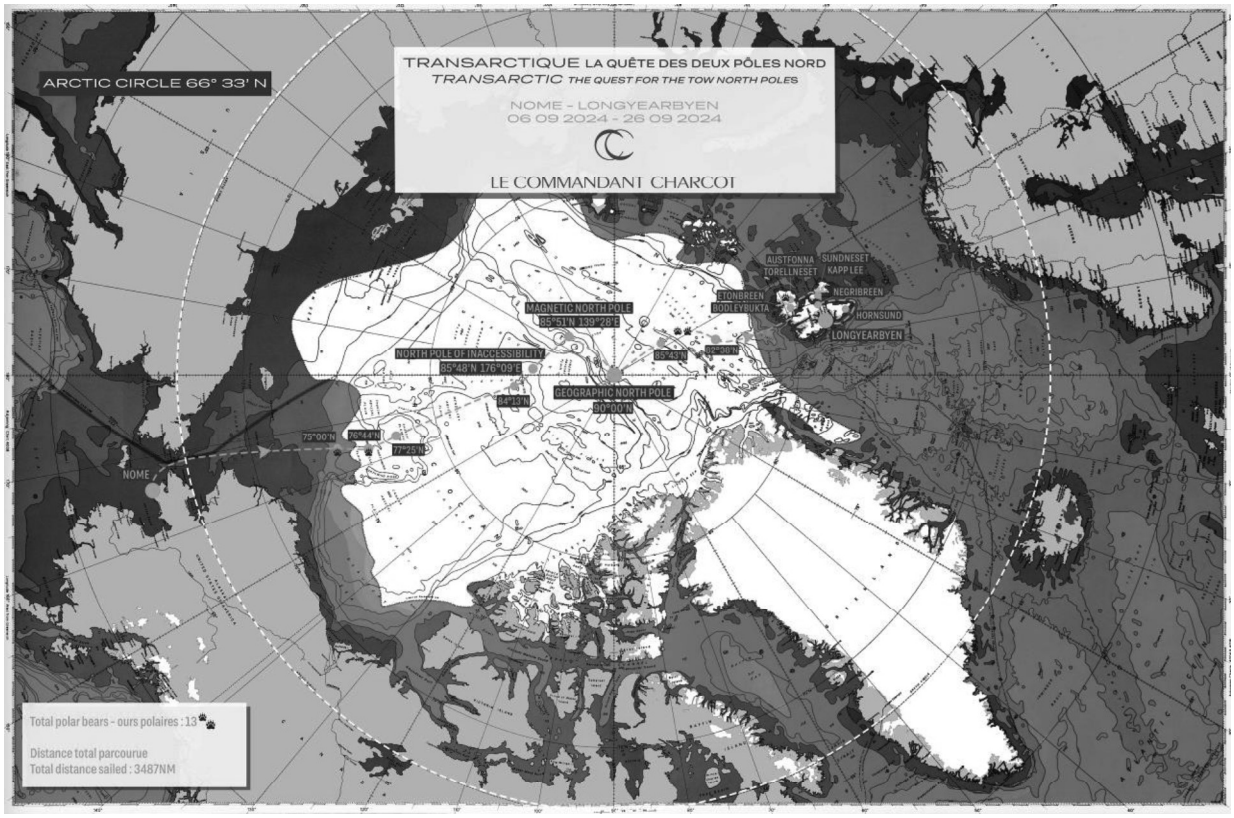

Figure 1. *Working area and track chart (orange line) of R/V Le Commandant Charcot during the oceanographic cruise CHARCOT.*

To achieve these goals, CHARCOT has pursued 6 key foci: A) physical and biogeochemical state; B) biota diversity and ecosystem functioning; C) carbon cycle; D) plastisphere; E) vessel performance and structural response; F) ethnography of Arctic Science. The specific objectives of the focal areas are: A1) characterize the thermo-aline properties and the biogeochemistry of water masses and sea-ice; A2) observe long-term changes of the sea-ice thickness distribution and it's regional variability across the Arctic Ocean, in continuation of our research on “Le Commandant Charcot” since 2021 and for the validation of satellite observations and climate models; B1) evaluate biota abundances and diversity, their distribution and stability; B2) further elucidate the biogeography of marine primary production by deploying the very first instrument that will enable high-resolution in situ measurements of primary productivity in the ocean, with the overall goal of improving our understanding of photosynthesis and its biogeochemical forcings, also in conjunction with ecophysiological measurements to ascertain the factors driving photosynthesis in the central Arctic; B3) quantifying how the remineralization processes vary in relation to production processes and nutrient availability; B4) estimate the biomass flux in the analyzed ecosystems; B5) monitor Arctic mammals

populations to assess their conservation status; C1) quantify the input and fate of organic carbon; C2) evaluate how much and if micro- and nanoplastics reduce the efficiency of the biological carbon pump; D1) determine the stock of microplastics in the marine environment and in the sea-ice, the associated microbial compartment, and the action of the latter by on-board incubation; D2) document the distribution and quantify the fluxes of anthropogenic nanoparticles and associated contaminants from and in between the different Arctic Ocean reservoirs (sea-ice, snow, water, microorganisms – phyto/zooplankton) through the purposeful development of innovative sampling methodologies and analytical instrumentation; E1) gain an understanding of environmental conditions in the Arctic to evaluate their impact on vessel performance and vessel structures in order to contribute to a long-term optimization of vessels operating in ice by reducing weight and emissions; F1) conduct an ethnographic study of scientific knowledge production on the Arctic cruise ship by examining the social and infrastructural aspects of the work of the CHARCOT project Science Team, including the interactions between the scientists, the Arctic environment, and the Vessel.

2. Narrative of the Cruise

6th September, 2024

The CHARCHOT team boarded the vessel on September 6 from the harbour of Nome (Alaska). In the afternoon, a meeting was held with the science officers and all other scientists on board, followed by a tour of the laboratories to assess the spaces and equipment to be used during the activities by the various research groups and an illustrative tour of the vessel was also carried out from the laboratories, to the work areas on the decks, and in general to all the common areas of the vessel.

Each Team began to assemble its equipment in the laboratories that had been agreed upon (Wet Laboratory, Dry Laboratory, Hangar at the stern) in a meeting before departure and following the pre-established scheme. Instrumentation for measuring Bioaerosol was assembled on deck 10 portside (Sample collection started on the same day) and other oceanographic equipment on the aft deck from where the instrumentation is lowered into the sea.

For continuous seawater measurements, the unpacking and installation of the GOPTICAS instrument and the automated underway partial pressure of carbon dioxide (pCO2) system in the wet lab have begun.

The Vessel Performance and Structural Response team performed a 12-month data download, maintenance and repair of existing temperature sensors and associated data loggers in the wetlab and waste room, as well as in the void spaces below. New installations of additional temperature sensors and a data logger were also performed in the void space next to the bow thruster room.

The ship set sail from the harbour of Nome at 14:00 PM (CEST).

7th September, 2024

On this day, Bioaerosol samplings continued on deck 10 portside and additionally 4 bioaerosol samplings from the bow of the ship were carried out. The automated system to measure the underway partial pressure of carbon dioxide (pCO_2) started collecting data.

Moreover, hydrological samplings from peristaltic pump (10 m) were carried out for biogeochemical and microbiological measurements, as well as the related sample treatments. From the same pump, the team dealing with microplastics the 1st incubation experiment was set up. Briefly, the surface seawater at the depth of 10 meter supplied by the ship's underway peristaltic pump was used for the incubation after passing through 1.6-µm glass filter. Then the filtered seawater in 5-L glass bottles were amended in three different ways : 1) 890 µl plastic-DOM; 2) 600 µl Glucose solution + 290 Milli-Q water; and 3) 890 Milli-Q water. Each treatment has two replicates. POC, DOC, DBC, plastic additive samples were started collecting. The samples were collected every 2-3 latitudes with extra samples for specific location.

On this day, the equipment for the ice stations was assembled. This included the Mobile Ice Strength Test Device (MISTD), the core drill and the devices for measuring the ice temperature and salinity.

The scientists continued to set-up the equipment (The Cassar lab finished installing the GOPTICAS instrument), participated in diverse meetings to organize the sampling plan. A part of the wet lab refrigerator was prepared to receive the nutrient amendment experiment (set-up of lights, timer).

8th September, 2024

During this day, Bioaerosol samplings continued on deck 10 portside and from the bow of the ship. Additionally, an air sampler for microplastic sampling was set up on deck 10 portside. Samples were collected ~24 hours, except for specific weather conditions or events.

Continuos data acquisitions with GOPTICAS instrument and the automated underway partial pressure of carbon dioxide (pCO2) system have begun. Moreover, hydrological samplings from the peristaltic pump were

carried out for chemical, biogeochemical, biological and microbiological measurements, as well as the related sample treatments. 15 L of seawater was collected through the peristaltic pump in order to start a nutrient amendment experiment. The experiment was set-up in the fridge, for approximately 3.5 days, under low light conditions (20:4 light:dark cycle).

The team dealing with microplastics finished the incubation experiment started the previous day after 12 hours. 4 ml incubation seawater from each bottle was fixed with 1 ml 0.2-um filtered 5% paraformaldehyde for cell count. eDNA were then collected by filtering the remained seawater in each glass bottle through a SterivexTM filter. After collecting eDNA, 20 ml seawater was acidified to pH 2 using HCl (HPLC grade) for the dissolved organic carbon analysis. Finally, the rest incubation seawater was acidified to pH 2 using HCl, and solid-phase-extracted using PPL for measuring molecular signatures.

The team dealing with nanoplastics and nano-iron particles has carried out the first sampling.

On the same day, the Dynamic Motion Unit (DMU) was installed at the bow winch station, to record the ship's motions.

9th September, 2024

On this day, scientific officers tested the functionality of the Rosette system for collecting water samples at different depths. Unfortunately, the test was not successful, and it was decided to conduct additional tests during the cruise.

Bioaerosol and Microplastic samplings continued on deck 10 portside and Bioaerosol from the bow of the ship. Data acquisitions with GOPTICAS instrument and the automated underway partial pressure of carbon dioxide (pCO2) system have continued. Moreover, hydrological samplings from the peristaltic pump were carried out for chemical, biogeochemical, biological and microbiological measurements, as well as the related sample treatments.

A first station was set up for the collection of phytoplankton and zooplankton with nets, as well as the collection of sea water with Niskin bottles and a first acquisition with the CTD. The nets were deployed when the ship was stationary. The phytoplankton and zooplankton nets were lowered to a depth of respectively 30 and 50 meters. The Niskins bottles allowed gaining water samples from the sea surface and 50 m of depth. The water from the Niskin bottles was filtered for DNA analysis, and an unfiltered sample was taken to analyze the phytoplankton community under the microscope. The contents of the plankton nets were fractioned using gauze with different mesh sizes, and the solid phase was extracted via centrifuge, allowing later on, in the lab, the analysis for toxins. All samples were frozen at -20°C for storage and transport, apart from the phytoplankton live samples, that were kept in the fridge under low light settings.

The team working on microplastics set up the 2nd incubation experiment. Furthermore, the manta net was devoted to collecting floating microplastics for the 'Plastisphere' research. In general, a Zodiac was used to tow the net away from the M/V Le Commandant Charcot. A beam was fixed on the Zodiac. The manta net was hung to the beam and towed 25~40 min to concentrate the particles at the sea surface. At each station, two nets were towed. Potential microplastics for 'Plastisphere' analysis were saved in RNAlater.

The team dealing with nanoplastics and nano-iron particles has carried out other samplings including through use by Zodiac.

Two specimens of polar bear (Ursus maritimus) were sighted.

During this day, the Installation, calibration and start of continuous measurements of the Sea Ice Monitoring System (SIMS) and visual recordings (cameras) were made. In addition, the continuous measurements of the Dynamic Motion Unit (DMU) were started. The First Ice Station (CH-ICE-S01) was carried out. Zodiac landed on two small ice floes in the MIZ. On the first floe, one ice core was taken to determine the temperature and salinity profile and one core was taken to determine the strength. The temperature profile was determined directly. The subsequent analysis of the strength and salinity of the ice cores was carried out on board outside

at the aft winch station. On both ice floes, the thickness profile of the ice floe was determined by measuring the thickness in boreholes.
In the afternoon, Dr. Maurizio Azzaro (PI of the CHARCOT project) and all lead scientists of the participating research groups presented to passengers the activities planned for the scientific data collection campaign as part of the CHARCOT project in the Vessel's theater.

10th September, 2024

On this day, Bioaerosol and Microplastic samplings continued on deck 10 portside and Bioaerosol from the bow of the ship.
Data acquisitions with GOPTICAS instrument and the automated underway partial pressure of carbon dioxide (pCO2) system have continued. Moreover, hydrological samplings from the peristaltic pump were carried out for chemical, biogeochemical, biological and microbiological measurements, as well as the related sample treatments.
A second station was set up for the collection of phytoplankton and zooplankton with nets, as well as the collection of sea water with Niskin bottles and a acquisition with the CTD.
The 2nd incubation experiment with microplastics was ended and samples were collected.
The team dealing with nanoplastics and nano-iron particles has carried out another sampling.
During this day a first constant power test (CH-ICE-T01) was done. To do this, the ship traveled a straight course on autopilot with a specified, constant propulsion power and parameters such as the ship's speed and ice thickness were logged.

11th September, 2024

During this day, Bioaerosol and Microplastic samplings continued on deck 10 portside and Bioaerosol from the bow of the ship. Bioaerosol sampling was also done on the pack ice.
Data acquisitions with GOPTICAS instrument has continued. The pCO_2 system was turned off while transiting through the sea ice. Moreover, hydrological samplings from the peristaltic pump were carried out for chemical, biogeochemical, biological and microbiological measurements, as well as the related sample treatments.
The first hydrological station was made by Niskin bottles and the CTD up to 900 m depth; water samples were collected, and depending on the oceanographic measurement (chemical, biogeochemical, biological and microbiological) processed, filtered, pre-treated, fixed and cataloged for subsequent analysis. At the same station, the collection of phytoplankton and zooplankton with nets was carried out.
Seawater samples were also taken from a hole on the pack ice.
Unfortunately there was no time to collect microplastics with the manta due to lack of ship time. The team dealing with nanoplastics and nano-iron particles has done other sampling including under the sea ice.
During this day a second constant power test (CH-ICE-T02) was done. For test description see 10.09.
The Second Ice station(CH-ICE-S02) was carried out. Ship landed on an ice floe. One ice core was taken to determine the temperature and salinity profile and strength and one core was taken to determine the strength. The temperature profile and the strength were determined directly. For the subsequent analysis of the ice core's salinity, it was sawn into sections and brought on board. The thickness profile of the ice floe was determined by measuring the thickness in boreholes and with an EM sensor.
Using the core drilling holes, seawater samples were also taken from a hole on the pack ice.

12th September, 2024

On this day, Le Commandant Charcot reached the Arctic Pole of inaccessibility (85°48’ N - 176°09’ E). Bioaerosol and Microplastic samplings continued on deck 10 portside and Bioaerosol from the bow of the ship .

Data acquisitions with GOPTICAS instrument has continued. The pCO_2 system was turned off while transiting through the sea ice. Moreover, hydrological samplings from the peristaltic pump were carried out for chemical, biogeochemical, biological and microbiological measurements, as well as the related sample treatments. An hydrological sampling (CH-P23) from peristaltic pump was not conducted due to the ice thickness, which prevented the pump from being activated.
A new incubation for the nutrient amendment experiment was launched.
It was not possible to use either nets or Niskin bottles due to the ice.
The microplastic Team set up the 3rd incubation experiment. The ship entered the ice region and the manta net was not able to be towed. Whenever there was an opportunity to land on the ice, snow samples were collected for plastic additives analysis.
The team dealing with nanoplastics and nano-iron particles has carried another sampling.
During this day a third constant power test (CH-ICE-T03) (For test description see 10.09) was done. Measurement of the salinity were made on ice core sections extracted on 10./11.09. and melted in the meantime.

13th September, 2024
During this day, Le Commandant Charcot reached the Magnetic North Pole (85°51.2' N - 139°28.5' E). Bioaerosol and Microplastic samplings continued on deck 10 portside and Bioaerosol from the bow of the ship. Bioaerosol sampling was also done on the pack ice.
Data acquisitions with GOPTICAS instrument and the automated underway partial pressure of carbon dioxide (pCO2) system have continued. Moreover, hydrological samplings from the peristaltic pump were carried out for chemical, biogeochemical, biological and microbiological measurements, as well as the related sample treatments.
A second hydrological station was made by Niskin bottles and the CTD. Seawater samples were collected, and depending on the oceanographic measurement (chemical, biogeochemical, biological and microbiological) processed, filtered, pre-treated, fixed and cataloged for subsequent analysis. At the same station, the collection of phytoplankton and zooplankton with nets was carried out.
On this day, the microplastics team the 3rd incubation experiment was ended and other samples were collected.
The team dealing with nanoplastics and nano-iron particles has carried other samplings.
During this day a third Ice station (CH-ICE-S03) was done. Ship landed on an ice floe. Two different areas separated by an ice ridge were analysed here: at the first position one ice core was taken to determine the temperature and salinity profile, one ice core was taken to determine the temperature and salinity profile and strength and one core was taken to determine the strength; at the second position one ice core was taken to determine the temperature and salinity profile and strength and one core was taken to determine the strength. The temperature profile and the strength were determined directly in all cases. For the subsequent analysis of the ice core's salinity, they were sawn into sections and brought on board. The thickness profile of the ice floe was determined by measuring the thickness in boreholes and with an EM sensor. A Fourth constant power test (CH-ICE-T04) was done (For test description see 10.09).
Snow samples were also taken from the pack ice and using the core drilling holes, seawater samples were also taken from a hole on the pack ice.

14th September, 2024
On this day, Bioaerosol and Microplastic samplings continued on deck 10 portside and Bioaerosol from the bow of the ship, as well as the related sample treatments.

Data acquisitions with GOPTICAS instrument and the automated underway partial pressure of carbon dioxide (pCO2) system have continued. Moreover, hydrological samplings from the peristaltic pump were carried out for chemical, biogeochemical, biological and microbiological measurements, as well as the related sample treatments.
No sampling activity for the two teams dealing with microplastics and nanoplastics/nano-iron particles, respectively.
Measurement of the salinity were made on ice core sections extracted on 13.09. and melted in the meantime.

15th September, 2024

In the afternoon, Le Commandant Charcot reached the Geographic North Pole Pole. On this day, Bioaerosol and Microplastic samplings continued on deck 10 portside and Bioaerosol from the bow of the ship, as well as the related sample treatments. Bioaerosol sampling was also done on the pack ice.
Data acquisitions with GOPTICAS instrument and the automated underway partial pressure of carbon dioxide (pCO2) system have continued. Moreover, hydrological samplings from the peristaltic pump were carried out for chemical, biogeochemical, biological and microbiological measurements, as well as the related sample treatments.
A third hydrological station was made by Niskin bottles and the CTD. Seawater samples were collected, and depending on the oceanographic measurement (chemical, biogeochemical, biological and microbiological) processed, filtered, pre-treated, fixed and cataloged for subsequent analysis. At the same station, the collection of phytoplankton and zooplankton with nets was carried out.
The microplastic Team set up the 4th incubation experiment. The team dealing with nanoplastics and nano-iron particles has carried other samplings.
During this day a fourth Ice station (CH-ICE-S04) was done. Ship landed on an ice floe. One ice core was taken to determine the temperature and salinity profile and strength and three cores were taken to determine the strength. The temperature profile and the strength were determined directly. For the subsequent analysis of the ice core's salinity, it was sawn into sections and brought on board. The thickness profile of the ice floe was determined by measuring the thickness in boreholes and with an EM sensor.
Snow samples were also taken from the pack ice and using the core drilling holes, seawater samples were also taken from a hole on the pack ice.

16th September, 2024

During this day, Bioaerosol and Microplastic samplings continued on deck 10 portside and Bioaerosol from the bow of the ship, as well as the related sample treatments. Bioaerosol sampling was also done on the pack ice. Bioaerosol sampling was also done on the pack ice.
Data acquisitions with GOPTICAS instrument and the automated underway partial pressure of carbon dioxide (pCO2) system have continued. Moreover, hydrological samplings from peristaltic the pump were carried out for chemical, biogeochemical, biological and microbiological measurements, as well as the related sample treatments. A new incubation for the nutrient amendment experiment was launched.
The 4th incubation experiment with microplastics was ended and samples were collected.
During this day a fifth Ice station(CH-ICE-S05) was done. The ship was still at the ice floe from the previous day. In order to gain further insights, the team was taken with the SHERP behind an ice ridge further away from the ship, assuming that this was initially another ice floe. One ice core was taken to determine the temperature and salinity profile and four cores were taken to determine the strength. The temperature profile and the strength were determined directly. For the subsequent analysis of the ice core's salinity, it was sawn into sections and brought on board. The thickness profile of the ice floe was determined by measuring the thickness in boreholes and with an EM sensor.

Snow samples were also taken from the pack ice and using the core drilling holes, seawater samples were also taken from a hole on the pack ice.

17th September, 2024

On this day, Bioaerosol and Microplastic samplings continued on deck 10 portside and Bioaerosol from the bow of the ship, as well as the related sample treatments.
Data acquisitions with GOPTICAS instrument has continued. No pCO2 data collected on this day (pumps off). Moreover, hydrological samplings from the peristaltic pump were carried out for chemical, biogeochemical, biological and microbiological measurements, as well as the related sample treatments.
The ship was moving fast and no new research activities for microplastics was performed. The team dealing with nanoplastics and nano-iron particles has carried another sampling.
A fifth constant power test (CH-ICE-T05) was done (For test description see 10.09). Measurement of the salinity were made on ice core sections extracted on 15./16.09. and melted in the meantime.

18th September, 2024

During this day, Bioaerosol and Microplastic samplings continued on deck 10 portside and Bioaerosol from the bow of the ship, as well as the related sample treatments. Bioaerosol sampling was also done on the pack ice.
Data acquisitions with GOPTICAS instrument and the automated underway partial pressure of carbon dioxide (pCO2) system have continued. Moreover, hydrological samplings from the peristaltic pump were carried out for chemical, biogeochemical, biological and microbiological measurements, as well as the related sample treatments. A new incubation for the nutrient amendment experiment was launched.
The 4th incubation experiment with microplastics was ended and samples were collected.
A fourth hydrological station was made by Niskin bottles and the CTD. Seawater samples were collected, and depending on the oceanographic measurement (chemical, biogeochemical, biological and microbiological) processed, filtered, pre-treated, fixed and cataloged for subsequent analysis. At the same station, the collection of phytoplankton and zooplankton with nets was carried out.
The microplastic team set up the 5th incubation experiment. The team dealing with nanoplastics and nano-iron particles has carried other samplings.
During this day a sixth Ice station (CH-ICE-S06) was done. Ship landed on an ice floe. Two ice cores were taken to determine the temperature and salinity profile and seven cores were taken to determine the strength. The temperature profile and the strength were determined directly. For the subsequent analysis of the ice core's salinity, it was sawn into sections and brought on board. The thickness profile of the ice floe was determined by measuring the thickness in boreholes and with an EM sensor. A sixth constant power test (CH-ICE-T06) was done (For test description see 10.09).
Snow samples were also taken from the pack ice and using the core drilling holes, seawater samples were also taken from a hole on the pack ice.

19th September, 2024

On this day, Bioaerosol and Microplastic samplings continued on deck 10 portside and Bioaerosol from the bow of the ship, as well as the related sample treatments.
Data acquisitions with GOPTICAS instrument and the automated underway partial pressure of carbon dioxide (pCO2) system have continued. Moreover, hydrological samplings from the peristaltic pump were carried out for chemical, biogeochemical, biological and microbiological measurements, as well as the related sample treatments.
The 5th incubation experiment with microplastics was ended and samples were collected. The team dealing with nanoplastics and nano-iron particles has carried another sampling.

Four specimens of polar bear (Ursus maritimus) were sighted, a group of three specimens (mom and two puppies) and a one specimen alone.
A Seventh constant power test (CH-ICE-T07) was done (For test description see 10.09). Measurement of the salinity were made on ice core sections extracted on 18.09. and melted in the meantime.

20th September, 2024

During this day, Bioaerosol and Microplastic samplings continued on deck 10 portside and Bioaerosol from the bow of the ship, as well as the related sample treatments. Bioaerosol sampling was also done on the pack ice. Data acquisitions with GOPTICAS instrument and the automated underway partial pressure of carbon dioxide (pCO2) system have continued. Moreover, hydrological samplings from the peristaltic pump were carried out for chemical, biogeochemical, biological and microbiological measurements, as well as the related sample treatments. A new incubation for the nutrient amendment experiment was launched.
A fifth hydrological station was made by Niskin bottles and the CTD. Seawater samples were collected, and depending on the oceanographic measurement (chemical, biogeochemical, biological and microbiological) processed, filtered, pre-treated, fixed and cataloged for subsequent analysis. At the same station, the collection of phytoplankton and zooplankton with nets was carried out.
The 6th incubation experiment with microplastics was set up and the 2nd Manta Net station was done. The team dealing with nanoplastics and nano-iron particles has carried other samplings.
During this day a seventh Ice station(CH-ICE-S07): Zodiac landing on one small ice floe in the MIZ. One ice core was taken to determine the temperature and salinity profile and the strength and one core was taken to determine only the strength. The temperature profile was determined directly. The subsequent analysis of the strength and salinity of the ice cores was carried out on board. Continuous measurements of the Sea Ice Monitoring System (SIMS), Dynamic Motion Unit (DMU) and visual recordings (Cameras) have been stopped.

21st September, 2024

On this day, Bioaerosol and Microplastic samplings continued on deck 10 portside and Bioaerosol from the bow of the ship, as well as the related sample treatments. The bioaerosol sampling from the bow of the ship was completed on this day because the device was damaged, making it impossible to continue sampling until the end of the cruise
Data acquisitions with GOPTICAS instrument and the automated underway partial pressure of carbon dioxide (pCO2) system have continued. Moreover, hydrological samplings from the peristaltic pump were carried out for chemical, biogeochemical, biological and microbiological measurements, as well as the related sample treatments.
Two hydrological stations (sixth and seventh) were made by Niskin bottles and the CTD. Seawater samples were collected, and depending on the oceanographic measurement (chemical, biogeochemical, biological and microbiological) processed, filtered, pre-treated, fixed and cataloged for subsequent analysis. At the same station, the collection of phytoplankton and zooplankton with nets was carried out.
The 6th incubation experiment with microplastics was ended and samples were collected. The 3rd Manta Net station was done. A first on-shore survey for macroplastics along the landed coast has been carried out. The team dealing with nanoplastics and nano-iron particles has carried other samplings.
On this day the equipment for the ice stations (MISTD and core drills) was cleaned and dried.

22nd September, 2024

During this day, Bioaerosol and Microplastic samplings continued on deck 10 portside, as well as the related sample treatments.

Data acquisitions with GOPTICAS instrument and the automated underway partial pressure of carbon dioxide (pCO2) system have continued. Moreover, hydrological samplings from the peristaltic pump were carried out for chemical, biogeochemical, biological and microbiological measurements, as well as the related sample treatments.
A eighth hydrological station was made by Niskin bottles and the CTD. Seawater samples were collected, and depending on the oceanographic measurement (chemical, biogeochemical, biological and microbiological) processed, filtered, pre-treated, fixed and cataloged for subsequent analysis. At the same station, the collection of phytoplankton and zooplankton with nets was carried out.
The 7th incubation experiment with microplastics was set up and the 4th Manta Net station was done. A second on-shore survey for macroplastics along the landed coast has been carried out. The team dealing with nanoplastics and nano-iron particles has carried the last samplings of the cruise.
Measurement of the salinity were made on ice core sections extracted on 20.09. and melted in the meantime.

23rd September, 2024

On this day, Bioaerosol and Microplastic samplings continued on deck 10 portside, as well as the related sample treatments.
Data acquisitions with GOPTICAS instrument and the automated underway partial pressure of carbon dioxide (pCO2) system have continued. Moreover, hydrological samplings from the peristaltic pump were carried out for chemical, biogeochemical, biological and microbiological measurements, as well as the related sample treatments.
The 7th incubation experiment with microplastics was ended and samples were collected. The 5th Manta Net station was done. The third and fourth survey on shore for macroplastics along the landed coast have been carried out.
The Vessel Performance and Structural Response team took care of the data collection and preliminary plausibility checks.

24th September, 2024

During this day, Bioaerosol and Microplastic samplings continued on deck 10 portside, as well as the related sample treatments.
Data acquisitions with GOPTICAS instrument and the automated underway partial pressure of carbon dioxide (pCO2) system have continued. Moreover, hydrological samplings from peristaltic pump were carried out for chemical, biogeochemical, biological and microbiological measurements, as well as the related sample treatments.
A ninth hydrological station was made by Niskin bottles and the CTD. Seawater samples were collected, and depending on the oceanographic measurement (chemical, biogeochemical and biological) processed, filtered, pre-treated, fixed and cataloged for subsequent analysis. At the same station, the collection of phytoplankton and zooplankton with nets was carried out. The nets had been cleaned and rinsed after the morning station, in order to prepare the packing and transportation.
The 6th Manta Net station for the collection of microplastics was done.
The Vessel Performance and Structural Response team took care of the data collection and preliminary plausibility checks and preparation of constant power tests for the following cruise, where a higher data resolution is available.

25th September, 2024

On this day, Dr. Maurizio Azzaro, as PI of the project and all responsables of the research groups illustrated in the Vessel's theater the activities carried out during the cruise period as part of the CHARCOT project.

Bioaerosol and Microplastic samplings continued on deck 10 portside for the last day.
Data acquisitions with GOPTICAS instrument and the automated underway partial pressure of carbon dioxide (pCO2) system were stopped on this day. Hydrological samplings from the peristaltic pump were also carried out for chemical, biogeochemical, biological and microbiological measurements for the last day.
In the afternoon, a Fin whale (*Balaenoptera physalus*) were sighted.
The Vessel Performance and Structural Response team took care of the data download of the cruise for all temperature data loggers in the wetlab and garbage treatment room as well as the void spaces below and in the void space next to the bow truster room.
This day was spent by all teams packing the equipment and preparing the disembarkation the next day. All the boxes were displayed in pallets, strapped and labeled for their return in the various scientific institutions. Furthermore, the refrigerated and non-refrigerated samples of each team were well packaged. All the ship's oceanographic data were copied by scientists.

26th September, 2024

The cruise concluded in Longyearbyen on September 26, 2024, marked by the disembarkation of scientific personnel from the vessel “Le Commandant Charcot”. The CHARCOT scientific team landed between 10:00am and noon.

3. Science Activity

3.1 Water and Plankton Sampling

3.1.1 CTD Measurements, Seawater Sampling and Plankton Sampling

AZZARO Lab:

MICROBIOLOGY

Science lead: Maurizio Azzaro (Institute of Polar Sciences)
Scientist on board: Maurizio Azzaro, Francesco Filiciotto (Institute of Polar Sciences), Alessandro Ciro Rappazzo (Institute of Polar Sciences), Federico Citterich (Institute of Polar Sciences)

In total, the following activities were carried out during the entire cruise: 5 hydrological stations at different depths along the water column (Tab. 1), 70 hydrological samplings from peristaltic pump at a depth of 9 m (Table 2) and 7 ice stations (Table 3).

During the cruise seawater samples were taken at 9 stations (Tab.1) at fixed depths. Sampling was carried out using Niskin bottles (8L capacity) and a CTD connected to a nautical rope and by the use of a winch. The water samples, once taken were pretreated on board for the analysis concerning the project, namely nutrients (Ammonium, NH4; Nitrite, NO2; Nitrate, NO3; Phosphate, PO4; dissolved inorganic nitrogen (DIN) and phosphorus (DIP); Total Phosphorous/Nitrogen, TN-TP), viral abundance (Virus; Cytometry), prokaryotic abundance and biomass (DAPI; Cytometry, Epifluorescence Microscopy), Bacterial Viability (Live/Dead), size-fractionated Chlorophyll a (CHL a; 0.2-2µm; 2-10µm; 10-200µm; spectrofluorimetric analysis), molecular detection of the prokaryotic phylogenetic composition and metabolic potential (DNA/RNA; next generation sequencing), Cultivable Bacteria, respiring cells (CTC), Metabolic profiles (Biolog), Particulate and dissolved organic matter remineralization (ETS). In addition, CTD probe recorded physical-chemical parameters (temperature, conductivity, pressure, oxygen, turbidity) (Table 1).

Table 1. Hydrological stations (Niskin bottles, CTD) sampled by the AZZARO Lab during the CHARCOT project.

TABLE 1	Date	Time	Latitude	Longitude	Gear	Remarks/Recovery
Station No.	2024	[UTC]	[°N]	[°E/°W]		Depth (m)
CH-W1	11.09	16:54	84°12'25.39''	173°33'42.74'' W	Niskin/CTD	-1; -50; -100; -200; -500; -900 m
CH-W2	15.09	19:28	89°54'11.89''	46°52'19.78''W	Niskin/CTD	-1; -50; -100; -200; -500; -900 m
CH-W3	18.09	01:21	85°43'40.23''	30°58'8.54''E	Niskin/CTD	-1; -50; -100; -200; -500; -900 m
CH-W4	20.09	14:32	82°37'25.63''	19°49'48.29''E	Niskin/CTD	-1; -50; -100; -200 m
CH-W5	21.09	23:23	79°36'50.64''	19°25'13.59''E	Niskin/CTD	-1; -50; -100; -200 m

Water samples for determining nutrients (Ammonium, NH4; Nitrite, NO2; Nitrate, NO3; Phosphate, PO4; dissolved inorganic nitrogen (DIN) and phosphorus (DIP); Total Phosphorous/Nitrogen, TN-TP), size-fractionated Chlorophyll a (CHL a; 0.2-2µm; 2-10µm; spectrofluorimetric analysis), molecular detection of the prokaryotic phylogenetic composition and metabolic potential (DNA/RNA; next generation sequencing), Cultivable Bacteria, respiring cells (CTC) were also sampled by peristalitic pump every 6 hours from 7 to 24 September (Ferrybox, Tab. 2). These latest samplings were done in synergy with the **CASSAR Lab**.

Table 2. Collection of surface samples (9 m depth) taken with pertistalc pump (Ferrybox) by the AZZARO Lab.

TABLE 3 Station No.	Date	Time Start [UTC]	Latitude	Longitude
CH-P1	07/09/24	06:10	64°38'3.37" N	167°17'53.96" W

CH-P2	07/09/24	11:56	65°42'19.29"N	168°25'0.12"W
CH-P3	07/09/24	17:55	67°9'54.08"N	168°27'19.41"W
CH-P4	07/09/24	23:59	68°36'9.49"N	168°27'52.61"W
CH-P5	08/09/24	05:57	69°58'47.82"N	168°28'37.87"W
CH-P6	08/09/24	11:56	71°20'57.46"N	168°21'1.06"W
CH-P7	08/09/24	17:59	72°44'18.74"N	168°31'40.68"W
CH-P8	09/09/24	00:00	73°50'23.46"N	167°46'18.71"W
CH-P9	09/09/24	06:01	74°59'25.31"N	166°1'6.13"W
CH-P10	09/09/24	12:00	76°5'36.01"N	164°19'6.60"W
CH-P11	09/09/24	18:36	77°9'6.15"N	164°20'50.07"W
CH-P12	10/09/24	00:00	77°33'42.30"N	164°29'43.46"W
CH-P13	10/09/24	06:05	78°42'21.68°N	163.29'30.22"W
CH-P14	10/09/24	12:02	79°45'47.29"N	165°48'10.28"W
CH-P15	10/09/24	17:50	80°41'59.74"N	164°37'32.30"W
CH-P16	10/09/24	23:48	81°33'6.46"N	167°20'53.92"W
CH-P17	11/09/24	11:52	82°19'53.33"N	168°20'30.96"W
CH-P18	11/09/24	11:52	83°24'37.63"N	170°57'15.75"N
CH-P19	11/09/24	18:14	84°12'22.40"N	173°33'16.05"N
CH-P20	11/09/24	23:58	84°26'52.79"N	174°49'26.41"W
CH-P21	12/09/24	05:53	85°8'58.57"N	178°14'4.57"W
CH-P22	12/09/24	12:00	85'41'51.69"N	177°38'5.81"E
CH-P23	Sample CH-P23 was not collected due to the ice thickness, which prevented the pump from being activated			
CH-P24	12/09/24	23:42	86°3'6.21"N	161°38'49.92"E
CH-P25	13/09/24	06:09	86°0'41.00"N	146°6'26.49"E
CH-P26	13/09/24	12:09	85°50'39.12"N	139°55'16.71"E
CH-P27	13/09/24	18:25	85°51'16.06"N	139°1'13.60"E
CH-P28	14/09/24	00:02	85°55'18.44"N	139°1'8.00"E
CH-P29	14/09/24	06:07	86°38'11.11"N	140°34'5.92"E
CH-P30	14/09/24	11:58	87°30'45.95"N	139°13'36.88"E
CH-P31	14/09/24	18:14	88°25'58.46"N	140°58'7.17"E
CH-P32	15/09/24	00:02	89°14'7.73"N	148°18'59.83"E
CH-P33	15/09/24	06:26	89°59'45.49"N	25°52'32.31"E
CH-P34	15/09/24	12:13	89°58'34.50"N	26°42'12.89"E
CH-P35	15/09/24	18:23	89°53'50.85"N	43°3'38.88"W
CH-P36	15/09/24	23:57	89°52°2.09"N	27°16'51.26"W
CH-P37	16/09/24	05:59	89°49'42.21°N	15°42'25.46"W
CH-P38	16/09/24	12:07	89°47'54.76"N	8°47"28.11"W
CH-P39	16/09/24	18:01	89°46'1.74"N	5°8'5.39"W
CH-P40	17/09/24	00:05	89°59'33.49"N	50°1'42.72"E
CH-P41	17/09/24	06:04	89°28'5.95"N	13°41'43.23"E
CH-P42	17/09/24	12:04	88°37'59.96"N	19°11'10.57"E
CH-P43	17/09/24	17:58	87°58'0.93"N	26°29'2.55"E
CH-P44	18/09/24	00:18	87°15'32.84"N	34°56'35.28"E
CH-P45	18/09/24	06:01	86°38'56.73"N	33°51'9.23"E
CH-P46	18/09/24	12:12	85°50'10.72"N	32°15'37.34"E

CH-P47	18/09/24	18:06	85°44'1.41"N	30°45"48.67"E
CH-P48	19/09/24	00:09	85°8'20.20"N	28°26'30.73"E
CH-P49	19/09/24	05:57	84°34'10.81"N	26°22'21.43"E
CH-P50	19/09/24	12:01	84°8'41.68"N	27°4'10.69"E
CH-P51	19/09/24	17:57	83°47'52.59"N	27°30'45.93"E
CH-P52	19/09/24	23:54	83°11'49.90"N	25°58'22.21"E
CH-P53	20/09/24	06:14	82°44'3.69"N	19°48'32.09"E
CH-P54	20/09/24	12:04	82°37'54.55"N	19°51'57.87"E
CH-P55	20/09/24	17:59	81°55'15.45"N	18°13'1.16"E
CH-P56	20/09/24	23:55	80°23'24.24"N	16°42'40.41"E
CH-P57	21/09/24	06:28	79°42'34.43"N	21°46'12.00"E
CH-P58	21/09/24	11:58	79°48'15.58"N	21°25'35.78"E
CH-P59	21/09/24	17:55	79°43'9.94"N	21°20'5.86"E
CH-P60	21/09/24	23:51	79°33'43.07"N	19°34'20.47"E
CH-P61	22/09/24	05:57	79°21'12.62"N	20°45'44.00"E
CH-P62	22/09/24	12:04	79°11'47.43"N	22°34'35.75"E
CH-P63	22/09/24	18:05	78°58'41.50"N	22°19'7.97"E
CH-P64	22/09/24	23:55	78°45'15.13"N	22°36'47.28"E
CH-P65	23/09/24	05:59	78°12'22.07"N	20°57'12.41"E
CH-P66	23/09/24	11:57	78°5'11.76"N	20°44'42.09"E
CH-P67	23/09/24	18:00	78°5'36.37"N	19°59'39.97"E
CH-P68	23/09/24	23:57	78°5'44.91"N	19°14'6.68"E
CH-P69	24/09/24	05:55	78°33'31.89"N	19°11'01.03"E
CH-P70	24/09/24	11:57	78°25'18.00"N	19'21'20.07"E

Water samples for determining nutrients (Ammonium, NH4; Nitrite, NO2; Nitrate, NO3; Phosphate, PO4; dissolved inorganic nitrogen (DIN) and phosphorus (DIP); Total Phosphorous/Nitrogen, TN-TP), size-fractionated Chlorophyll a (CHL a; 0.2-2µm; 2-10µm; spectrofluorimetric analysis), molecular detection of the prokaryotic phylogenetic composition and metabolic potential (DNA/RNA; next generation sequencing), Cultivable Bacteria, respiring cells (CTC) were also sampled under the pack ice (Table 3).

Table 3. ice stations.

TABLE 3	**Date**	**Time (start)**	**Time (end)**	**Temperature**	**Humidity**	**Air Pressure**	**Longitude**	**Longitude**
Station No.	**2024**	**[UTC]**	**[UTC]**	**[°C]**	**[%]**	**[hPa]**	**[°N]**	**[°E/°W]**
CH-Bice 1	11.09	18:10	19:18	-3	98	1011	84°12'25.39''N	173°33'42.74''W
CH-Wice 1								
CH-Nice 1								
CH-Bice 2	13.09	16:00	16:50	-8.4	96	1025.5	85°51'10.34''N	139°9'18.87''E
CH-Wice 2								

CH-Nice 2								
CH-Bice 3	15.09	17:16	18:10	-4.4	91	908.5	89°54'11.89''N	46°52'19.78''W
CH-Wice 3								
CH-Nice 3								
CH-Bice 4	16.09	10:40	12:10				89°47'21.53''N	6°55'2.95''E
CH-Wice 4								
CH-Nice 4								
CH-Bice 5	18.09	14:47	15:50	-6.7	100	1017.3	85°43'40.23''N	30°58'8.54''E
CH-Wice 5								
CH-Nice 5								

CASSAR Lab:

GOPTICAS

Science lead: Nicolas Cassar (Duke University)
Scientist on board: Nicolas Cassar (Duke University), Alireza Merikhi, (Duke University)

The Cassar lab deployed its new underway instrument (GOPTICAS) for the first time to measure gross primary production (GPP) with high resolution under ice. To calibrate the recordings of this instrument, the Cassar lab took discrete water samples to assess using the traditional method (DI-IRMS). They also designed three other side projects to measure oxygen isotope composition of water molecules in different water depths, in and under sea ice, and on glacier system of Svalbard. Seawater oxygen isotope ratios are the base for GPP measurements by our newly developed instrument and thus understanding the variability in oxygen isotopes helps unravel new insights about GPP. The CASSAR lab was maintaining the GOPTICAS from the beginning to the end of the cruise. The Cassar lab sampled water from Niskin casts on (9/11/2024 4:40UTC), (9/11/2024 19:18UTC CH-W1), (9/15/2024 18:10UTC CH-W2), and (9/18/2024 15:50UTC CH-W3). They froze the samples after coming back from the cruise to prevent evaporation that impacts the measurements, and they will try to analyze these samples as soon as possible.

In addition to the Niskin casts, the Cassar lab sampled top, and bottom of the ice cores and water under ice to characterize the isotopic composition of the H2O molecule.

The Cassar lab also sampled water from streams, ponds, and glaciers of multiple islands in Svalbard archipelago. They will measure the oxygen isotope ratios of H2O in these water samples.

Underway pCO_2 Analyses

Science lead: Denis Pierrot (AOML/NOAA)
Scientist on board: Leticia Barbero (University of Miami-AOML/NOAA)

An automated underway partial pressure of carbon dioxide (pCO2) system from NOAA's Atlantic Oceanographic and Meteorological Laboratory (AOML) was situated in the wetlab during Le Commandant Charcot's Transarctic crossing. The instrumental design follows principles outlined in Wanninkhof and Thoning

(1993) and Feely et al. (1998), with detailed descriptions of the instrument and data processing found in Pierrot et al. (2009). This permanently installed system operates on a repeating cycle, analyzing four gas standards, five ambient air samples, and 100 headspace samples from its equilibrator within a 4.8-hour period.

The standard gases, ranging from 283 to 539 ppm CO2 in compressed natural air, were purchased from NOAA/ESRL in Boulder, Colorado, and are directly traceable to the World Meteorological Organization (WMO) scale.

The system features an equilibrator where approximately 0.6 liters of continuously refreshed surface seawater, drawn from the bow intake, is equilibrated with 0.8 liters of gaseous headspace. The water flow rate through the equilibrator (1.7-2.2 liters/min) generated a spray pattern during the cruise.

The equilibrator headspace circulates through a non-dispersive infrared (IR) analyzer (LI-COR™ model 6262) before returning to the equilibrator. When analyzing ambient air or standard gas, the analyzer vents the gas leaving it to the lab. A KNF pump continuously draws 6-8 liters/min of marine air through 100 meters of 0.95 cm diameter Dekoron™ tubing, which has an intake on the bow mast equipped with a rain guard and a glass wool filter to prevent water and large particles from reaching the pump. The headspace and marine air are dried before flushing the IR analyzer.

A custom LabView™ program controls the system, providing a graphical display of air and water results. This program meticulously records the output of the infrared analyzer, GPS position, water and gas flows, water and air temperatures, internal and external pressures, and data from various other sensors for each analysis.

The automated pCO2 system functioned well throughout most of the cruise, except during ice transits when the peristaltic pump was turned off, requiring the system to be shut down. While off, the system underwent troubleshooting and routine maintenance procedures. Currently, the data is being processed at the AOML lab in Miami, Florida. Following quality checks, the data will be made publicly available on the AOML ocean carbon group's website (https://www.aoml.noaa.gov/ocd/ocdweb/charcot/charcot_introduction.html) and international repositories for public access (https://www.ncei.noaa.gov/access/ocean-carbon-acidification-data-system/oceans/VOS_Program/Charcot.html).

Discrete inorganic carbon samples

Science lead: Leticia Barbero (University of Miami-AOML/NOAA)
Scientist on board: Leticia Barbero (University of Miami-AOML/NOAA)

a) Sample collection:

Samples were collected according to the procedures outlined in the Guide to Best Practices for Ocean CO2 Measurements (Dickson et al., 2007). Seawater samples were drawn from Niskin bottles or the underway system on the Charcot and transferred into cleaned 500-ml glass bottles. To minimize bubble entrainment, the bottles were filled from the bottom, leaving a 6-ml headspace. After adding 0.2 ml of saturated HgCl2 solution as a preservative, the sample bottles were sealed with glass stoppers lightly coated with Apiezon-L grease and stored at room temperature for subsequent analysis in the lab back on land (Table 4).

Table 4. Samples collected during the cruise.

Type	station	sample ID	date	time (UTC)	Latitude, N	Longitude, E	Sample depth
profile	1	1	9/11/24	23:45	84.21	-173.55	200
profile	1	2	9/11/24	23:45	84.21	-173.55	100
profile	1	6	9/11/24	23:45	84.21	-173.55	100
profile	1	3	9/11/24	23:45	84.21	-173.55	50
profile	1	4	9/11/24	23:45	84.21	-173.55	30

profile	1	5	9/11/24	23:45	84.21	-173.55	1
ice	1	7	9/11/24	23:45	84.21	-173.55	1
ice	1	8	9/11/24	23:45	84.21	-173.55	1
profile	2	11	9/13/24	15:00	85.85	139.13	900
profile	2	12	9/13/24	15:00	85.85	139.13	500
profile	2	18	9/13/24	15:00	85.85	139.13	500
profile	2	13	9/13/24	15:00	85.85	139.13	200
profile	2	14	9/13/24	15:00	85.85	139.13	100
profile	2	15	9/13/24	15:00	85.85	139.13	50
profile	2	16	9/13/24	15:00	85.85	139.13	30
profile	2	17	9/13/24	15:00	85.85	139.13	1
ice	2	19	9/13/24	15:00	85.85	139.13	1
ice	2	20	9/13/24	15:00	85.85	139.13	1
profile	3	21	9/15/24	17:00	89.5	148.6	900
profile	3	22	9/15/24	17:00	89.5	148.6	500
profile	3	23	9/15/24	17:00	89.5	148.6	200
profile	3	24	9/15/24	17:00	89.5	148.6	100
profile	3	28	9/15/24	17:00	89.5	148.6	100
profile	3	25	9/15/24	17:00	89.5	148.6	50
profile	3	26	9/15/24	17:00	89.5	148.6	30
profile	3	27	9/15/24	17:00	89.5	148.6	1
ice	3	29	9/15/24	17:00	89.5	148.6	1
ice	3	30	9/15/24	17:00	89.5	148.6	1
profile	4	31	9/18/24	15:00	85.73	30.97	900
profile	4	32	9/18/24	15:00	85.73	30.97	500
profile	4	33	9/18/24	15:00	85.73	30.97	200
profile	4	34	9/18/24	15:00	85.73	30.97	100
profile	4	35	9/18/24	15:00	85.73	30.97	50
profile	4	38	9/18/24	15:00	85.73	30.97	50
profile	4	36	9/18/24	15:00	85.73	30.97	30
profile	4	37	9/18/24	15:00	85.73	30.97	1

ice	4	39	9/18/24	15:00	85.73	30.97	1
ice	4	40	9/18/24	15:00	85.73	30.97	1
profile	5	42	9/20/24	12:15	82.63	19.85	200
profile	5	41	9/20/24	12:15	82.63	19.85	100
profile	5	43	9/20/24	12:15	82.63	19.85	50
profile	5	44	9/20/24	12:15	82.63	19.85	30
profile	5	45	9/20/24	12:15	82.63	19.85	1
profile	5	46	9/20/24	12:15	82.63	19.85	1
profile	6	47	9/21/24	11:15	79.71	21.76	50
profile	6	48	9/21/24	11:15	79.71	21.76	30
profile	6	49	9/21/24	11:15	79.71	21.76	1
profile	7	51	9/21/24	21:00	79.62	19.45	200
profile	7	55	9/21/24	21:00	79.62	19.45	200
profile	7	50	9/21/24	21:00	79.62	19.45	100
profile	7	52	9/21/24	21:00	79.62	19.45	50
profile	7	53	9/21/24	21:00	79.62	19.45	30
profile	7	54	9/21/24	21:00	79.62	19.45	1
profile	8	56	9/22/24	19:30	78.92	21.45	100
profile	8	57	9/22/24	19:30	78.92	21.45	50
profile	8	58	9/22/24	19:30	78.92	21.45	30
profile	8	59	9/22/24	19:30	78.92	21.45	1
profile	9	60	9/24/24	7:15	78.56	19.18	100
profile	9	61	9/24/24	7:15	78.56	19.18	50
profile	9	62	9/24/24	7:15	78.56	19.18	30
profile	9	63	9/24/24	7:15	78.56	19.18	10
Flowthrough	n/a	UW-1	9/7/24	18:08	67.23	-168.46	10
Flowthrough	n/a	UW-2	9/8/24	0:04	68.63	-168.46	10
Flowthrough	n/a	UW-3	9/8/24	6:07	70.01	-168.47	10
Flowthrough	n/a	UW-4	9/8/24	18:00	72.74	-168.53	10
Flowthrough	n/a	UW-5	9/9/24	0:02	73.85	-167.76	10
Flowthrough	n/a	UW-6	9/9/24	6:09	74.99	-166.03	10

Flowthrough	n/a	UW-7	9/9/24	18:01	77.18	-164.35	10
Flowthrough	n/a	UW-8	9/10/24	0:01	77.56	-164.5	10
Flowthrough	n/a	UW-9	9/10/24	6:05	78.71	-163.49	10
Flowthrough	n/a	UW-10	9/10/24	18:25	80.76	-164.81	10
Flowthrough	n/a	UW-11	9/10/24	23:44	81.55	-167.35	10
Flowthrough	n/a	UW-12	9/11/24	3:20	82.08	-168.55	10
Flowthrough	n/a	UW-13	9/11/24	12:10	83.39	-170.77	10
Flowthrough	n/a	UW-14	9/11/24	18:28	84.21	-173.55	3
Flowthrough	n/a	UW-15	9/12/24	0:06	84.47	-175.07	10
Flowthrough	n/a	UW-16	9/12/24	12:12	85.7	-177.65	10
Flowthrough	n/a	UW-17	9/12/24	15:17	85.81	-176.06	10
Flowthrough	n/a	UW-18	9/12/24	15:18	85.81	-176.06	3
Flowthrough	n/a	UW-19	9/12/24	18:06	85.9	-173.28	10
Flowthrough	n/a	UW-20	9/12/24	23:41	86.05	161.63	10
Flowthrough	n/a	UW-21	9/13/24	22:24	85.85	139.04	10
Flowthrough	n/a	UW-22	9/14/24	0:07	85.94	139.08	10
Flowthrough	n/a	UW-23	9/14/24	11:58	87.52	139.21	10
Flowthrough	n/a	UW-24	9/14/24	18:20	88.42	140.82	10
Flowthrough	n/a	UW-25	9/15/24	0:13	89.25	146.79	10
Flowthrough	n/a	UW-26	9/15/24	12:08	89.5	148.6	10
Flowthrough	n/a	UW-27	9/16/24	0:06	89.5	148.6	10
Flowthrough	n/a	UW-28	9/16/24	10:33	89.81	-10.5	10
Flowthrough	n/a	UW-29	9/16/24	16:01	89.78	-5.89	10
Flowthrough	n/a	UW-30	9/16/24	17:57	89.77	-5.15	10
Flowthrough	n/a	UW-31	9/17/24	0:09	89.99	52.67	10
Flowthrough	n/a	UW-32	9/17/24	12:15	88.62	19.46	10
Flowthrough	n/a	UW-33	9/17/24	18:01	87.95	26.52	10
Flowthrough	n/a	UW-34	9/18/24	0:17	87.26	39.94	10
Flowthrough	n/a	UW-35	9/18/24	12:35	85.81	31.9	10
Flowthrough	n/a	UW-36	9/18/24	18:05	85.73	30.76	3
Flowthrough	n/a	UW-37	9/19/24	0:06	85.14	28.46	10

Flowthrough	n/a	UW-38	9/19/24	12:02	84.14	27.06	10
Flowthrough	n/a	UW-39	9/19/24	17:59	83.8	27.52	10
Flowthrough	n/a	UW-40	9/20/24	6:07	82.72	19.96	3
Flowthrough	n/a	UW-41	9/20/24	11:52	82.64	19.85	3
Flowthrough	n/a	UW-42	9/20/24	14:54	82.63	19.82	3
Flowthrough	n/a	UW-43	9/20/24	21:42	80.95	16.39	3
Flowthrough	n/a	UW-44	9/21/24	9:35	79.71	21.74	3
Flowthrough	n/a	UW-45	9/21/24	17:55	79.72	21.34	3
Flowthrough	n/a	UW-46	9/22/24	9:27	79.35	20.76	3
Flowthrough	n/a	UW-47	9/22/24	19:08	78.92	21.45	3
Flowthrough	n/a	UW-48	9/23/24	7:30	78.21	20.95	3
Flowthrough	n/a	UW-49	9/23/24	12:32	78.09	20.76	3
Flowthrough	n/a	UW-50	9/24/24	8:12	78.56	19.17	3
Flowthrough	n/a	UW-51	9/24/24	8:13	78.56	19.17	3
Flowthrough	n/a	UW-52	9/24/24	14:04	77.98	19.05	3
Flowthrough	n/a	UW-53	9/24/24	21:31	76.87	17.95	3
Flowthrough	n/a	UW-54	9/25/24	6:59	77.07	15.99	3
Flowthrough	n/a	UW-55	9/25/24	12:28	76.89	14.62	3
Flowthrough	n/a	UW-56	9/25/24	20:09	78.04	12.96	3

Note: Type indicates whether the sample was collected from a niskin bottle during a profile station ("profile") or drawn from the underway system ("flowthrough"). Location and time are approximate.

b) pH:

The same sample bottle will be used for all inorganic carbon analyses, with pH being determined first. pH will be measured on the total scale using a spectrophotometric technique. An Agilent 8453 spectrophotometer equipped with a custom-made temperature-controlled cell holder is used for the analysis.

Samples are thermostated at 20 ± 0.05 degrees Celsius in a water bath. Approximately 80 ml of sample are extracted from each sample bottle using a syringe. The temperature of each sample is measured before analysis using a Hart Scientific Fluke 1523 reference thermometer.

Absorbance blanks are obtained for each sample, and 10 microliters of purified m-cresol purple (10 mmol kg^{-1}) are added to each sample for analysis. The equations of Liu et al. (2011), formulated using the purified m-cresol purple indicator, are employed to determine the pH of the samples.

The pH measurement is calibration-free, eliminating the need for calibrations. Duplicate samples will be analyzed to assess the stability of the measurements.

c) Dissolved Inorganic Carbon (DIC) concentration:

DIC will be analyzed using coulometry with two analytical systems (AOML5 and AOML6) operating simultaneously. In coulometric analysis, all carbonate species in the seawater sample are converted to CO_2 gas by adding excess hydrogen ions (acid). The evolved CO_2 gas is then swept into the coulometer's titration cell using pure air or compressed nitrogen, where it reacts quantitatively with a proprietary ethanolamine-based reagent to generate hydrogen ions. This reaction causes a color change in the solution from blue to colorless, triggering a current through the cell. Coulometric generation of OH^- ions at the anode neutralizes the H^+ ions, returning the solution to its original blue color. A photometric detector senses this color change, and the coulometric titration is stopped when the percent transmission returns to its initial value. The total charge during the titration is integrated to determine the amount of CO_2 that entered the cell.

The volume of the pipette used to deliver the sample in each system is calibrated using aliquots of distilled water at known temperatures. The corresponding densities are used to calculate the pipette volume. The amount of injected CO_2 is determined according to the CO_2 Handbook (Dickson et al., 2007). While the instrument has a salinity sensor, all DIC values are recalculated to a molar weight (micromol/kg) using density obtained from the CTD salinity. The DIC values are corrected for dilution caused by the addition of 0.2 ml of saturated $HgCl_2$ preservative and for any offset from the Certified Reference Materials (CRMs). This additive correction is applied to each cell using the CRM value obtained at the beginning of its operation.

The stability of each coulometer cell solution is confirmed through three methods:

1. **Gas loop analysis:** Conducted at the beginning of each cell's operation.
2. **CRM analysis:** Certified Reference Materials (CRMs) supplied by Dr. A. Dickson of SIO are analyzed at the beginning of each cell before sample analysis.
3. **Duplicate sample analysis:** Duplicate samples from the same Niskin bottle are measured on average every 6-8 samples.

d) Total alkalinity:

All samples will be analyzed using leftover water from the sample bottles used for DIC and pH measurements. Two titration systems will be employed for the analysis: “System 1” utilizes a Metrohm 765 Dosimat Titrator and an Orion 720A pH meter controlled by a personal computer (Millero et al., 1993), while “System 2” employs a Metrohm 665 Dosimat Titrator and an Orion 2-Star pH meter. The titration cells consist of 250-ml water-jacketed glass beakers. A plexiglass reference electrode (Orion 900200) and a glass pH electrode (Orion 8101BNWP) are used to measure the electromotive force (emf) during the titration. Approximately 200 ml of seawater sample are titrated with an HCl solution of certified concentration (0.25175 moles per kilogram-solution) provided by Dr. Andrew Dickson of UCSD.

The volume of HCl delivered to the cell is traditionally assumed to have a small uncertainty (Dickson, 1981) and is equated with the digital output of the titrator. Certified Reference Materials (CRMs) are used to monitor the performance of the titrators. Approximately two CRMs are analyzed per day to calibrate the instruments, once at the beginning and once at the end of the day. All TA data are corrected using the average of the before and after CRM measurements for each cell, unless one measurement is deemed unreliable, in which case only the good measurement is used for the correction.

The titration process is controlled by a computer program written in National Instruments' LabWindows/CVI 4.1. Total alkalinity is calculated from the titrant volume, concentration, and emf measurements using a non-linear least-squares approach that corrects for the reactions with sulfate and fluoride ions (Dickson et al., 2007).

KOCH Lab:

NUTRIENTS, PHYTOPLANKTON, ZOOPLANKTON

Science lead: Florian Koch (Alfred Wegener Institute)
Scientist on board: Fuat Dursun (Istanbul University), Elisabeth Rosselli (Alfred Wegener Institute), Ricarda Kluge (Alfred Wegener Institute)

The goal for CHARCOT was to obtain unique kind spatial coverage of plankton diversity, phycotoxins and macro- and micro nutrient in one of the worlds most undersampled regions. To this end, water and the net tows each were sub-samples for different parameters such as chlorophyll a, particulate organic carbon and nitrogen (POC/PON), particulate and dissolved vitamins, dissolved inorganic nutrients and different toxins. Some DNA extractions, sample fixation and cell isolations were also performed on board.

a) Phytoplankton net

A mesh-size 20 µm net was used. The phytoplankton net was deployed twice to a depth of 30 m (Table 5). The content of the net was collected and its volume adjusted to 2 L, with 0.2µm filtered seawater (FSW). 18 mL of water was preserved with 2 mL of formaldehyde (1%, V/V). A 50 mL aliquot of this net tow was placed in the fridge, for subsequent cell isolation. The remaining volume was filtered over a filter tower consisting of 200, 50 and 20 µm pore sized mesh. Each mesh was then rinsed with FSW, and the content of each fraction was transferred into 50 ml centrifugation tubes, and the volumes adjusted to 45 ml using FSW. The samples were centrifuged at maximum speed for 10 minutes, and the supernatants were discarded. Each subsample was transferred to a cryovial with about 1.5 mL of FSW and centrifuged again for 10 minutes at maximum speed. After that, the supernatant was discarded and the pellets of the samples were stored at -20 °C for subsequent toxin analysis back at the AWI.

Table 5. Phytoplankton nets.

Station	Coordinates	Date	Net tows	Fraction >200um	Fraction 200-50um	Fraction 50-20um
2	77*24'4.23''N 164*22'31.04''W	09.09.24	2x30m	PSP,DSP,DNA	PSP,DSP,DNA	PSP,DSP,DNA
4	82*4'37.87''N 168*33'9.62''W	10.09.24	2x30m	PSP,DSP,DNA	PSP,DSP,DNA	PSP,DSP,DNA
6	84*12'31.54''N 173*35'8.77''W	11.09.24	2x30m	PSP,DSP,DNA	PSP,DSP,DNA	PSP,DSP,DNA
9	85*51'9.85''N 139*8'44.92''E	13.09.24	2x30m	PSP,DSP,DNA	PSP,DSP,DNA	PSP,DSP,DNA
12	89*53'57.12''N 44*8'0.81''W	15.09.24	2x30m	PSP,DSP,DNA	PSP,DSP,DNA	PSP,DSP,DNA
16	85*43'42.68''N 30*55'27.85''E	18.09.24	2x30m	PSP,DSP,DNA	PSP,DSP,DNA	PSP,DSP,DNA
20	82*40'31.00''N 19*54'43.42''E	20.09.24	2x30m	PSP,DSP,DNA	PSP,DSP,DNA	PSP,DSP,DNA
21	79*42'35.64''N 21*46'7.94''E	21.09.24	2x30m	PSP,DSP,DNA	PSP,DSP,DNA	PSP,DSP,DNA
22	79*36'52.39''N 19*26'20.99''E	21.09.24	2x30m	PSP,DSP,DNA	PSP,DSP,DNA	PSP,DSP,DNA
23	79*21'14.46''N 20*45'16.15''E	22.09.24	2x30m	PSP,DSP,DNA	PSP,DSP,DNA	PSP,DSP,DNA
24	79*14'51.07''N 22*57'6.09''E	22.09.24	2x30m	PSP,DSP,DNA	PSP,DSP,DNA	PSP,DSP,DNA
25	78*54'8.65''N 21*38'24.73''E	22.09.24	2x30m	PSP,DSP,DNA	PSP,DSP,DNA	PSP,DSP,DNA
28	78*33'30.44''N 19*10'44.25''E	24.09.24	2x30m	PSP,DSP,DNA	PSP,DSP,DNA	PSP,DSP,DNA

b) Zooplankton net

Similarly, a 150 µm mesh sized net was deployed for collecting zooplankton. The zooplankton net on the other hand was deployed twice to a depth of 50 m (Table 6). 160 mL of the obtained sample was preserved

with 40 mL of 20% formaldehyde (final 4% V:V). The inspection of the content of the sample and species identification was conducted visually. The sample was filtered over a 1000, 500, 250 and 100 µm filter tower. Each fraction was transferred and adjusted into a 15 mL centrifugation tube using FSW. The samples were centrifuged at maximum speed for 10 minutes, and the supernatants were discarded. The pellet was resuspended in 4ml FSW, and each sample was divided into two aliquots of 2 ml into cryovials. The tubes were centrifuged and the pellets stored frozen until toxin analysis back at the AWI in Bremerhaven.

Table 6. Zooplankton nets.

Station	Date	Coordinates	Net tows (combined)	Fraction >1000um	Fraction 1000-500um	Fraction 500-250um	Fraction 250-100um
2	09.09.24	77*24'4.23''N 164*22'31.04''W	2x50m	PSP,DSP	PSP,DSP	PSP,DSP	PSP,DSP
4	10.09.24	82*4'37.87''N 168*33'9.62''W	2x50m	PSP,DSP	PSP,DSP	PSP,DSP	PSP,DSP
6	11.09.24	84*12'31.54''N 173*35'8.77''W	2x50m	PSP,DSP	PSP,DSP	PSP,DSP	PSP,DSP
9	13.09.24	85*51'9.85''N 139*8'44.92''E	2x50m	PSP,DSP	PSP,DSP	PSP,DSP	PSP,DSP
12	15.09.24	89*53'57.12''N 44*8'0.81''W	2x50m	PSP,DSP	PSP,DSP	PSP,DSP	PSP,DSP
16	18.09.24	85*43'42.68''N 30*55'27.85''E	2x50m	PSP,DSP	PSP,DSP	PSP,DSP	PSP,DSP
20	20.09.24	82*40'31.00''N 19*54'43.42''E	2x50m	PSP,DSP	PSP,DSP	PSP,DSP	PSP,DSP
21	21.09.24	79*42'35.64''N 21*46'7.94''E	2x50m	PSP,DSP	PSP,DSP	PSP,DSP	PSP,DSP
22	21.09.24	79*36'52.39''N 19*26'20.99''E	2x50m	PSP,DSP	PSP,DSP	PSP,DSP	PSP,DSP
25	22.09.24	78*54'8.65''N 21*38'24.73''E	2x50m	PSP,DSP	PSP,DSP	PSP,DSP	PSP,DSP
28	24.09.24	78*33'30.44''N 19*10'44.25''E	2x50m	PSP,DSP	PSP,DSP	PSP,DSP	PSP,DSP

c) Water Samples

In order to get good spatial coverage of core oceanographic parameters, water was collected from 10m via the ship's peristaltic pump. In additon integrated samples for DNA analyses were obtained by mixing water from the surface and 50m (obtained via Niskin bottles) with the water collected via the peristaltic pump.

d) Chlorophyll a, POC/PON and particulate B-vitamins

At every station, 10 L of seawater were collected from the peristaltic pump in 2 L plastic amber bottles and stored in the fridge of the wet lab until further processing. For Chlorophyll a, water was filtered over triplicate glass fibre filters (GFF, 0.7 µm mesh size) and polycarbonate filters (PC, 5 µm mesh size) with a gentle vacuum of <200 mbar (Figure 2). The filters were then collected and frozen at -20°C for post-cruise analysis. Similarly, samples for POC/PON and particulate vitamins were collected by filtering water onto pre combusted and non-combusted GFF filters respectively for subsequent analysis back at the AWI. The volume of water filtered depended on the station. Some were richer in organic matter than others. However, it never exceeded 1L per filter.

Figure 2. *Filtration rack deployed in the wet lab. A tube connects the filtration rack to the water recovery bottle and to the pump responsible for the system's vacuum suction.*

e) Flowcytometric analysis of the nano and picoplankton community

Two samples, of 4.75 mL whole sea water were collected in 5mL cryovials, preserved with 250µL formalin and stored at -20°C for later analysis at the AWI.

f) Dissolved B-vitamins and macronutrients

Figure 3. *Dissolved B-vitamins concentration over C18 SPE columns.*

One 2 L plastic amber bottle was collected at each station for dissolved B-vitamin. The water was first filtered using a Masterflex peristaltic pump and a 0.2/0.4µm prose size AcroPakTM filtration cartridge. Once filtered, the exact volume of water was measured before being acidified to a pH of 6.2-6.8 using HCl (3.2N). An internal standard, N15 -B12, was also added in order to calculate % recovery.

The 2 L water where then slowly concentrated onto a previously methanol-conditioned SPE column (Figure 3). The laminar flow speed through the SPE column was fixed at 1 ml/min, using a micro-peristaltic pump. After the whole volume of water had passed through the column, those were rinsed with MQ water and dried with a syringe before being parafilmed on both sides and dried in the -20°C freezer, waiting for further analysis back in the laboratory at AWI. Two 10 mL water samples were collected from the filtered water from the filtration rack at every station to quantify dissolved nutrients in the seawater using standard colorimetric techniques.

g) DNA samples

For DNA, 2 to 4 L were filtered following the same procedure as for AZA. Then, the filter rinsed with 500 µL of SL1-Buffer (part of the DNA extraction kit) until complete discoloration. The solution was then transferred to a bead tube and stored at -20 °C.

The analysis of DNA samples will take place in the laboratories of AWI in Bremerhaven .

h) SPATT bag sampling

Figure 4. *SPATT-bag. Continuous lipophilic sampling in the wet-labs's sink*

Solid phase adsorption toxin tracking (SPATT) bags were deployed in the wet lab (Figure 4). Those were submitted to a constant flow (~0.8L/min) of water from the peristaltic pump to absorb dissolved toxins. After 48 hours they were removed from the water and stored at 4°C. The extraction and measurement of the toxins will be performed in the laboratories of the Alfred Wegener Institute in Bremerhaven.

i) Nutrient amendment experiments

15 L of water were collected from 10m depth using the ship's peristaltic pump. The water volume was divided between 15 bottles of 1 L each. The experiment consisted of five treatments, in triplicate, as presented in **Figure 5**.

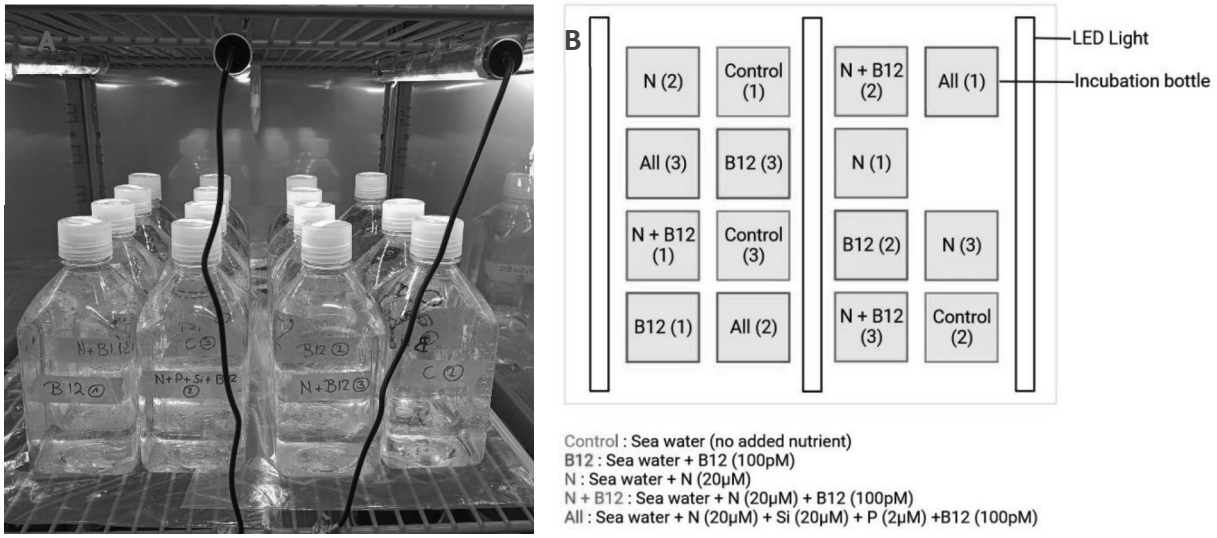

Figure 5. *Experiment Setup in the wet-laboratory fridge (A), and schematic of the different treatments used (B).*

The incubations were carried out in a fridge, at ambient temperatures and equipped with a LED lights set up at ~ 30uE and a 20/4 light/dark cycle. Every incubation lasted approximately 3.5 days and was terminated by collecting samples of each bottle. Per bottle, two GF and two PC filters were collected for chlorophyll analysis and one sample for flow cytometry analysis. Once collected, the samples were stored in the -20 °C freezer. Phytoplankton samples consisting of a 90mL pool of 30mL per replicate within one treatment were also collected, and Lugol's solution was added reaching a final concentration of 1% (V/V). The samples were stored in a dark box for the rest of the expedition.

3.1.2 First results

The inspection of the isolates collected back at **KOCH Lab** at AWI under the optic microscope revealed some growing cells belonging to the genus Pseudo-nitzschia ssp. Those cells are left to continue growing in the laboratory before further analysis.

3.2 Bioaerosol Sampling

The risks of biological invasions of remote ecosystems by new microorganisms is a major threat to native microbial communities as they are likely to impact the diversity and ultimately the function of resident communities and local ecosystems. In the Arctic, aerial transport is the primary source of new biological inputs. Airborne communities are believed to be influenced by environmental and climatic conditions, which are already changing rapidly on a global scale, but especially in the Arctic region. Yet, the influence of climate change, weather patterns and environmental conditions on these airborne communities are still unclear. Airborne microorganisms are known to travel intercontinental distances and if they survive, they may colonize previously remote and potentially pristine environments. The bioaerosol component aimed to characterize airborne communities in the Arctic region, identify potential drivers, determine the risks of microbial invasion and, most importantly, monitor the interannual variability of these airborne communities and the associated environmental drivers.

3.2.1 Airborne microbes sampling

PEARCE Lab:

MICROBIAL DIVERSITY

Science lead: David Pearce (Nortumbria University)
Scientist on board: David Pearce (Nortumbria University)

Samples were collected onboard Ponant's LCC over a 20-day period between 6th September and 25th September 2024. Air sampling was performed on Deck 10 portside (Fig 2) which was away from the general direction of smoke from the ships stack and outlets of internal ship air. Three methods of air sampling were used; (i) Wet samples were collected (when possible – below 0 ^{o}C the water froze) with a Bertin Coriolis micro fitted with collection cones filled with molecular biology grade water at a flow rate of 300 L min-1, one sample was collected per day during daylight hours, (ii) dry samples were collected with a Bertin Coriolis Micro at 6hr intervals with a flow rate of 50 L min-1, (iii) additional samples were collected using a vacuum pump fitted with a Whatman membrane filter at a flow rate of 20 L min-1 continuously (membrane filters were changed every 12 hours) and iv) sample for virus extraction were collected onto filter papers stored in PBS. All samples

were stored at -20°C in the onboard wet laboratory freezer for the duration of the cruise. This dataset was supported by the ships log of atmospheric and weather data.

Opportunistic air sampling with the Bertin Coriolis micro (μ) and compact were also performed onshore and on the sea-ice to complement the dataset from the ship and determine whether the ship itself was impacting the data.

Figure 6*. Deployment and location of sampling kit on the vessel.*

All sequence data will be submitted on publication (indeed it is a requirement of publication) to the EMBL (European Molecular Biology Laboratory) Nucleotide Sequence Database (http://www.ebi.ac.uk/embl.html). Ship-based tracking and weather data have been requested and will be made available according to PONANT's policy with regard to this information.

AZZARO Lab:

MICROBIAL ABUNDANCE, BIOMASS AND ACTIVITY

Science lead: Maurizio Azzaro (Institute of Polar Sciences)
Scientist on board: Maurizio Azzaro (Institute of Polar Sciences), Francesco Filiciotto (Institute of Polar Sciences), Alessandro Ciro Rappazzo (Institute of Polar Sciences), Federico Citterich (Institute of Polar Sciences)

The airbone microbes sampling were collected daily every 6 hours, using a commercially available cyclonic collector (Coriolis®μ cyclonic system air sampler; ITINERIS project, WP5), which was placed vessel's bow, only when the sampler was not downwind of the ship's exhaust to avoid contamination. The air sampling flow rate and duration were 300 L/min and 10 min, respectively. Air was aspirated twelve times into a sterile cone filled with 15 ml of sterile phosphate buffer saline (PBS 1x). The samples collected were pretreated for the parameters regarding viral component, prokaryotic abundance and biomass, phylogenetic composition, Cultivable Bacteria, respiring cells (CTC), Metabolic profiles (Biolog), Bacterial Viability (Live/Dead). Similar to

the water samples, the bioaerosol samples have not yet arrived at the workplace and will be analyzed upon delivery. Results for the bioaerosol samples are pending, as they are still in transit. The bioaerosol samplings carried out during the CHARCOT project are listed below in Table 7.

Table 7. Samples collected during the cruise.

TABLE 7	Date	Time Start	Time End	Latitude – Start	Longitude - Start	Latitude - End	Longitude – End
Station No.	2024	[UTC]	[UTC]	[°N]	[°E/°W]	[°N]	[°E/°W]
CH-B1	07.09	06:24	07:08	64°39'30.19''	167°24'40.57''W	64°43'48.82''	167°44'59.39''W
CH-B2	07.09	12:09	12:52	65°45'44.87''	168°25'0.62''w	65°56'35.07''	168°24'57.16''W
CH-B3	07.09	17:55	18:41	67°9'54.08''	168°27'16.41''W	67°20'34.91''	168°27'53.88''W
CH-B4	07.09	23:59	00:43	68°36'9.49''	168°27'52.61''W	68°46'40.47''	168°27'51.79''W
CH-B5	08.09	06:13	06:56	70°2'20.86''	168°28'30.02''W	70°12'3.01''	168°25'5.67''W
CH-B6	08.09	11:56	12:42	71°20'57.46''	168°21'1.06''W	71°31'44.81''	168°21'58.79''W
CH-B7	08.09	17:59	18:43	72°50'23.46''	167°46'18.71''W	72°53'24.24''	168°45'45.92''W
CH-B8	09.09	00:00	00:46	73°50'23.46''	167°46'18.71''W	73°56'9.50''	167°40'37.20''W
CH-B9	09.09	06:13	06:56	74°59'41.84''	166°1'46.56''W	75°2'39.87''	165°46'39.04''W
CH-B10	09.09	12:00	12:46	76°5'36.01''	164°18'6.60''W	76°15'22.16''	164°6'18.36''W
CH-B11	09.09	17:53	18:36	77°9'6.15''	164°20'50.07''W	77°18'2.31''	164°25'0.40''W
CH-B12	10.09	00:00	00:45	77°33'42.30''	164°29'43.46''W	77°42'31.84''	164°16'34.97''W
CH-B13	10.09	06:19	07:37	78°45'16.53''	163°32'31.94''W	79°2'28''	163°34'2.19''W
CH-B14	10.09	12:02	12:45	79°45'47.29''	165°48'10.28''W	79°53'31.57''	166°0'8.89''W
CH-B15	10.09	17:50	18:40	80°41'59.74''	164°37'32.30''W	80°46'33.05''	164°47'48.53''W
CH-B16	10.09	23:50	00:46	81°33'25.96''	167°21'39.57''W	81°46'54.35''	167°50'17.12''W
CH-B17	11.09	05:55	07:12	82°18'41.15''	168°16'18.38''W	82°32'43.88''	168°25'0.95''W
CH-B18	11.09	11:52	12:46	83°22'24.67''	170°36'39.07''W	83°31'46.84''	171°2'57.26''W
CH-B19	11.09	17:52	18:36	84°12'19.27''	173°32'59.90''W	84°12'25.39''	173°33'42.74''W
CH-B20	11.09	23:54	00:40	84°26'35.32''	174°47'24.63''W	84°30'44.00''	175°38'31.08''W
CH-B21	12.09	06:06	07:21	85°9'33.78''	178°22'6.32''W	85°14'7.56''	179°1'59.86''W
CH-B22	12.09	12:00	12:56	85°41'54.44''	177°41'42.52''E	85°43'38.56''	176°53'59.28''E
CH-B23	12.09	17:53	18:42	85°52'24.09''	173°56'37.46''E	85°54'18.78''	172°28'45.84''E
CH-B24	12.09	23:52	00:47	86°4'22.40''	161°13'58.36''E	86°3'7.04''	159°7'44.94E
CH-B25	13.09	06:23	07:47	85°59'40.58''	146°4'10.32''E	85°56'59.00''	142°30'3.13''E
CH-B26	13.09	11:59	12:44	85°50'41.15''	139°55'39.67''E	85°50'32.91''	139°53'51.29''E
CH-B27	13.09	17:54	18:44	85°51'14.77''	139°1'29.31''E	85°51'14.77''	139°1'29.31''E
CH-B28	14.09	00:01	01:01	85°55'13.01''	133°0'53.83''E	86°0'6.23''	139°2'6.72''E
CH-B29	14.09	06:26	07:20	86°39'18.24''	140°17'50.28''E	86°46'55.93''	140°56'23.56''E
CH-B30	14.09	11:56	12:57	87°30'31.97''	138°11'28.07''E	87°37'39.86''	139°39'44.36''E
CH-B31	14.09	18:18	19:14	88°26'25.35''	141°8'33.00''E	88°35'4.34''	142°42'11.25''E
CH-B32	15.09	00:02	00:55	89°14'21.02''	148°17'45.61''E	89°21'15.21''	148°52'58.67''E
CH-B33	15.09	06:33	07:26	89°59'44.92''	20°57'10.09''E	89°59'42.77''	7°18'5.70''W
CH-B34	15.09	11:51	12:37	89°58'41.39''	28°0'35.34''E	89°58'26.68''	25°33'20.41''E

CH-B35	15.09	19:01	19:56	89°53'38.82''	41°4'37.13''W	89°53'38.82''	41°4'37.13''W
CH-B36	16.09	00:00	00:51	89°52'1.05''	27°9'6.89''W	89°51'42.51''	25°2'4.55''W
CH-B37	16.09	06:10	06:55	89°49'38.53''	15°29'47.74''W	89°49'24.30''	14°41'52.50''W
CH-B38	16.09	11:50	12:51	89°48'0.58''	9°4'8.18''W	89°47'39.65''	8°7'34.91''W
CH-B39	16.09	17:59	19:01	89°46'2.29''	5°8'46.00''W	89°45'47.57''	4°49'15.10''W
CH-B40	16.09	23:49	00:40	89°59'36.18''	52°48'45.59''E	89°59'28.37''	47°38'5.26''E
CH-B41	17.09	06:15	07:06	89°27'46.68''	13°42'9.73''E	89°20'34.31''	149°33'54.14''E
CH-B42	17.09	11:51	13:14	88°39'7.75''	19°7'14.13''E	88°30'41.1''	19°26'18.52''E
CH-B43	17.09	18:02	19:04	87°57'6.69''	26°30'21.94''E	87°47'35.97''	28°55'55.37''E
CH-B44	17.09	23:51	00:55	87°16'25.85''	35°40'21.38''E	87°14'39.89''	34°5'9.54''E
CH-B45	18.09	06:12	07:00	86°38'10.37''	33°41'40.48''E	86°32'11.28''	33°33'40.94''E
CH-B46	18.09	11:51	12:54	85°52'57.41''	32°20'28.18''E	85°46'51.01''	31°35'10.59''E
CH-B47	18.09	17:59	18:50	85°44'0.31''	30°46'10.42''E	85°44'8.55''	30.43'26.37''E
CH-B47	18.09	23:52	00:37	85°8'58.74''	28°36'55.75''E	85°6'52.75''	28°5'35.13''E
CH-B49	19.09	06:20	07:06	84°33'55.21''	26°26'41.81''E	84°29'31.32''	26°21'2.48''E
CH-B50	19.09	11:49	12:34	84°9'24.67''	27°2'40.25''E	84°5'0.99°	26°58'50.93''E
CH-B51	19.09	17:50	18:35	83°48'31.21''	27°27'35.13''E	83°44'9.35''	27°38'16.51''E
CH-B52	20.09	00:18	01:01	89°11'16.81''	25°50'33.07''E	83°11'21.78''	25°6'41.83''E
CH-B53	20.09	06:06	06:51	82°43'16.37''	19°87'3.05''E	82°48'56.42''	19°19'17.70''E
CH-B54	20.09	11:51	12:58	82°38'12.92''	19°51'7.99''E	82°37'25.63''	19°49'48.29''E
CH-B55	20.09	17:53	18:37	81°56'41.20''	18°15'56.71''E	81°45'34.85''	17°54'8.85''E
CH-B56	21.09	00:07	00:44	80°20'31''	16°14'21''E	80°11'37.46''	16°42'40.41''E

3.3 Ice mechanics

von BOCK und POLACK Lab:

ICE MECHANICS

Science lead: Franz von Bock und Polach (Hamburg University of Technology)
Scientist on board: Franz von Bock und Polach (Hamburg University of Technology), Christian Haas (Alfred Wegener Institute), Jan Kubiczek (Hamburg University of Technology)

3.3.1 Underway measurements

While sailing in ice, properties of the surrounding ice (thickness, surface type, and roughness), the motion of the ship, and the temperature of the outer shell of the ship's structure at selected positions were collected autonomously.

Sea Ice Monitoring System (SIMS)

Continuous ship-based ice thickness observations were carried out using onboard Sea Ice Monitoring System (SIMS). The SIMS consists of two main instruments: a sonar, which records the distance to the air-snow interface, and an EM31, which records the distance to the ice/ocean interface. The SIMS is located in front of the bow of the ship. Figure 7 displays the preliminary total (snow+ice) thickness time series measured by the SIMS.

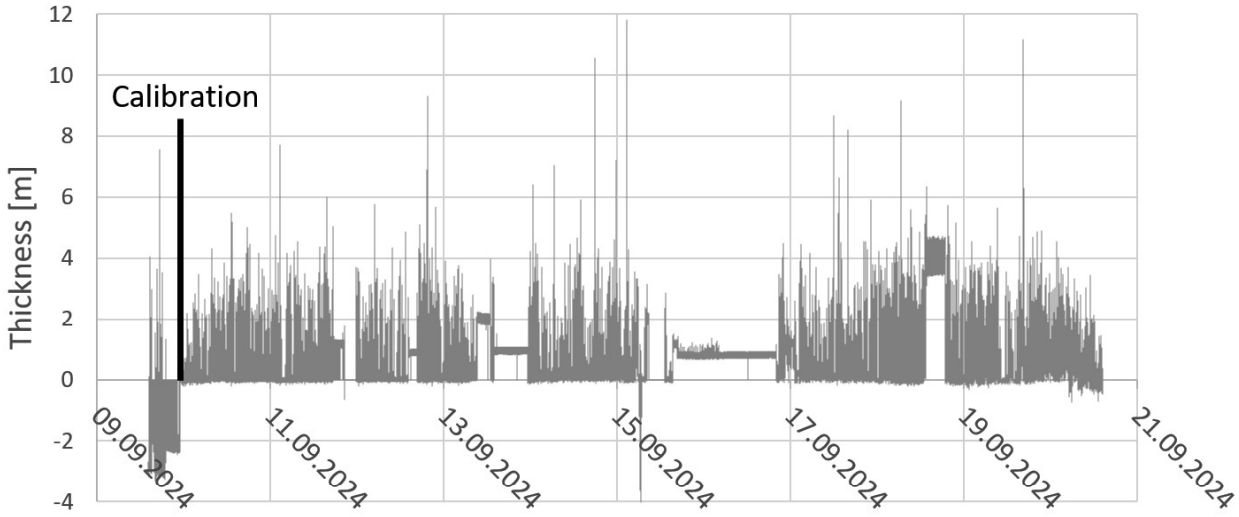

Figure 7. *Preliminary SIMS sea ice thickness time series.*

Visual Ice Condition Observations

The underway ice thickness measurements from the SIMS and the ship motions measurement from the DMU were complemented by visual images from two time lapse (manufacturer: Reolink) cameras. The front camera was installed on a wooden stick attached to the SIMS metal structure. The back camera was installed directly on the metal structure of the SIMS. The front camera monitored the ice below the SIMS and in the surroundings and the back camera viewed the ship's bow. The aim is to use the visual images to quality-control the SIMS measurements, interpret the SIMS data in a large-scale context and in relationship to the constant power tests, and monitor the ice and its shape that hits the ship's bow. Figure 8 gives an impression of the image data obtained. Work is now continuing on automatic image recognition to automatically analyse the images

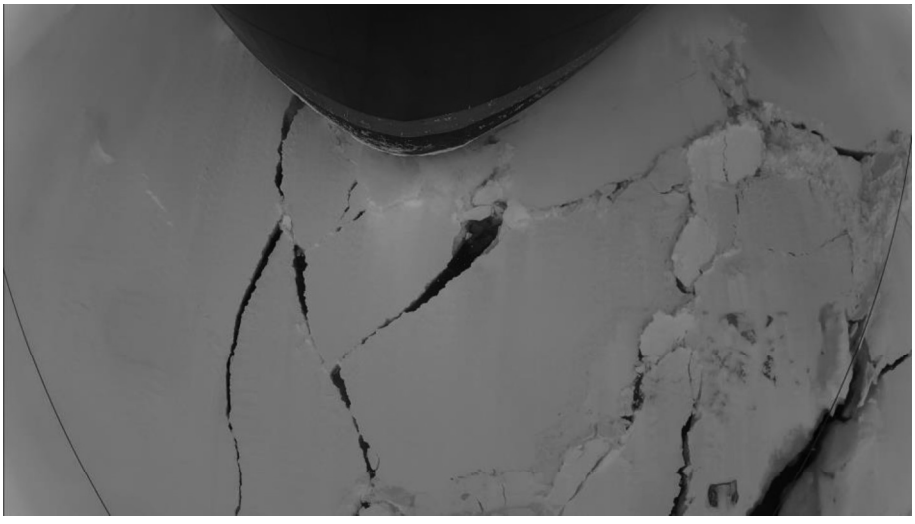

Figure 8. *View of the backward facing camera.*

Dynamic Motion Unit

The Dynamic Motion Unit (DMU) was used to record the accelerations in all three dimensions (x, y, and z) as well as the ship's motions roll, pitch, and yaw rate. In combination with the SIMS and the cameras, this measurement setup will be used to investigate a correlation between the ice breaking and the resulting ship

motions. The DMU was installed at the bow of the ship on deck 4 close to the SIMS before reaching the ice edge and removed after leaving the ice.
The measured motions and accelerations for the 14.09.2024 are shown as an example in Figure 9.

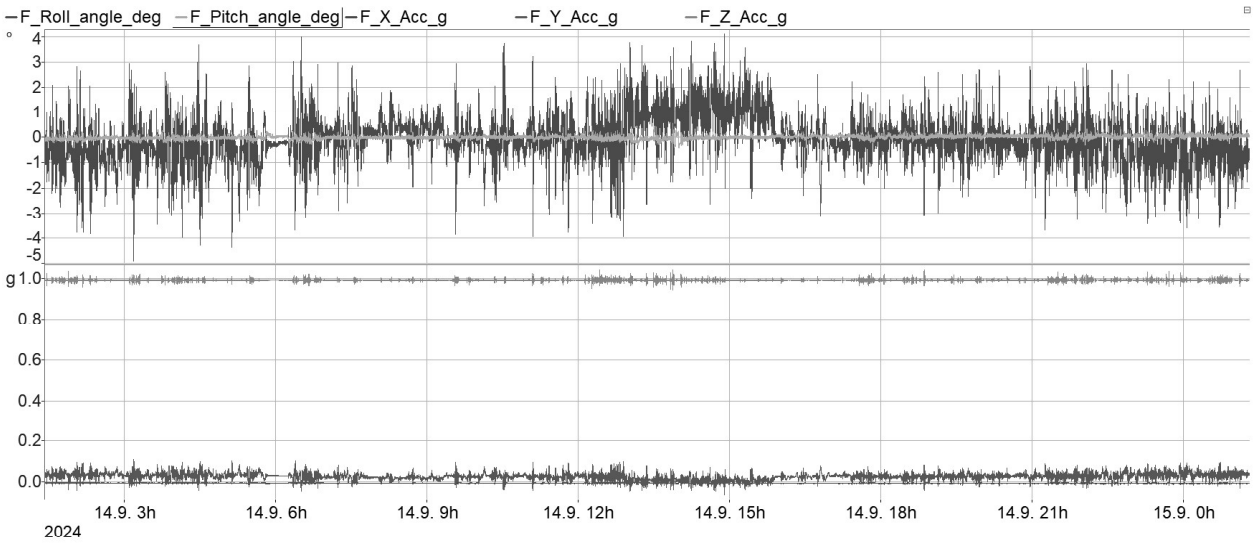

Figure 9. *Motions and accelerations for the 14.09.2024*

Based on the motion data and accelerations, a method will be developed in correlation with the measured ice thickness, the ship's speed and the ice conditions recorded by the cameras in order to the response of the ship in ice and its resistance. This data can then be used to derive a statement about the ship's performance in ice.

Constant Power Tests

In the constant power tests, the ship sailed a straight course on autopilot with a specific, constant propulsion power. Parameters such as the ship's speed and ice thickness were logged and the ice conditions were visually recorded via the cameras. In such tests velocity variations can be linked to ship and ice conditions, which however requires further investigations. The following 8 with the information on the tests contains both the start and end coordinates as well as the corresponding times:

Table 8: List of constant power tests during transit.

TABLE 8	Date	Time Start	Time End	Latitude Start	Longitude Start	Latitude End	Longitude End	Gear
Station No.	**2024**	**[UTC]**	**[UTC]**	**[dd.ddd°]**	**[dd.ddd°]**	**[dd.ddd°]**	**[dd.ddd°]**	**[-]**
CH-ICE-T01	10.09.	17:30	18:08	80.658	-164.611	80.724 N	-164.637	Ship's onboard sensors, SIMS, DMU, cameras
CH-ICE-T02	11.09.	14:35	15:28	83.886	-171.175	84.005 N	-171.721	Ship's onboard sensors, SIMS, DMU, cameras
CH-ICE-T03	12.09.	18:36	19:24	85.904	172.672	85.933 N	171.384	Ship's onboard sensors, SIMS, DMU, cameras, LIDAR

CH-ICE-T04	13.09.	13:21	13:55	85.842	139.669	85.854 N	139.29	Ship's onboard sensors, SIMS, DMU, cameras, LIDAR
CH-ICE-T05	17.09.	13:17	14:19	88.507	19.471	88.461 N	20.277	Ship's onboard sensors, SIMS, DMU, cameras, LIDAR
CH-ICE-T06	18.09.	12:25	13:19	85.817	32.014	85.744 N	31.134	Ship's onboard sensors, SIMS, DMU, cameras, LIDAR
CH-ICE-T07	19.09.	15:40	16:41	83.921	27.718	83.852 N	27.676	Ship's onboard sensors, SIMS, DMU, cameras, LIDAR

Temperature loggers

Firstly, preliminary results of the temperature measurements are presented using the example of the measurements on the outer shell structure in the wet lab (WL) and in the waste treatment room (GTR) as well as the void spaces below and the void space next to the bow thruster room (BTR). The temperature distribution in the outer shell in these areas is shown in Firure 10 to *Figure* 12. The temperature curves are very similar, with minimum temperatures of around -5°C and maximum temperatures of around 48°C. While the lowest temperatures measured are within the expected range, the highest temperatures were not expected. These high temperatures cannot be caused by one or more heat sources in the ship, but must have been caused by environmental influences. One hypothesis that can be formulated is the impact of solar radiation in relation to the ship's dark paintwork

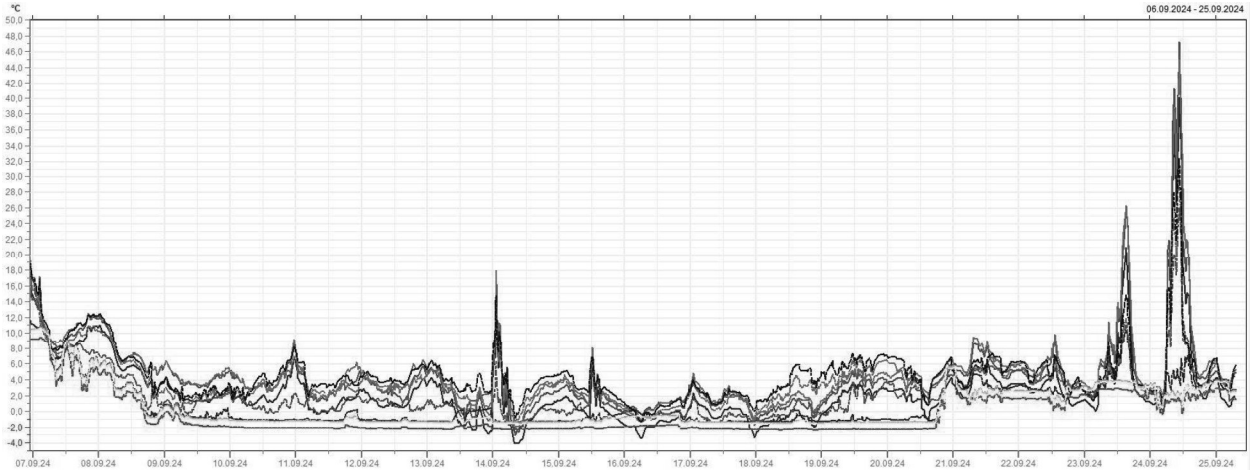

Figure 10. *Outer shell temperature distribution of the WetLab (WL) and the void space below on starboard side*

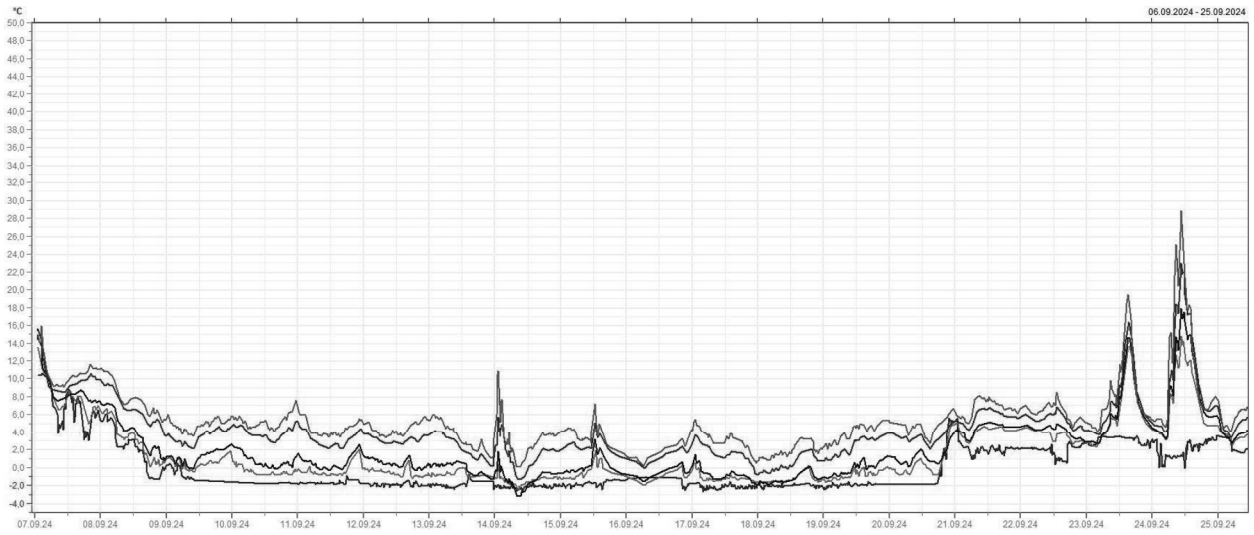

Figure 11. *Outer shell temperature distribution of the void space next to the Bow Thruster Room (BTR) on starboard side.*

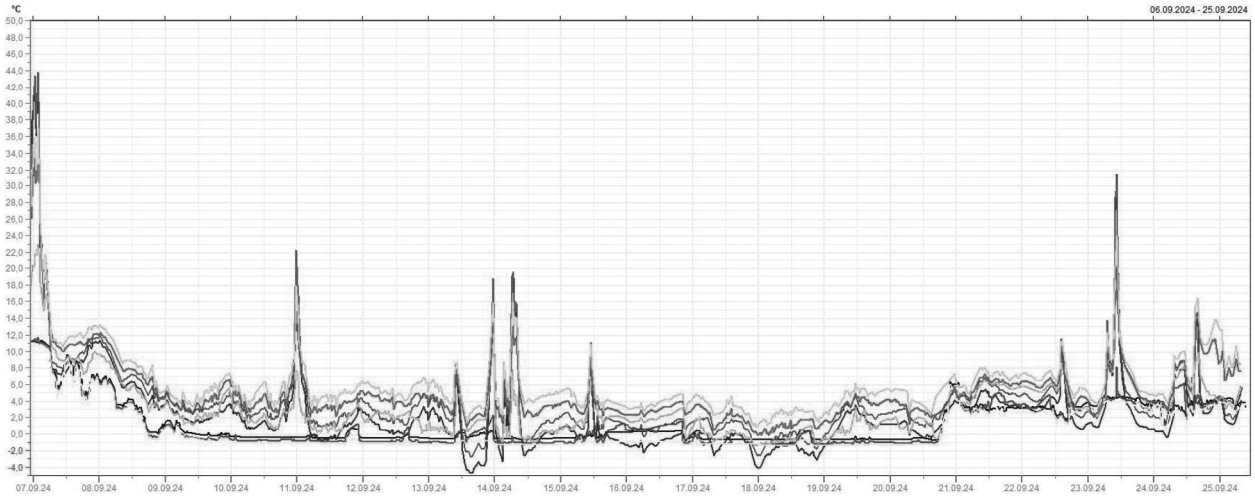

Figure 12*. Outer shell temperature distribution of the Garbage Treatment Room (GTR) and the void space below on port side.*

3.3.2 Station work on sea ice and from the vessel

During the station work, ice cores were drilled and experiments on the ice to characterize the (mechanical) properties of the ice, ice thickness measurements and drone flights were carried out. Three buoys were deployed on ice floes of ice stations CH-ICE-S03 and CH-ICE-S04 (see Table 4 and below). The ice stations were carried out during landings on the ice from the ship or by Zodiac. The measurements lasted several hours while the ship was stationary. The following 9 with the information on the tests therefore only contains the coordinates and times at the start of the respective investigations:

Table 9: Ice station list

TABLE 9	Date	Time	Latitude	Longitude	Gear	Remarks/Recovery
Station No.	2024	[UTC]	[°]	[°]	[-]	[-]
CH-ICE-S01	09.09.	21:51	77.401	-164.347	coring system, auger drill, MISTD, thermometer	thickness measurements, coring: temperature, salinity, strength

CH-ICE-S02	11.09.	19:38	84.210	-173.602	coring system, auger drill, MISTD, thermometer	thickness measurements, coring: temperature, salinity, strength
CH-ICE-S03	13.09.	18:30	85.854	139.029	coring system, auger drill, MISTD, thermometer	thickness measurements, coring: temperature, salinity, strength
CH-ICE-S04	15.09.	18:04	89.899	-44.005	coring system, auger drill, MISTD, thermometer	thickness measurements, coring: temperature, salinity, strength
CH-ICE-S05	16.09.	13:05	89.791	-7.172	coring system, auger drill, MISTD, thermometer	thickness measurements, coring: temperature, salinity, strength
CH-ICE-S06	18.09.	15:42	85.729	30.910	coring system, auger drill, MISTD, thermometer	thickness measurements, coring: temperature, salinity, strength
CH-ICE-S07	20.09.	09:41	82.623	19.802	coring system, auger drill, MISTD, thermometer	thickness measurements, coring: temperature, salinity, strength

Sea ice surface properties and roughness based on aerial photographs: Mavic 3 drone flights

While the ship was stationary, aerial photographs were taken with a drone during six flights. Variable weather conditions led to different flight altitudes (20-450 metres) and flight times (approx. 5-20 minutes). So-called orthomosaics are created from the images obtained. These provide an aerial overview of the surveyed and surrounding ice floes of the respective ice stations, the distribution of ridges, leads and level ice. Frozen and partially snow-covered melt ponds can also be detected and their distribution analysed. The compilation of several orthomosaics along the route provides valuable insights into the developing characteristics of the sea ice surface, e.g. the melt ponds from the sea ice edge to the central pack ice.

Figure 13 displays the orthomosaic captured on 13.09.2024 at the magnetic pole.

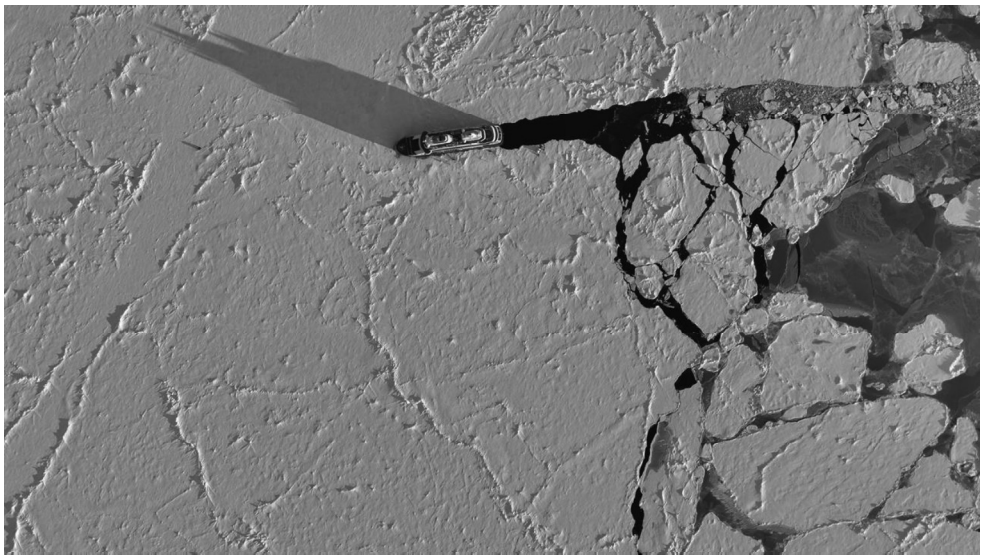

***Figure 13**. Orthomosaic from drone images at the magnetic pole captured on 13.09.2024.*

Ice thickness drilling

Ice thickness drillings are carried out by following an imaginary straight line on the ice, drilling holes at regular intervals (ten steps, i.e. ca. 10 m) and determining the thickness using an ice thickness measuring gauge. The snow thickness and ice freeboard are also recorded. The data obtained in this way are then used to produce a thickness profile for the ice floe being analysed. Initial results are shown in the Figure 14.

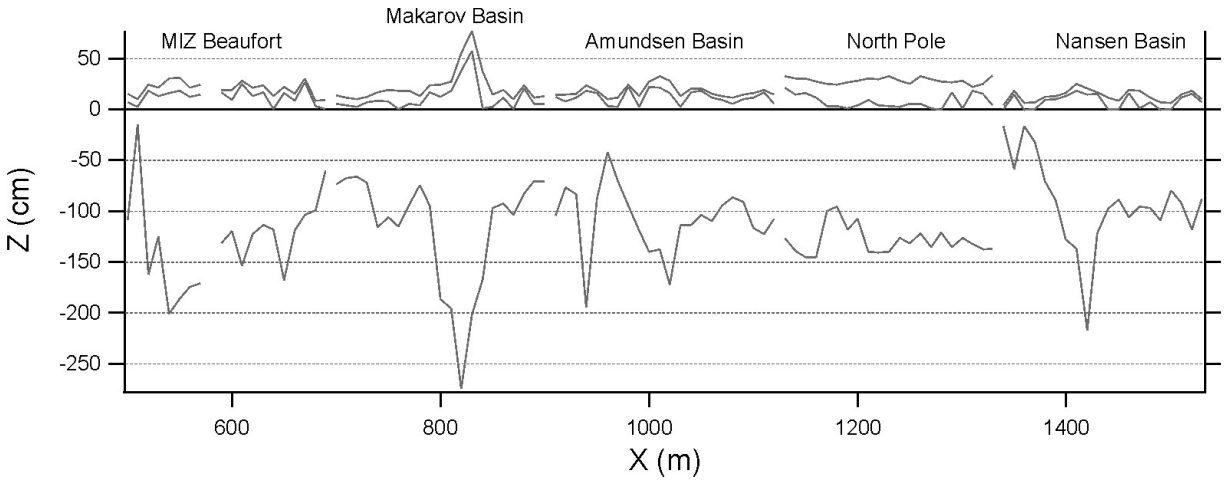

Figure 14. *Ice thickness drill-hole profiles of all floes visited during CHARCOT2024.*

Coring

During the ice stations, several ice cores were drilled to determine the distribution of temperature, salinity, and strength in the ice over the thickness. The temperature was measured immediately after taking the cores. The cores were then cut into 10 cm long sections and brought on board in appropriate transport containers. There they were allowed to melt to determine the salinity in the melt water.

Separate cores were used to measure the compressive -, plate bending - and tensile strength. These were cut into sections and then loaded with a special Mobile Ice Strength Test Device (MISTD), a hydraulic driven test apparatus and the forces and deformations that occurred were measured. The tests were usually carried out directly on the ice. The tests at stations CH-ICE-S01 and CH-ICE-S07 are an exception. Here, the ice was brought on board and tested, as it was not possible to bring the test device onto the ice.

The exact number of cores taken and their utilization can be seen in the following list:

- CH-ICE-S01: 1 core temperature and salinity; 1 core strength
- CH-ICE-S02: 1 core temperature, salinity and strength; 1 core strength
- CH-ICE-S03: 1 core temperature and salinity; 2 core temperature, salinity and strength; 2 cores strength
- CH-ICE-S04: 1 core temperature, salinity and strength; 3 cores strength
- CH-ICE-S05: 1 core temperature and salinity; 4 cores strength
- CH-ICE-S06: 2 cores temperature and salinity; 7 cores strength
- CH-ICE-S07: 1 core temperature, salinity and strength; 1 core strength

The measured temperature and salinity distribution of ice core #14 obtained at ice station CH-ICE-S05 is shown as an example in Figure 15.

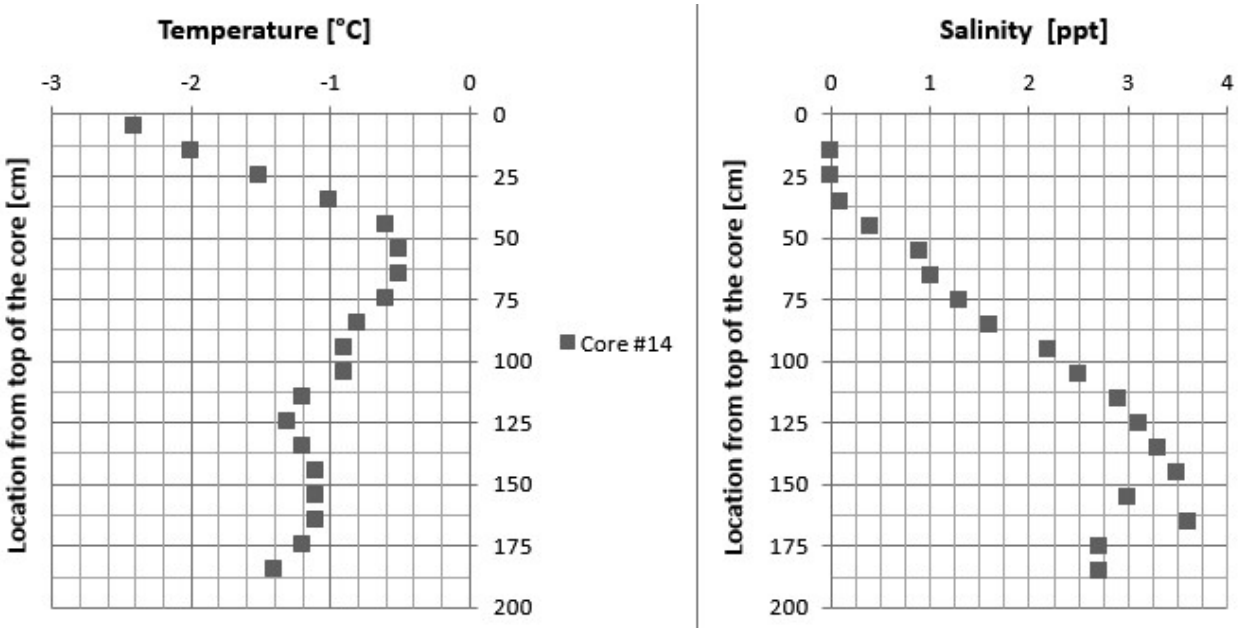

Figure 15. *Temperature and salinity distribution of ice core '14 from ice station CH-ICE-S05.*

The profiles are recorded with a resolution of 10 cm. The recorded profiles are in line with existing theories that salt migrates towards the bottom of the ice. The salinity at the top layers was at times zero due to refrozen melt ponds which are formed from snow. The cause of discontinuities and deviations remains to be investigated, but is in some cases already linked to a high local property variation.
Mechanical ice properties are linked to the temperature and the salinity which is reflected in the compiled averaged compressive strength measurements in Figure 16.

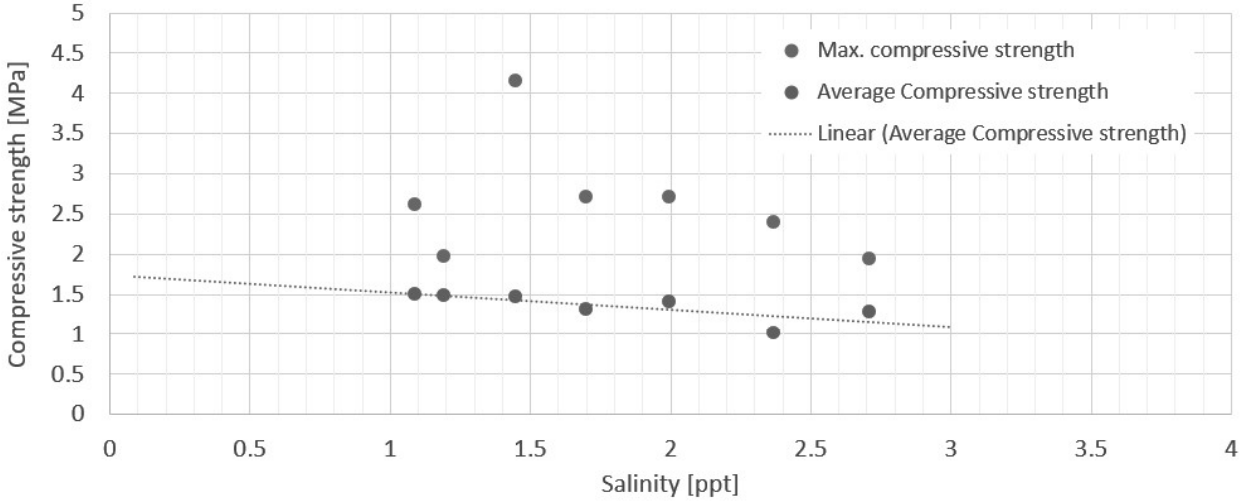

Figure 16. *Variation of the mean and maximum compressive strength as a function of the salinity measured.*

Deployments of buoys on sea ice for continuous measurements

In total, three buoys were deployed: two Snow Buoys measuring snow depth and surface atmospheric conditions, and one thermistor string sea ice mass balance buoy (type SIMBA) measuring temperature profiles of air, snow, sea ice, and ocean. One Snow Buoy was deployed on the ice floe of ice station CH-ICE-S03, and one Snow Buoy and one SIMBA were deployed at CH-ICE-S04. All data are made available through the data and information

portal Meereisportal.de, at the following link: https://data.meereisportal.de/relaunch/buoy?lang=en (search for Charcot 2024 under "Expedition" on the right). Buoy deployment included testing of the buoys on board before deployment, drilling of holes in the ice, installation, and deployment, and complementary measurements and descriptions of the sea ice conditions and sensors.

3.4 Microplastics and Nanoplastics

3.4.1 Microplastics

ZHAO Lab:

MICROPLASTICS

Science lead: Shiye Zhao (Japan Agency for Marine-Earth Science and Technology)
Scientist on board: Shiye Zhao (Japan Agency for Marine-Earth Science and Technology), Lixin Zhu (East China Normal University)

Plastic pollution has been identified as one of the significant environmental changes in the Arctic Ocean, which has also been proposed as an important sink of plastic debris inputted by surface and subsurface currents from lower latitudes (Pacific and Atlantic sections) and Arctic rivers. During their travel to the Arctic Ocean, plastic debris degrades into small particles such as microplastics, nanoplastics, and releases different chemicals into the surrounding seawater under different physical, chemical and biological forces. However, the state of these small fragments and chemicals in the Arctic Ocean is limitedly studied and how microorganisms respond to these chemicals are unknown.

In CHARCOT project, our goals are to 1) understand the response of microorganisms to the dissolved organic matter (DOM) releasing from plastic debris; 2) study the differences of 'Plastisphere' along the Arctic Transect, which is defined as microorganisms living on the surface of plastic debris. The results of this study will contribute to explore the role of microbial communities coping with plastic pollution in the context of climate-driven changes, which is of utmost importance for understanding the interwoven effects of plastic pollution on the fragile Arctic marine ecosystem; 3) Explore the pollution level and characterization of typical plastic additives, especially UV stabilizers in the seawater, sea ice, snow and typical plastic debris collected; some biogeochemical parameters such as DOC, POC, DBC, nutrients, CDOM, FDOM, N_2O were planned to be analyzed in the sampled stations to check the relationships with plastic additives and further promote our understanding about its sources and sinks; 4) As the side project, microplastics in the air were sampled continuously while the cruise was sailing to explore the contribution pattern and characterization of microplastics in the Arctic ocean.

In total, the following activities were conducted during the whole cruise: 7 incubation stations across the Arctic Ocean (Figure 17, 18; Table 10); 6 Manta net two stations (Figure 19; Table 11); 45 samples were collected for POC and DOC (Table 12); 35 samples were collected for plastic additives analysis (Table 13); 24 samples were collected for DBC or FTICR MS analysis (Table 14); 68 samples in total were collected for DOC, CDOM, nutrients and N_2O analysis. 17 samples were collected for air microplastic study (Table 15).

Table 16 shows the future analysis of the samples gained during the cruise.

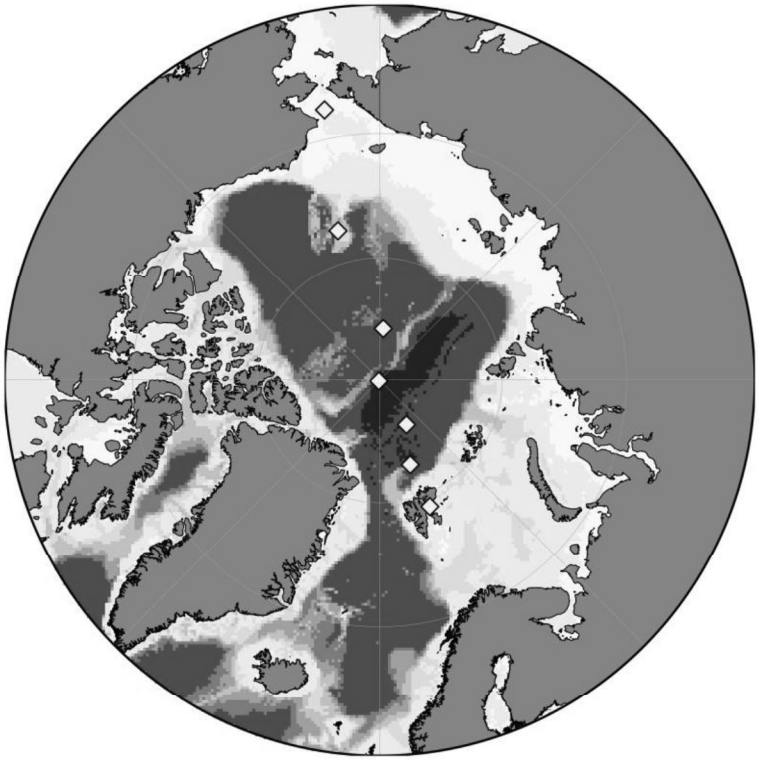

Figure 17. *The stations where the incubation experiments were conducted.*

Figure 18. *The incubation experiments conducted onboard.*

Table 10. The station information of the incubation experiment.

Latitude^{o}	Longitude^{o}	Station No.
67.71	-168.46	1
77.34	-164.41	2
85.81	176.03	3
89.89	-38.07	4
85.73	30.83	5
82.65	19.83	6
78.90	21.64	7

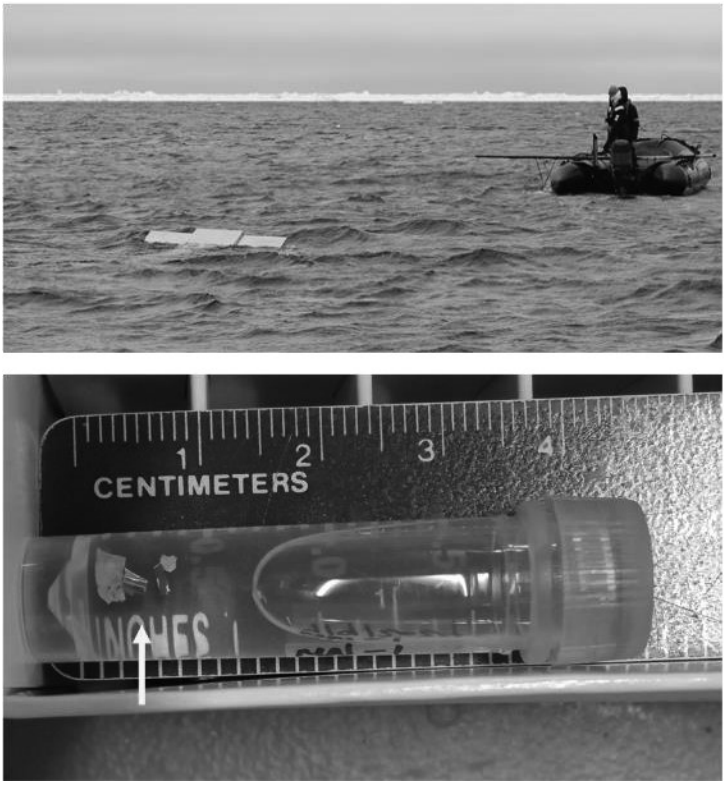

Figure 19. *Upper) Towing the manta net during the cruise; Lower) Plastisphere samples collected*

Table 11. The stations for towing the Manta Net.

Latitude°	Longitude°	Station No.
77.34	-164.41	1
82.65	19.83	2
79.71	21.77	3
79.35	20.77	4
78.21	20.95	5
78.90	21.64	6

Table 12. The stations for POC samples.

Latitude°	Longitude°	Station No.
64.80	-168.06	Sample#1
68.43	-168.46	Sample#2
70.12	-168.44	Sample#3
73.11	-168.52	Sample#4
75.66	-164.83	Sample#5
78.78	-163.57	Sample#6
81.67	-167.40	Sample#7
82.08	-168.55	Sample#8
82.08	-168.55	Sample#9
84.21	-173.58	Sample#10
84.21	-173.58	Sample#11
84.21	-173.58	Sample#12
84.21	-173.58	Sample#13
85.81	-176.05	Sample#14
85.85	-139.48	Sample#15
85.85	-139.48	Sample#16
85.85	-139.48	Sample#17

85.85	-139.48	Sample#18
85.85	-139.48	Sample#19
88.44	-141.13	Sample#20
90.00	0.00	Sample#21
90.00	0.00	Sample#22
90.00	0.00	Sample#23
90.00	0.00	Sample#24
90.00	0.00	Sample#25
90.00	0.00	Sample#26
90.00	0.00	Sample#27
90.00	0.00	Sample#28
87.24	34.69	Sample#29
85.73	30.83	Sample#30
85.73	30.83	Sample#31
85.73	30.83	Sample#32
85.73	30.83	Sample#33
82.65	19.83	Sample#34
82.65	19.83	Sample#35
82.65	19.83	Sample#36
79.61	19.41	Sample#37
79.61	19.41	Sample#38
79.61	19.41	Sample#39
78.90	21.64	Sample#40
78.90	21.64	Sample#41
78.56	19.16	Sample#42
78.56	19.16	Sample#43
78.56	19.16	Sample#44
78.56	19.16	Sample#45

Table 13. The stations for plastic additives samples

Latitude°	Longitude°	Station No.
64.80	-168.10	Sample#2
67.71	168.46	Sample#3
68.43	-168.50	Sample#4
70.12	-168.40	Sample#5
73.11	-168.50	Sample#6
75.66	-164.80	Sample#7
77.34	164.40	Sample#8
78.78	-163.60	Sample#9
81.67	-167.40	Sample#10
82.08	-168.60	Sample#11
82.08	-168.60	Sample#12
84.21	-173.60	Sample#13
85.81	-176.10	Sample#14
85.85	-139.50	Sample#15
85.85	-139.50	Sample#16
85.85	-139.50	Sample#17
85.85	-139.50	Sample#18
88.44	-141.10	Sample#19
90.00	0.00	Sample#20
90.00	0.00	Sample#21
90.00	0.00	Sample#22
90.00	0.00	Sample#23
90.00	0.00	Sample#24
90.00	0.00	Sample#25
85.73	30.83	Sample#26

85.73	30.83	Sample#27
85.73	30.83	Sample#28
85.73	30.83	Sample#29
85.73	30.83	Sample#30
82.65	19.83	Sample#31
79.61	19.41	Sample#32
78.90	21.64	Sample#33
78.90	21.64	Sample#34

Table 14. The stations for DBC/FTICR-MS samples

Latitude°	**Longitude°**	**Station No.**
64.80	-168.10	Sample#2
67.71	168.46	Sample#3
68.43	-168.50	Sample#4
70.12	-168.40	Sample#5
73.11	-168.50	Sample#6
75.66	-164.80	Sample#7
77.34	164.40	Sample#8
78.78	-163.60	Sample#9
81.67	-167.40	Sample#10
82.08	-168.60	Sample#11
84.21	-173.60	Sample#12
84.21	-173.60	Sample#13
84.21	-173.60	Sample#14
85.81	-176.10	Sample#15
85.85	-139.50	Sample#16
85.85	-139.50	Sample#17
90.00	0.00	Sample#18

90.00	0.00	Sample#19
90.00	0.00	Sample#20
87.24	34.69	Sample#21
85.73	30.83	Sample#22
82.65	19.83	Sample#23
78.90	21.64	Sample#24

Table 15. The stations for airborne microplastic samples

Latitude°	Longitude°	Station No.
68.19	-168.46	Sample#1
75.76	-164.71	Sample#2
79.27	-163.72	Sample#3
84.39	-168.54	Sample#4
85.15	-178.24	Sample#5
86.00	-149.47	Sample#6
86.57	140.83	Sample#7
89.98	169.20	Sample#8
89.84	-17.31	Sample#9
89.55	16.53	Sample#10
86.73	33.17	Sample#11
84.67	26.22	Sample#12
82.70	19.92	Sample#13
79.71	21.76	Sample#14
79.35	20.76	Sample#15
78.21	20.95	Sample#16
78.56	19.19	Sample#17

Table 16. Future analysis of samples and the principal approaches required.

Studies	Sample type	Future Measurements	Methods utilized
Incubation experiment	eDNA	Microbiomes	Shotgun sequencing
	DOC	DOC concentration	TOC analyzer
	DOM (PPL columns)	Molecular signature	FT-ICR-MS

Manta Net	eDNA on plastics	Microbiomes	Shotgun sequencing
	plastics	Polymer	FTIR
Plastic additivers	HLB columns;	Plastic additives	GC-MS
DBC	PPL columns	DBC	LC
CDOM	Filtered water	CDOM	Fluorescence Spectrophotometer
N_2O	Seawater	N_2O	IRMS
Nutrients	Seawater	Nutrients	Nutrients Analyzer
POC	GF/F filters		EA-IRMS
Air microplastics	GF/A filters	Air microplastics	µ-FTIR; py-GC/MS

3.4.2 Nanoplastics

GIGAULT Lab:

NANOPLASTICS

Science lead: Giulien Gigault (Laval University/TAKUVIK)

Scientist on board: Caroline Guilmette (Laval University/TAKUVIK), Indiana Bruzac (Laval University/TAKUVIK)

The main objective of this project is to document the presence, fate and impact of anthropogenic nanoparticles in the Arctic Ocean.

To do this, the team used a scientific pump from the boat to collect seawater in 20-liter intakes, which we filtered to concentrate the colloidal portion where we find the nanoparticles (7 times during this cruise; Tabble 17). To do this we used Amicon cells (10 and 150 kDa filters) in the laboratory to concentrate large volumes of water into volumes of more or less 20mL so that they could be brought back to Quebec more easily (Table 17). These samples will then be cold-dried at Université Laval and stored for later analysis (Size-characterization, quantification and characterization in nano particles).

The team also used an in situ pump to filter seawater directly under the fast ice or from a zodiac (Table 17). We pumped more or less 20 liters of water to sample the nano plastics and the nano iron whenever we could, at different depths. We made 4 zodiac trips and 4 trips on the fast ice.

Table 17. Sampling activities for nano plastic and nano iron.

Name Sample	Tyoe	Station	Latitude	Longitude	Day (dd/mm/yy)	Sampling	Volume (L)	analysis
CC_20240908_Station1	SWS	1	69°35'17.36"N	168°28'32.92"W	08/09/2024	OP	20,0	nano iron
CC_20240909_Station2	SWS	2	74°22'54.30"N	167°2'29.96"W	09/09/2024	OP	26,5	nano iron
CC_20240909_80_Station3_1	SWS	3	77°24.5484'N	164°25.320'W	09/09/2024	Z, M	20,2	nanoplastic
CC_20240909_200_Station3_1	SWS	3	77°24.5484'N	164°25.320'W	09/09/2024	Z, M	20,2	nano iron
CC_20240909_Station3	SWS	3	77°26'9.86"N	164°29'44.01"W	09/09/2024	op	28,9	nano iron
CC_20240910_Station4	SWS	4	80°45'28.72"N	164°48'26.10"W	10/09/2024	OP	20,0	nano iron
CC_20240911_Station5	SWS	5	84°13'0.08"N	173°41'40.26"W	11/09/2024	UI, M	20,0	nano iron
CC_20240911_80_Station5_1	SWS	5	84°12.4959'N	173°34.887'W	11/09/2024	UI, M	20,2	nanoplastic
CC_20240911_200_Station5_1	SWS	5	84°12.4959'N	173°34.887'W	11/09/2024	UI, M	20,1	nano iron
CC_20240912_Station6	SWS	6	85°48'29.81"N	176°4'2.90"E	12/09/2024	OP	20,0	nano iron
CC_20240913_80_Station7_1	SWS	7	85°51.0534'N	139°7.9140'E	13/09/2024	UI, M	20,1	nanoplastic
CC_20240913_200_Station7_1	SWS	7	85°51.0534'N	139°7.9140'E	13/09/2024	UI, M	20,2	nano iron
CC_20240913_80_Station7_20m	SWS	7	85°51.0534'N	139°7.9140'E	13/09/2024	UI, M	20,2	nanoplastic
CC_20240913_80_Station7_50m	SWS	7	85°51.0534'N	139°7.9140'E	13/09/2024	UI, M	20,1	nanoplastic
CC_20240913_200_Station7_20m_1	SWS	7	85°51.0534'N	139°7.9140'E	13/09/2024	UI, M	20,1	nano iron
CC_20240913_200_Station7_50m	SWS	7	85°51.0534'N	139°7.9140'E	13/09/2024	UI, M	20,0	nano iron
CC_20240913_Station7	SWS	7	85°51'0534"N	139°7'9140"E	13/09/2024	UI, MP	20,0	nano iron
CC_20240915_80_Station8_8m_1	SWS	8	89°54.309'N	45°43.959'E	15/09/2024	UI, M	20,2	nanoplastic
CC_20240915_200_Station8_8m_1	SWS	8	89°54.309'N	45°43.959'E	15/09/2024	UI, M	20,3	nano iron
CC_20240915_80_Station8_20m_1	SWS	8	89°54.309'N	45°43.959'E	15/09/2024	UI, M	20,2	nanoplastic
CC_20240915_200_Station8_20m_1	SWS	8	89°54.309'N	45°43.959'E	15/09/2024	UI, M	20,1	nano iron
CC_20240915_Station8	SWS	8	89°54.309'N	45°43.959'E	15/09/2024	UI, MP	20,0	nano iron
CC_20240917_Station9	SWS	9	87°16'13,85"N	35°20'13,55"E	17/09/2024	OP	20,0	nano iron
CC_20240918_80_Station10_1	SWS	10	85°43'51,88"N	30°49'44,39"E	18/09/2024	UI, M	20,2	nanoplastic
CC_20240918_200_Station10_1	SWS	10	85°43'51,88"N	30°49'44,39"E	18/09/2024	UI, M	20,4	nano iron
CC_20240918_200_Station10_2	SWS	10	85°43'51,88"N	30°49'44,39"E	18/09/2024	UI, M	20,2	nano iron
CC_20240918_Station10	SWS	10	85°43'51,88"N	30°49'44,39"E	18/09/2024	UI, MP	20,0	nano iron
CC_20240919_Station11	SWS	11	83°47'52,95"N	27°30'40,49"E	19/09/2024	OP	20,0	nano iron
CC_20240920_80_Station12_1	SWS	12	82°40'8,09"N	19°52'43,63"E	20/09/2024	Z, M	20,1	nanoplastic
CC_20240920_200_Station12_1	SWS	12	82°40'8,09"N	19°52'43,63"E	20/09/2024	Z, M	20,2	nano iron
CC_20240920_Station12	SWS	12	82°40'8,09"N	19°52'43,63"E	20/09/2024	Z, MP	20,0	nano iron
CC_20240921_80_Station13_1	SWS	13	79°42'33,14"N	21°46'5,32"E	21/09/2024	Z, M	20,8	nanoplastic
CC_20240921_200_Station13_1	SWS	13	79°42'33,14"N	21°46'5,32"E	21/09/2024	Z, M	20,3	nano iron
CC_20240921_Station13	SWS	13	79°42'33,14"N	21°46'5,32"E	21/09/2024	Z, MP	20,0	nano iron
CC_20240922_Station14	SWS	14	79°14'48,40"N	22°57'32,69"E	22/09/2024	Z, MP	20,0	nano iron
CC_20240922_Station14_Glace	ICE	14	79°14'48,40"N	22°57'32,69"E	22/09/2024	Z	20,0	nano iron

SWS = Sea-water sample; OP = ongoing pump; Z = zodiac; UI = under ice; M = micropump; MP = manual pump

3.5 Mammal Observation

3.5.1 Observation Effort and Sightings

FILICIOTTO Lab:

MAMMAL OBSERVATION

Science lead: Francesco Filiciotto (Institute of Polar Sciences)
Scientist on board: Francesco Filiciotto (Institute of Polar Sciences)

The sampling effort for this study spanned 24 days and was primarily concentrated in the time interval available in accordance with the other on board activities and data collection requirements of the campaign.

In total, we recorded six sightings of the following mammal species during the observation effort:

1. Polar bear (Ursus maritimus); in total 7 specimens
2. Fin Whale (Balaenoptera physalus); in total 1 specimen

In the observed instances, all mammals exhibited travel behavior, consistently refraining from any alterations or adjustments in response to the presence of the ship.

3.6 Ethnography study

3.6.1 Etnography of Arctic Science

ADASHEVA-KLEIN Lab

ETNOGRAPHY

Science lead: Elena Adascheva-Klein (Yale University)
Scientist on board: Elena Adascheva-Klein (Yale University)

The social sciences project titled Ethnography of Arctic Science carried out an ethnographic study of sampling practices during a research cruise. The study addressed the following research questions: In what ways do scientists engage with the Arctic environment through their field practices and interactions on board? How do scientists organize their data collection practices on ice, in the open water, and on board? What methods, instruments, and technologies do scientists employ in their data sampling, and how do these tools shape their engagement with the environment and the knowledge-making process? The research employed several methods, including participant observation, where the researcher followed scientists during their sampling and some lab work; semi-structured interviews conducted with the science team, science officers, the chief engineer, and the bridge crew; and the collection of a visual dataset comprising over 3,000 photographs and video clips. In the first stage of the research, the researcher conducted an overview of all the projects and the science team on board, assessing access to interlocutors and selecting targeted projects. Interviews with the chief engineer and the science officer provided deeper insights into the ship's scientific infrastructure and the organization of research activities. Following this assessment, four science teams or

individual scientists were chosen for focused observation: Takuvik Laboratory for open-water sampling; Christian Haas for ice measurements; David Pears for aerobiological sampling conducted both outside and on board; and Fuat Dursun for onboard sampling using Niskin bottles and zooplankton and phytoplankton nets. These projects involved scientists sampling air, water, and ice from the Arctic environment using a range of techniques for various research purposes. During the active research phase, the researcher accompanied the selected teams at their sampling sites and, in some cases, worked as a field assistant. Field notes, visual notes, and interview clips were recorded during these sessions. Between ice landings and sampling events, the researcher conducted interviews with the selected scientists as well as with two captains on board. The post-fieldwork stage involves organizing and categorizing the collected data, writing descriptive accounts of the observed sampling practices, interpreting and analyzing the findings within the context of existing literature, and exploring potential implications for disciplinary theory along with practical recommendations. This research provided valuable insights into the processes through which scientific knowledge about the Arctic environment is created today. It also showcased the importance of the Ponant Science initiative and "Le Commandant Charcot" in supporting polar research, aiming to raise public awareness and share knowledge from the Charcot Transarctic expedition with a broader audience.

4. Preliminary Results

At present, the samples have not yet arrived in most of the laboratories.

5. Data and Sample Storage / Availability

The data will be made available following what was already described in the design phase.

6. Participants

Name	**Institute, Country**	**Scientific discipline**
Maurizio Azzaro*	Institute of Polar Sciences, Italy	Microbial Ecology, Marine Mammals
Alessandro Ciro Rappazzo		
Federico Citterich		
Francesco Filiciotto		
Franz von Bock und Polach	Hamburg University of Technology, Germany	Sea-ice properties, ship structure
Jan M. Kubiczek		
Christian Haas	Alfred Wegener Institute, Germany	Sea-Ice Physics
Nicolas Cassar	Duke University, United States of America	Biogeochemistry
Alireza Merikhi		
Leticia Barbero	National Oceanic and Atmospheric Administration, United States of America / CIMAS, University of Miami, United States of America	Biogeochemistry
Fuat Dursun	Istanbul University, Türkiye	Plankton ecology
Elisabeth Rosselli	Alfred Wegener Institute, Germany	Plankton ecology/micronutrients, Phycotoxins
Ricarda Kluge		

David Pearce	Northumbria University, United of Kingdom	Microbial Ecology
Shiye Zhao	Japan Agency for Marine-Earth Science and Technology, Japan	Plastic and microplastics
Lixin Zhu	East China Normal University, China	Biogeochemistry
Caroline Guilmette	Laval University/TAKUVIK, Canada	Environmental chemistry, anthropogenic (nano)particles
Indiana Bruzac		
Elena Adasheva-Klein	Yale University, United States of America	Sociocultural Anthropology

*Principal Investigator

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