

Forel Heritage Association

Activity Report 2025

2025



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Forel Heritage Association – 2025 Activity Report

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Preamble

Note on gender usage: For ease of reading, the masculine form is used as a neutral term and refers to all people, regardless of gender.

The Forel Heritage Association, a Swiss non-profit organization, is responsible for managing the FOREL research vessel. Its mission is to provide Swiss and international scientists with an oceanographic research platform specially designed for polar and subpolar environments, with a particular focus on coastal oceanography and the land-air-ocean continuum. This mission also includes the development of new research instruments in close collaboration with world-renowned universities such as EPFL and ETHZ.

The Association also aims to train young sailors and scientists in polar environments, while raising awareness of environmental issues among younger generations and the general public through educational programs and community actions. This objective also includes a commitment to indigenous communities in polar regions, which are heavily impacted by the consequences of climate change.

Finally, through its activities, the Association aims to pay tribute to François-Alphonse Forel, a Swiss scientist born in 1841, considered the father of limnology, who lived in French-speaking Switzerland.

The website www.forel-heritage.org provides more information about the Association and the FOREL sailing vessel.



PART I
2025 Expeditions

1. Introduction

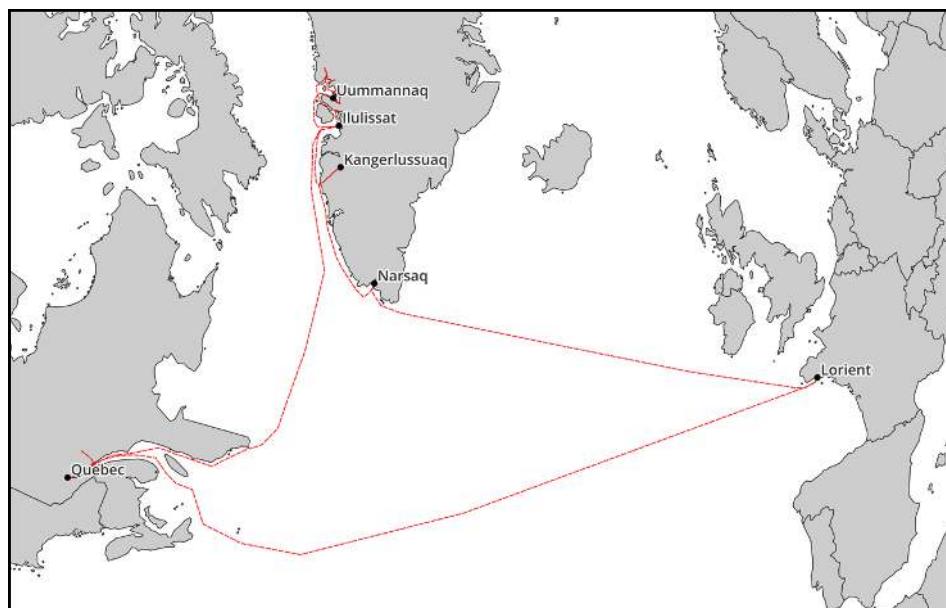
After a trial year in 2024, which validated FOREL as a platform capable of hosting and carrying out high-quality scientific projects, the goal for 2025 was to expand both the number of expedition days and the number of projects. As a result, the 2025 navigation program was increased to 127 days, compared to 60 in 2024.

The 2025 mission was divided into two main parts. Following excellent interactions with Canadian scientists involved in polar research, the first part of the mission took place in Canadian waters, particularly in the St. Lawrence River and Saguenay Fjord. The second part took place on the west coast of Greenland, partly as a continuation of projects already carried out during the 2024 mission, thus enabling a multi-year continuum in data collection and analysis. This second part of the mission also enabled the deployment of new measurement technologies, whether from a tethered balloon or a drone, innovations that are in line with the specific nature of FOREL.

2. Convoying and navigation

The field campaign took place during the summer of 2025. The mission was divided into the following stages (legs):

- Leg 1 : from Lorient (France) to Quebec City (Canada)
- Leg 2 : from Quebec City to Ilulissat (Greenland)
- Leg 3 : from Ilulissat to Kangerlussuaq, via the Uummannaq region
- Leg 4 : from Kangerlussuaq to Narsaq



The FOREL left the docks of the Cité de la Voile Éric Tabarly (Lorient, France) on May 19, 2025, to begin its transatlantic crossing to Quebec City, where it arrived on June 4.

The mission in Canadian waters took place from June 14 to July 1. While sailing between Canada and Greenland, the vessel's crew recovered an Argos buoy (<https://www.argos-system.org>) that was defective and needed some repairs. These buoys are used to measure various physical and chemical conditions in the ocean, such as temperature, salinity, pressure, and ocean currents.

FOREL arrived in Ilulissat (Greenland) on July 5. The month of July was devoted to research projects on the northwest coast of Greenland. After another stopover, FOREL left Ilulissat on Swiss National Day, August 1st, heading for the southwest fjords (Sermilik, Narsarsuaq, and Igaliq).

Following the return voyage, FOREL docked in Lorient on the night of September 21-22, 2025.



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3. Scientific projects in Canada

3.1 Introduction

A total of four research programs were conducted in Canadian waters during the summer of 2025. These programs focused on: (a) analyzing the physicochemical properties of the water in the Saguenay Fjord, (b) sampling nanoparticles and microparticles in the Saguenay Fjord, the estuary, and the Gulf of St. Lawrence, (c) mapping the walls of the Saguenay Fjord, and (d) sampling plankton in the estuary and the Gulf of St. Lawrence.

The vessel served as a research platform for scientists affiliated with Canadian institutions, including Laval University and the University of Quebec at Chicoutimi, as well as ETH Zurich (Switzerland).

During this expedition, the team aboard FOREL conducted a wide range of oceanographic operations. A total of 34 sound velocity profilers (SVP) and 65 conductivity-temperature-depth (CTD) probes were deployed. In addition, 25 plankton collection nets were used, and 14 stations dedicated to particle filtration and 6 stations for environmental DNA (eDNA) sampling using peristaltic pumps for in situ filtration were carried out. The fjord walls were successfully mapped using multibeam sonar, a first in this region.

To supplement the data collected at each oceanographic station, an onboard system (SubCtech) was used to monitor the physicochemical properties of surface water in real time. This system was mainly used in the Saguenay Fjord.

The rest of this chapter provides an overview of the scientific projects carried out during the first part of the 2025 mission in Canadian waters.

3.2 Physico-chemical profiling of the water column

- Prof. **Philippe Archambault**, Department of Biology, ULaval, Canada

Project objectives

- Analyze the physicochemical properties of the water column;
- Identify water masses and understand their dynamics.

The relationship between biodiversity and ecosystem functioning has become a major area of research, highlighting the importance of biological diversity in maintaining ecosystem stability and resilience. Ecosystem functioning refers to the processes and interactions that support life and ensure the health and stability of the system. Among the key processes influenced by biodiversity, bioturbation plays a crucial role. This phenomenon, carried out by various benthic invertebrates, involves the mixing and reorganization of sediments, thereby altering their biogeochemistry and nutrient fluxes.

For this project, FOREL carried out physicochemical profiling of the water column using CTD. These data provided valuable measurements on the environmental controls of bioturbation and ecosystem functioning.

3.3 Characterization of natural and anthropogenic micro- and nanoparticles

- Prof. **Julien Gigault**, Department of Biology, ULaval, Canada

Project objectives

- Map the geographical distribution of pollutant particles;
- Quantify the concentration of these particles;
- Identify the nature and composition of the particles;
- Assess their environmental impact.

Natural and anthropogenic nanoparticles and microparticles are widespread in the environment. However, their role and effects in biogeochemical cycles and marine ecosystems remain poorly understood due to the difficulty in isolating and characterizing them. Analytical methods must therefore be developed to address this gap, especially since anthropogenic nanoparticles, such as nanoplastics or other engineered particles, are widely recognized as a significant threat.



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With climate change, inputs of natural and anthropogenic nanoparticles into the St. Lawrence Estuary and Gulf from various sources are expected to increase, potentially leading to unknown consequences for biogeochemical cycles and marine ecosystems.

Water sampling was carried out continuously through a clean intake located at the bow of the vessel, and periodically using an in situ pump. Samples were taken directly to the laboratory for processing and/or conditioning depending on the nature of the planned analyses.

3.4 Mapping of the Saguenay Fjord cliffs

- Prof. **Vincent Lecours**, Department of Human and Social Sciences, UQAC, Canada

Project objectives

- Produce high-resolution mapping of the fjord's vertical walls;
- Model potential habitats along these structures.

The objective of this project was to contribute to improving knowledge of marine and coastal habitats within a National Marine Conservation Area, as well as the area's richness in aquatic biodiversity.



@Stéphane Aebischer

The insights gained and the maps produced will serve to inform decision-making regarding the protection and conservation of habitats and species present in the Saguenay Fjord.

Habitat mapping using echo sounders is commonly used to assess benthic biodiversity, yet such assessments rarely include vertical structures, which, like seafloor habitats, can provide unique and critical environments for many species. As a result, biodiversity assessments have often underestimated the diversity, biomass, and availability of these habitats.

Among other outcomes, the project will identify new habitats that are critical for species at risk, which will fall under the protection mandate of Parks Canada. Additionally, by producing a baseline inventory of the habitats along the underwater vertical cliffs of the fjord – thus offering a reference of the natural heritage of the Saguenay-St. Lawrence Marine Park – Parks Canada will have the necessary information to support restoration efforts in the event of maritime incidents (such as oil spills) or to address the impacts of climate change, all within a sustainable development framework.

Parks Canada will also integrate the management of these coastal habitats into the next version of its management plan. Furthermore, the knowledge generated will be incorporated into outreach and educational initiatives through maps and 3D models of the fjord's vertical walls.

The Saguenay Fjord is a unique and understudied environment. Exploration of its vertical underwater cliffs is still in its early stages, and this project produced the first high-resolution maps of selected sections of these vertical formations.

3.5 Biodiversity gradient of mesozooplankton from the coast to the open ocean in high latitudes

- Dr. **Meike Vogt** and Dr. **Virginie Marques**, Environmental Physics, ETH Zurich, Switzerland

Project objectives

- Compare mesozooplankton diversity between open-ocean and coastal waters in high-latitude regions;
- Identify bioindicator species and key ecosystem structures.

This project compared mesozooplankton diversity between the open ocean and coastal waters in high latitudes, to assess what fraction of marine plankton may benefit more from offshore versus coastal Marine Protected Areas (MPAs). This project is part of the 30x30 Initiative, Canada's commitment to protect 30% of its land and waters by 2030 in order to combat biodiversity loss and climate change.

To do this, the project authors used optical instruments such as the Planktoscope (www.planktoscope.org), a participatory imaging tool that made it possible to identify species and collect data on their biomass, biovolume, and ecological characteristics. These analyses helped identify bioindicator species and key ecosystem structures, assess functional diversity, determine major contributors to ecosystem functioning, and monitor energy and matter flows within the food web. This work provided essential knowledge on plankton biodiversity and supported efforts toward improved marine conservation.

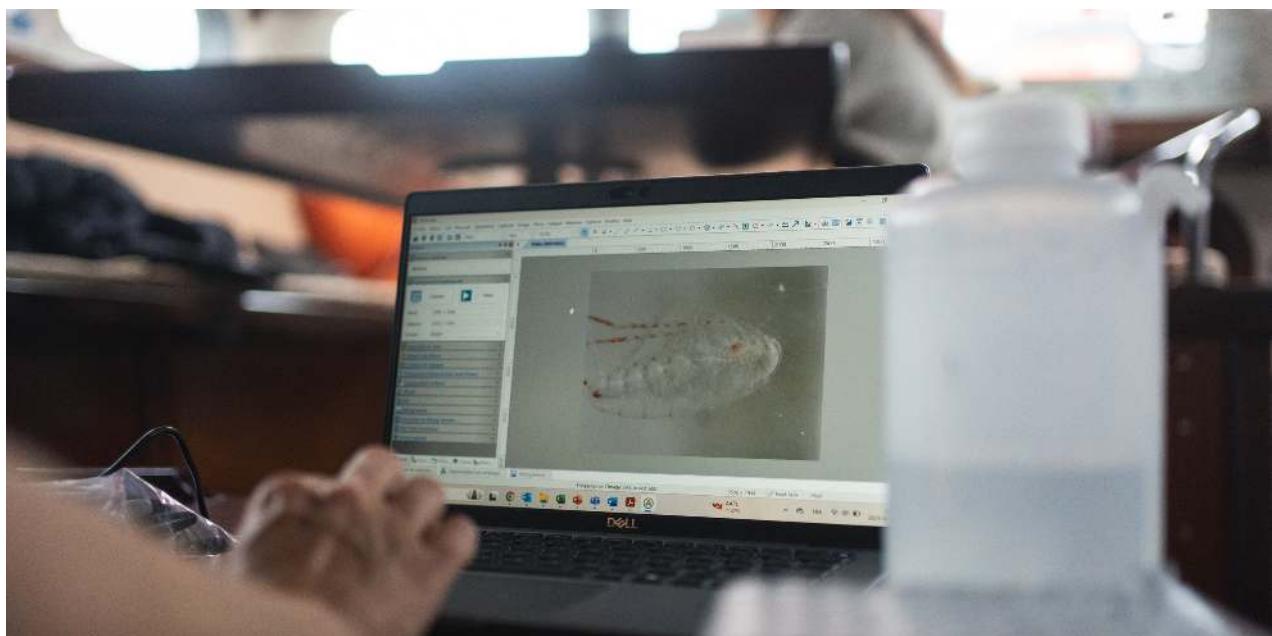
Water samples were also filtered using a dedicated system to compare data from the Planktoscope with results from environmental DNA (eDNA) analysis.

3.6 Sample collection

The table below shows for each project the open-access storage location for the data collected and processed during this mission.

The digital data collected via the onboard sonar will be processed over the coming months. The physicochemical data for surface waters and CTD measurements have already been processed and are available via the Canadian Integrated Ocean Observing System (CIOOS).

| Project | Storage |
|--------------|--|
| Water column | Canadian Integrated Ocean Observing System (CIOOS) |
| Particles | St. Lawrence Global Observatory (SLGO) |
| Mapping | St. Lawrence Global Observatory (SLGO) |
| Plankton | Ecotaxa |



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4. Scientific projects in Greenland

4.1 Introduction

After its mission in Canada, FOREL continued on to Greenland. Two research campaigns (northwest and southwest) and eight scientific programs were conducted there during the summer of 2025. A total of eleven fjords were sampled.

The vessel served as a research platform for scientists from Canadian institutions, notably Laval University, as well as Swiss institutions, notably ETH Zurich, EPF Lausanne, the University of Lausanne, the Swiss Federal Institute for Forest, Snow and Landscape Research (WSL), and the Swiss Federal Laboratories for Materials Science and Technology (EMPA). It also welcomed researchers from the University of Toulouse (France) and the University of Cape Town (South Africa).

During this second part of the 2025 mission, two types of fjords were studied: those influenced by marine glaciers (MT) and those influenced by land glaciers (LT). As marine glaciers are becoming increasingly rare with the advance of global warming, it is important to collect data in order to better understand and predict the effect of the disappearance of marine glaciers in Greenland's fjords.

The campaign on the northwest coast of Greenland aimed to deepen understanding of the influence of glacial processes on Arctic marine ecosystems. This involved (1) studying the effects of glacier melting on zooplankton assemblages, polar cod larvae, and the structure of the pelagic food web, (2) quantifying dissolved methane concentrations in subglacial outflows from major fjords, and (3) producing high-resolution spatial maps of aquatic micro- and nanopollutants. The study also aimed to assess how meltwater inputs from land and marine glaciers affect seawater chemistry, nutrient availability, and primary productivity through sampling at multiple depths, from the fjord to the continental shelf. Finally, the mission aimed to characterize plankton diversity gradients at different latitudes from coastal areas to the open ocean.

As in 2024, FOREL also served as a research platform for the GreenFjord program (www.greenfjord-project.ch) in August 2025. The overall objective of the campaign was to better understand the impact of climate change on fjord ecosystems and its effects on biodiversity and local communities.

The rest of this chapter provides a brief overview of the scientific projects carried out during the second part of the 2025 mission in Greenlandic waters.



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4.2 Impact of glacier melt on Greenlandic fjord ecosystems: assessing impacts on zooplankton, polar cod larvae, and carbon cycles

- Prof. **Caroline Bouchard**, Department of Biology, ULaval, Canada

Project objectives

- Investigate how glacier melt influences zooplankton communities, polar cod larval populations, and pelagic food webs in Arctic fjords;
- Improve understanding of the Arctic fjords carbon cycle, refine ocean models, and support climate resilience and food security in Arctic communities.

It is essential to understand how variations in glacier melt affect zooplankton assemblages, polar cod larval populations, and pelagic food webs in Arctic fjords. This research will help reduce uncertainties in the Arctic fjords carbon cycle and improve the parameterization of oceanographic models in these complex coastal environments. In the long term, it will enhance our knowledge of how Arctic fjord ecosystems respond to climate change and improve predictions of the consequences for Arctic communities, whose cultural identity and food security rely on these ecosystems.

At each station, a zooplankton net (50 cm diameter frame with a 150 µm mesh net) was deployed vertically to a depth of 170 m, and an ichthyoplankton net (100 cm diameter frame with a 500 µm mesh net) was towed at a speed of 2 knots to a maximum depth of 80 meters. Both nets were equipped with a flow meter. Fish larvae were measured and preserved in ethanol, while zooplankton samples were preserved in a 4% formaldehyde seawater solution.

4.3 Methane emissions and fate from subglacial waters along the west coast of Greenland

- Prof. **Jérôme Chappellaz**, ENAC Faculty, EPF Lausanne, Switzerland

Project objectives

- Measure dissolved methane in subglacial meltwater at major fjord outlets;
- Evaluate how much methane is oxidized in the fjords before reaching the atmosphere.

It has been suggested that subglacially-produced methane is transported to the Greenland ice sheet margin by the subglacial drainage system. Such process could constitute an underestimated export source of methane toward the atmosphere, which could then contribute significantly to the current increase of this greenhouse gas in the atmosphere. This hypothesis is based on existing measurements of dissolved methane conducted in a proglacial river of the Leverett Glacier. However, a large part of Greenland subglacial waters resulting from basal melting reaches the ocean at the base of marine-terminated glacier fjords. There, rapid oxidation in the water column could significantly reduce the amount of methane ultimately reaching the atmosphere.





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The objective of this project was to investigate for the first time how much dissolved methane is present in subglacial water streams exiting at the base of the main fjord outlets, where basal meltwater exits the central western and northern western sectors of the Greenland ice sheet. The project also planned to document the spatial evolution of possible methane anomalies along the water column in the corresponding fjords, to determine the importance of in-situ oxidation by bacterial processes.

A rosette equipped with up to 12 Niskin bottles of 8-liters capacity each was deployed along the water column in the fjords. Once back on the sailboat deck, the water from each bottle was sub-sampled into small vials, which were then sealed and stored before being shipped to Switzerland for analysis.

4.4 Characterization of natural and anthropogenic micro- and nanoparticles

- Prof. **Julien Gigault**, Department of Biology, ULaval, Canada

Project objectives

- Map the geographical distribution of natural and anthropogenic (nano)particles;
- Quantify the concentration of these (nano)particles;
- Identify the nature and composition of the (nano)particles;
- Assess their environmental impact.

Natural and anthropogenic nanoparticles are widespread in the environment. However, the role and effects of these particles in biogeochemical cycles and marine ecosystems are still poorly understood due to the difficulty of isolating and characterizing them. Analytical methods therefore need to be developed to fill this gap, particularly in a context where it is generally accepted that anthropogenic nanoparticles, such as nanoplastics, pose a significant threat.

With climate change, the inputs of natural and anthropogenic nanoparticles into the ocean from various sources are likely to increase, which could lead to unknown consequences on biogeochemical cycles and marine ecosystems. In this context, this study aimed to investigate the spatial distribution of these particles in the Arctic Ocean, particularly along the west coast of Greenland, with a particular focus on micro- and nanoparticles of plastic, black carbon, and metals released by glaciers into the ocean.

Natural and anthropogenic nanoparticles present in seawater were collected using the rosette and the seawater intake line leading directly to the wet lab. At each station, at least around 20 liters of water were sampled for each type of nanoparticle studied: anthropogenic contaminants, metals, and lithogenic tracers.

The water was then pre-filtered using 80 µm metal filters for anthropogenic nanoparticles and 200 µm nylon filters for metal nanoparticles and lithogenic tracers. Additional samples were also taken for nutrient and total organic carbon (TOC) analysis. Sampling was carried out at two different depths: at the surface and at a variable depth determined from the CTD profile.

The water samples were then transferred either to the wet lab or to the clean lab, depending on the type of analysis to be performed (plastics or metals). Tangential flow filtration (TFF) was used to separate and concentrate the micro- and nanoparticulate phases from the dissolved phase.

The micro/nanoparticulate phases were concentrated to a final volume of around 60 mL by removing the dissolved fraction. This concentrate was then left to settle at 4°C for 48 hours to separate the microparticles that settle and the nanoparticles that remain in suspension.



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4.5 Biogeogenic fluxes in Greenlandic fjords: impacts on marine ecosystems and nutrient cycling

- Prof. **Samuel Jaccard**, Institute of Earth Sciences, University of Lausanne, Switzerland

Project objectives

- Examine how glacial meltwater affects nutrient supply and primary productivity in Arctic fjords;
- Compare the impacts of marine- and land-terminating glaciers on seawater chemistry and phytoplankton growth.

Glacier-fed rivers and streams are characterized by elevated dissolved nutrients concentrations and sediments loads, which impact seawater chemistry/physics, nutrient availability and primary productivity. Non-glacial streams fed primarily by meteoritic precipitation are characterized by contrasting weathering processes, organic matter and nutrients sources compared to glacial catchments. Increasing supply of nutrients via meltwater (Si, P, Fe) and/or plume upwelling may stimulate primary productivity yet enhanced suspended sediment delivery may reduce light availability and thereby limit phytoplankton growth. The response of marine productivity to enhanced meltwater discharge is thus ultimately dependent on glacier type (marine- vs. land-terminating glacier), fjord glacier geometry, phytoplankton nutrient requirements, and trophic interactions.

Seawater samples were collected using the CTD rosette. The sampling plan included oceanographic stations located along the land-continental shelf continuum in each fjord. At each station, sampling covered 6 to 10 depths depending on the location, and included the measurement of several physicochemical parameters. To improve data resolution, additional CTD stations were added along the transect. These were supplemented by continuous monitoring of surface water properties (CO₂, temperature, fluorescence) using the Ferrybox installed on FOREL.

4.6 Biodiversity gradient of mesozooplankton from the coast to the open ocean in high latitudes

- Dr. **Meike Vogt** and Dr. **Virginie Marques**, Environmental Physics, ETH Zurich, Switzerland

Project objectives

- Compare mesozooplankton diversity between open-ocean and coastal waters in high latitude regions;
- Identify bioindicator species and key ecosystem structures.

This project is a continuation of the one carried out in Canadian waters (see description in section 3.5).

4.7 Land-Ocean-Atmosphere interactions of biodiversity- and climate-relevance (GreenFjord)

- Prof. **Julia Schmale**, ENAC Faculty, EPF Lausanne, Switzerland
- Prof. **Samuel Jaccard**, Institute of Earth Sciences, University of Lausanne, Switzerland
- Prof. **Loïc Pellissier**, Ecosystems and Landscape Evolution, ETH Zurich, Switzerland
- Dr. **Lucas Paoli**, Microbiome Immunity and Ecology lab, EPF Lausanne, Switzerland
- Dr. **Anna Carratala**, ENAC Faculty, EPF Lausanne, Switzerland

Project objectives

- Study microbial diversity in the air, water, ice, and soil in polar environments;
- Compare microbial communities along vertical gradients in the atmosphere and water column;
- Analyze how environmental factors (wind, humidity, temperature, solar radiation) influence microbial composition and distribution;
- Monitor atmospheric chemical composition, including aerosols and volatile organic compounds involved in new particles formation.

The overall objective of the GreenFjord research program (www.greenfjord-project.ch), supported by the Swiss Polar Institute (SPI) and running from 2022 to 2026, is to create process understanding of how climate change affects fjord ecosystems, and how this propagates to biodiversity and livelihoods. The program consists of six research clusters studying the ocean, glaciers, atmosphere, land, biodiversity, and the perception and effects of climate change on local communities in fjord ecosystems of southwestern Greenland.



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The goal of the 2025 expedition was to investigate the ocean-ice-air, and biodiversity interactions in the Nordre Sermilik, Tunulliarfik, and Igaliq fjords in southwestern Greenland, at high spatial and temporal resolution. The objective was to study processes relevant to climate change and biodiversity in these contrasting fjord systems, i.e. fjords where glaciers still terminate in the water, and fjords where glaciers have receded so far that only rivers flow into the fjord.

Mass fluxes between compartments encompass exchange of microbes as well as biogenic gases. Once in the air, microbes become bioaerosols that can drastically change clouds through nucleating ice, and gases can be converted into particles that form cloud droplets. Clouds are essential energy regulators in fjord systems subject to climate change. The project therefore aimed to chemically and microbiologically identify fluxes of biogenic gas and particles to estimate their climate impacts. To do this, the objective was to deploy a brand-new aerosol sampling and analysis technique developed at EERL-EPFL to quantify organic functional groups. In addition, high-throughput sequencing was performed to link the marine with the atmospheric microbiome.

The project also probed trace metals as well as nutrients circulation in the various fjords to investigate in how far the differing water circulation patterns impact the primary productivity of microbial organisms and their biodiversity.

Water, air, and soil samples were taken to investigate microbial communities and their diversity. While bioaerosols, ice, and water are often studied separately, comparative analyses across these interconnected environments, as well as their responses to environmental changes, remain limited. During this expedition, a time series of simultaneous bacterial samplings in both the atmosphere and the water column was carried out. This was achieved using a custom-built, automated tethered balloon system (Helikite) equipped with a microbial biosampler, in combination with a CTD-rosette and a submersible peristaltic pump. The bioaerosol and water samples were then analyzed to characterize bacterial communities using high-throughput sequencing and in vitro functional tests in the laboratory. At the same time, several meteorological parameters were monitored to assess how environmental changes influenced the abundance, diversity, and composition of bacterial communities along continuous atmosphere-ocean vertical profiles.

Seawater samples from both inside and outside the target fjords were size fractionated through serial filtration, with each filter size capturing a specific component of the microbial community. For each sample, the filters were cut into several pieces and flash-frozen in liquid nitrogen for downstream analyses. The frozen material was later used for DNA, RNA, protein, and metabolite extraction, followed by sequencing or biochemical profiling, as appropriate. These integrated approaches provided a comprehensive view of the molecular diversity of the microbial communities.

For selected samples, specific size fractions were resuspended in filter-sterilized seawater for on-site incubation and cultivation experiments. Using lightweight and innovative dilution- and probe-based isolation strategies, novel cultivation methods were tested to better characterize polar and subpolar microbial diversity.

4.8 Proof-of-concept studies for new technology and sensors

- Prof. **Julia Schmale**, ENAC Faculty, EPF Lausanne, Switzerland
- Prof. **Mirko Kovac**, ENAC Faculty, EPF Lausanne, Switzerland
- Dr. **Lucas Paoli**, Faculty of Life Sciences, EPF Lausanne, Switzerland

Project objectives

- Deploy innovative platforms to sample hard-to-reach polar environments;
- Use a tethered balloon (Helikite) to collect airborne microbiome and aerosol data up to cloud level;
- Launch an aerial-aquatic robot (MEDUSA) to sample surface and deep waters in unsafe zones near icebergs and glacier fronts.

It is inherently difficult, but essential, to conduct vertical observations of the atmosphere between the ground and cloud level. To do this, a custom-built automated tethered balloon system (Helikite), specially designed to measure the air microbiome and other aerosol particles, including those present in clouds, was deployed from FOREL.



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It should be noted that this was the first time this type of equipment had been deployed from a sailboat. All flights were carried out in strict compliance with civil aviation regulations, with the Helikite limited to a maximum altitude of 100 m.



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Pushing the limits even further, the aim of this project was also to demonstrate the relevance of launching an aerial-aquatic robot capable of performing automated sampling in surface and deeper waters away from the sailboat, in areas unsafe for scientists to operate, for example near large icebergs or glacier calving fronts. This part of the project relied on the MEDUSA (Multi-Environment Dual-robot for Underwater Sample Acquisition) platform, a multimodal drone equipped with a separate underwater sensor and sampler.

The MEDUSA consisted of a hexacopter measuring approximately 1.2 x 1.2 meters equipped with a tethered underwater robotic sampling tool. MEDUSA flew within 100 meters of the boat, landed on the water surface, and collected water samples. The robotic sampling tool contained electronics for propulsion and control, as well as an internal pump for collecting water samples (approximately 2 liters). It was physically connected to the floating drone.



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This first attempt demonstrated that future studies could equip MEDUSA with more complex underwater sensors to acquire samples in these hard-to-reach areas. This innovative method of sampling the marine microbiome will likely lead to a leap forward in our understanding of how the fjord ecosystem works.



@Julien Girardot



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4.9 Social science investigation on the perception of changing fjords by local residents

- Prof. **Laine Chanteloup**, Faculty of Geosciences and Environment, University of Lausanne, Switzerland

Project objectives

- Explore residents' perceptions of changing fjord systems and climate-related scientific research;
- Engage community members, especially young people, in field activities and conduct interviews to better understand their connection to the local environment.

The GreenFjord program includes social science studies aimed at understanding the perceptions of Narsaq residents on the changing fjord systems and of scientific research on climate change in the region. Since many residents, especially teenagers, have not seen much of the immediate area around Narsaq, the goal was to take two residents on board for about three days so they could discover the area and participate in scientific activities.

Narsaq residents were introduced to the scientific activities carried out on board, and structured interviews were conducted with them. At the same time, a teenager or young adult and an elderly person participated in scientific activities, observed, and shared their impressions. The social scientist assisted them and guided the interviews. Intercultural exchanges, which were not directly related to science, were also encouraged and emerged naturally as time was spent together.

A total of eight Greenlandic participants (four young people and four adults) embarked on FOREL and were directly involved in the vessel's scientific operations. Over two days each, they took part in the handling of Niskin bottles and received pedagogical instruction on scientific procedures carried out on board. It should be noted that this level of participation was significantly higher than initially planned, as only two participants had been expected.

In addition, an open day was organized for the residents of Narsaq. Approximately 100 schoolchildren visited the vessel, along with about 30 adults from the community.



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4.10 Sample collection

The data and samples collected by the campaign teams on the northwest coast of Greenland will be processed mainly at the following institutions:

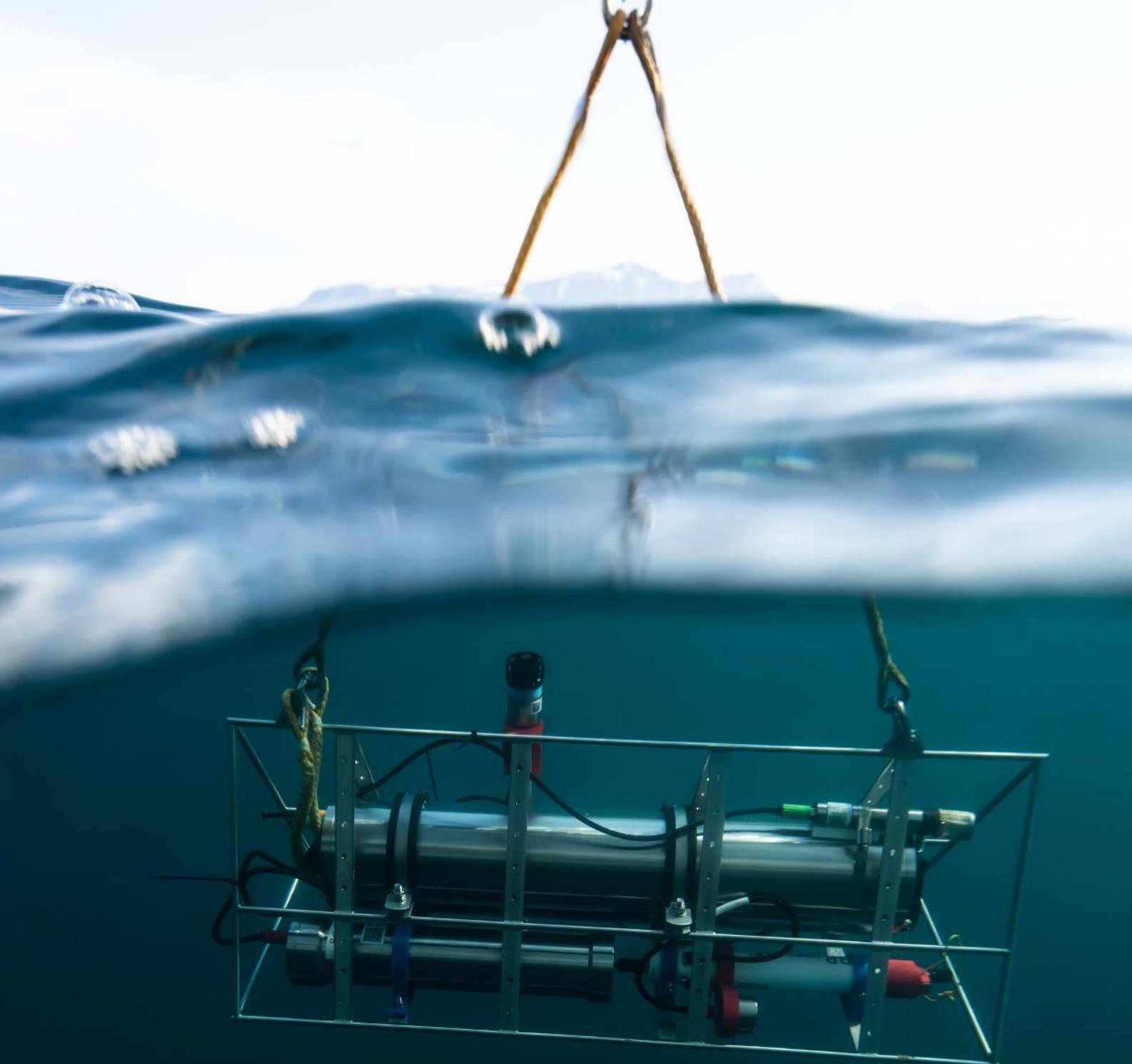
- Laval University, Department of Biology, Canada;
- Takuviq International Joint Laboratory, Laval University and CNRS, Canada;
- University of Toulouse, France;
- Smart Environmental Sensing in Extreme Environments, EPFL, Switzerland.

The data and samples collected by the GreenFjord team will mainly be processed at the following institutions:

- Department of Environmental Systems Science, ETH Zurich (ETHZ), Switzerland;
- Extreme Environments Research Laboratory (EERL), EPFL, Switzerland;
- Institute of Earth Sciences, University of Lausanne (UNIL), Switzerland;
- University of Liège, Belgium.

Researchers will share their data via open-access repositories.

| Projet | Stockage |
|--------------------|--|
| Ichtyoplankton | Polar Data Catalogue |
| GHG | Shared with Dr. Lorenz Meire (GINR) |
| Particles | By 2030, open access repository. Data base TBD |
| Plankton | By 2027, open access repository zenodo.org |
| Ocean | By 2027, open access repository zenodo.org |
| Atmosphere | By 2027, open access repository zenodo.org |
| Biodiversity | By 2027, open access repository envidat.ch |
| Microbial data | By 2029, open access at ENA (sequencing) and EBI (profiling) |
| Microbial isolates | By 2029, available upon requests or the public collection DSMZ |



PART II

Scientific Advisory Board

The year 2025 saw the creation of the Scientific Advisory Board (FOREL SAB), whose main mission is to help define FOREL's overall scientific strategy. Through this advisory role, the Board will make a key contribution to defining the calls for projects that will be implemented on the platform in the coming years.

The Board is made up of highly involved and renowned figures in the polar world, namely:

- **Jérôme Chappellaz**, paleoclimatologist and oceanographer, EPFL, Switzerland, co-chair;
- **Warwick Vincent**, limnologist and microbial ecologist, Laval University, Canada, co-chair;
- **Marcel Babin**, oceanographer, CNRS, Laval University, Canada;
- **Stéphane Blain**, microbial oceanographer, CNRS, Sorbonne University Paris, France;
- **Antje Boetius**, marine biologist, president and CEO of the Monterey Bay Aquarium Research Institute (MBARI), United States;
- **Françoise Gaill**, marine biologist, CNRS, Pierre Marie Curie University, France;
- **Philippe Gillet**, geophysicist, former Vice President of EPFL, Switzerland;
- **Gerald Haug**, climatologist and geologist, Director of MPI, Germany, and ETH Zurich, Switzerland;
- **Bethany Jenkins**, marine microbiologist, Vice President for Research, University of Rhode Island, United States.



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Thanks to their international involvement, the members of the FOREL SAB will be able to support the Association's networking activities, particularly in terms of access to major polar programs and projects.

During initial discussions, the SAB acknowledged the strong added value of FOREL for the polar science community, highlighting the platform's major assets, in particular the top-level scientific equipment supporting various disciplines, the capacity to address the rapidly changing, climate-driven and poorly documented coastal environments, the great flexibility of implementation, the science projects addressing specifically the land-air-ocean continuum through a multidisciplinary approach, the emphasis given to technological development with multi-platform support, as well as the inclusion of local communities through dialogue and knowledge exchange.

The Forel SAB also provided valuable ideas and specific recommendations in terms of measurement capacities, spatial coverage and areas for scientific exploration, as well as suggestions about innovative technologies to further develop and deploy on FOREL. Collaborations with other platforms like the research sailboat Eugen Seibold has also been encouraged.

At the same time, and in order to facilitate the implementation of future projects on FOREL, it was decided to create a scientific coordination committee based on the main domains related to the scientific projects carried out on the platform. This committee will be set up in 2026.



PART III

Shipyard activities 2

At the end of the 2024 expedition, the vessel docked in Lorient on August 17, 2024. The autumn period provided an opportunity to carry out a technical review following this first test year and to prepare for the work to be carried out during the winter and early spring of 2025.

In early January 2025, the crew gathered in Lorient to begin the planned work. As some of this work required the vessel to be taken out of the water, FOREL was placed in dry dock on January 15, 2025, for a period of three months.

In addition to routine maintenance, the main work focused on the following areas.

- **Engines:** overhaul and finalization of the SCR system (AdBlue injection into the exhaust lines), improvement of the vents for ventilation of the engine room.
- **Safety:** new fire detection system, new water detection system, installation of a class A automatic detection system (AIS).
- **Boat operation:** modification of seawater intakes, modification and improvement of the boiler chimney to move it as far away as possible from the scientific atmospheric air intakes, improvement of the wastewater treatment system, creation of a workbench and workstation in the workshop, installation of a new hydraulic pump for the autopilot, overhaul and simplification of the autopilot controls.
- **Deck and hull:** installation of new furling systems, new sails (mainsails and jibs), raising of deck railings, study and installation of the daggerboard, sealing of small rudders.
- **Science:** improved sealing of the clean lab, creation of a hull pole for the SONIC V 2020 multibeam echo sounder (Saguenay wall echo sounder), creation of a new flange for atmospheric air intake at the front of the boat, installation of an eccentric screw pump for surface water and its "clean" water line running from the front of the boat to the wet lab.
- **Bridge and living space:** creation of additional storage space in common areas.

A photograph of a group of people on the deck of a sailboat. In the foreground, a young girl in a dark purple jacket stands on the left. Behind her, four adults are sitting on the deck railing. From left to right: a woman in a black jacket, a woman in a brown sweater, a woman in a light grey hoodie, and a young girl in a dark blue and white striped jacket and a pink beanie. The boat's white hull is visible, with the word "Forel" written in red. In the background, there are large, rugged mountains under a clear blue sky.

PART IV

Communication & Outreach

1. Communication

1.1 Website

In 2025, the website www.forel-heritage.org continued to be the central platform for communication and scientific outreach for FOREL's missions, with a significant increase in traffic and engagement compared to the previous year.

Between January and October 2025, the site recorded 21,345 visits (January to October 2024: 10,167 visits). The English version accounts for around one-third of visits.

1.2 Multimedia content

- Photos: continuous production by the teams on board, used on social media, the website and in several educational and scientific documents.
- Professional photographers on board: Julien Girardot and Richard Mardens.
- Videos: creation of content for the Canadian and Greenlandic mission networks, including interviews and field footage. A longer video, recounting the expedition's scientific missions, will be produced at a later date.
- Image capture: Richard Mardens; scientific video editing: Valentin Proult.
- Contrary to what was done in 2024, it was decided not to produce podcasts in 2025.

1.3 Media coverage

By reaching the general public, local communities, and the scientific community, social media and multimedia content play a central role in communicating and popularizing FOREL's missions.

- Instagram: 131 posts (including 15 Reels), 792 followers (327 at the end of 2024), 310 accounts followed. The growth since the account was opened on October 25, 2023, is very clear, reflecting a growing interest in visual and educational content.
- X Network: 231 following, 52 followers. The account relays scientific and educational information in a concise manner.
- Facebook: new account opened in 2025, intended to communicate with Greenlandic communities, with some content translated into Greenlandic.
- YouTube: account opened at the end of 2025, with content to be added including mission profiles and interviews with scientists.
- Video shared on Instagram: portrait of the mapping mission in Saguenay Fjord (Canada), produced by Environment Canada with an interview of Vincent Lecours (UQAC).

In terms of press, media coverage in 2025 extended the visibility of the FOREL project through a series of articles published in France, Canada, England, and Switzerland.

- FOREL – A Swiss Research Vessel for the Scientists (Switzerland — March 2025).
- Sailing to Greenland: A scientific voyage of discovery (England — April 2025).
- The scientific expedition, the seventh port of Lorient (France — May 2025).
- Forel, first mission to the land of mirages (Switzerland — May 2025).
- Forel, first mission to the land of mirages (England — May 2025).
- Forel : at the innovative crossroads of science, culture, and education (Canada — June 2025).
- A Swiss research sailing ship to map the Saguenay Fjord (Canada — June 2025).
- The Forel sailing ship will sail the Saguenay Fjord to map it (Canada — June 2025).
- A Swiss sailing ship in La Baie to map the fjord walls (Canada — June 2025).

- Exploring the walls of the Saguenay Fjord on a Swiss research sailboat (Canada — June 2025).
- Mapping the Saguenay Fjord: the sailing ship Forel Heritage passing through La Baie (Canada — June 2025).
- Forel: from adventure to science (France — July 2025).
- Forel, the Swiss oceanographic sailing vessel in Greenland (France — July 2025).
- Forel, Polar Vessel: First Expedition to the Land of Mirages (France — December 2025).

It should be noted that geographical diversity and editorial quality have been enhanced, with an opening to international markets and new types of media (maritime magazines, scientific press, Canadian media).

Whales online
A GREMM PROJECT

DISCOVER OBSERVE ACT MAGAZINE

FOREL: AT THE INNOVATIVE CROSSROADS OF SCIENCE, CULTURE, AND EDUCATION



The FOREL in the St. Lawrence Estuary © Richard Mardens

1.4 Partnerships and events

Based at the Cité de la Voile Éric Tabarly pontoon, FOREL enjoys high visibility in Lorient, her home port, thanks to several key partnerships and events. This visibility is based on several levels:

- Educational partnerships: FOREL relies on a long-standing partnership with the Cité de la Voile and a new educational partnership with the Espace des Sciences – Maison de la Mer, reinforcing its role as a source of scientific and maritime information for the general public and young people.
- Port events: FOREL has been moored on occasion at the new Péristyle de Lorient pontoon, offering excellent local and national visibility.
- Joint visibility with TARA: in November 2025, FOREL and TARA moored side by side at the Cité de la Voile during a major event. This symbolic gathering of two sailing ships designed for science illustrates the complementarity and continuity of exploration and research projects at sea.



@Julien Girardot



@Julien Girardot

During FOREL's stopovers in Canada, numerous activities helped introduce the vessel to the scientific and local communities:

- Stopovers in Quebec City and La Baie: FOREL welcomed directors and students from research centers (Takuvik, Arctic Net, Quebec Ocean, CEN, INQ, Sentinelle Nord), professors and students from UQAC, teams from the Saguenay – St. Lawrence Marine Park, and staff from the Musée du Fjord. The stopover in Quebec City also provided an opportunity for an exchange of visits between the FOREL and the Canadian Coast Guard research vessel CCGS Amundsen.
- Reporting and outreach: The stopovers provided an opportunity to produce reports and disseminate educational content to local communities. To this end, the Association continued to translate its materials into Kalaallisut (Greenlandic) and distribute them locally (photo exhibitions in villages, communication via community Facebook pages, welcome messages and invitations to come aboard).

At several ports of call, particularly in Greenland, the crew opened the vessel to the public, allowing them to discover the platform and the scientific missions carried out, and to forge human ties between the crew and local communities.

1.5 Scientific communication

FOREL was presented at the Greenland Science Week in Nuuk, a major biennial event celebrating science across Greenland and organized by Arctic Hub from November 7 to 14, 2025. This was an important step towards strengthening the acceptability and integration of the FOREL project within the Greenlandic scientific and local landscape. The event brought together scientists, decision-makers, associations, and local residents, and provided an opportunity to present the project, the scientific missions carried out on board, and the educational and collaborative vision of the Forel Heritage Association.



@Arctic Hub

2. Outreach

2.1 Educational partnership

Since 2024, a permanent educational trail has been set up on the pontoon of the Cité de la Voile Éric Tabarly, alongside the panels dedicated to the Pen Duick sailing ships. These panels present the Forel Heritage Association and the FOREL scientific sailing vessel, allowing the general public to discover the scientific and educational missions of the project, even without boarding the vessel. Between January and October 2025, the pontoon received an estimated 110,000 visitors, including more than 10,000 schoolchildren, a level comparable to 2024.

In addition, school visits aboard FOREL were organized in May 2025, welcoming a total of 98 middle school students. In the fall, the visitor reception system was enhanced: more slots were offered, and the organizational procedure was simplified, now allowing complete autonomy for the guides and facilitators of the Cité de la Voile. These improvements should result in an increase in school attendance throughout 2025.

The partnership with the Maison de la Mer in Lorient, established during the FOREL winter shipyard operations (January 15–March 15, 2025), allowed the public to discover how the port of Keroman works and to get up close to the vessel in a safe environment. Three guided tours were organized, including a presentation of the boat and, where possible, a meeting with a member of the crew. This initiative strengthened the project's local roots and enriched the outreach activities around the vessel during its maintenance period on land.

2.2 Other examples of educational tools

- Educational mini-comic strip *The Forel Notebook*. Two new episodes were published in 2025 (in French, English, and Greenlandic), namely an introductory episode presenting FOREL and an episode on the research of Prof. Jérôme Chappellaz (EPFL). As a reminder, in 2024, an episode was published about Canadian research on benthos (Philippe Archambault). Illustrations: Lauriane Miara.
- Artistic residency: Canadian Madeleine-Zoé Corbeil Robitaille, a doctoral student in biology at Laval University, embarked on FOREL to document the work carried out by Professor Julien Gigault's team. Through her sketches, she captured life on board, the scientific missions, and the landscapes they passed through. Her work will contribute to the creation of a new episode of *The Forel Notebook*.

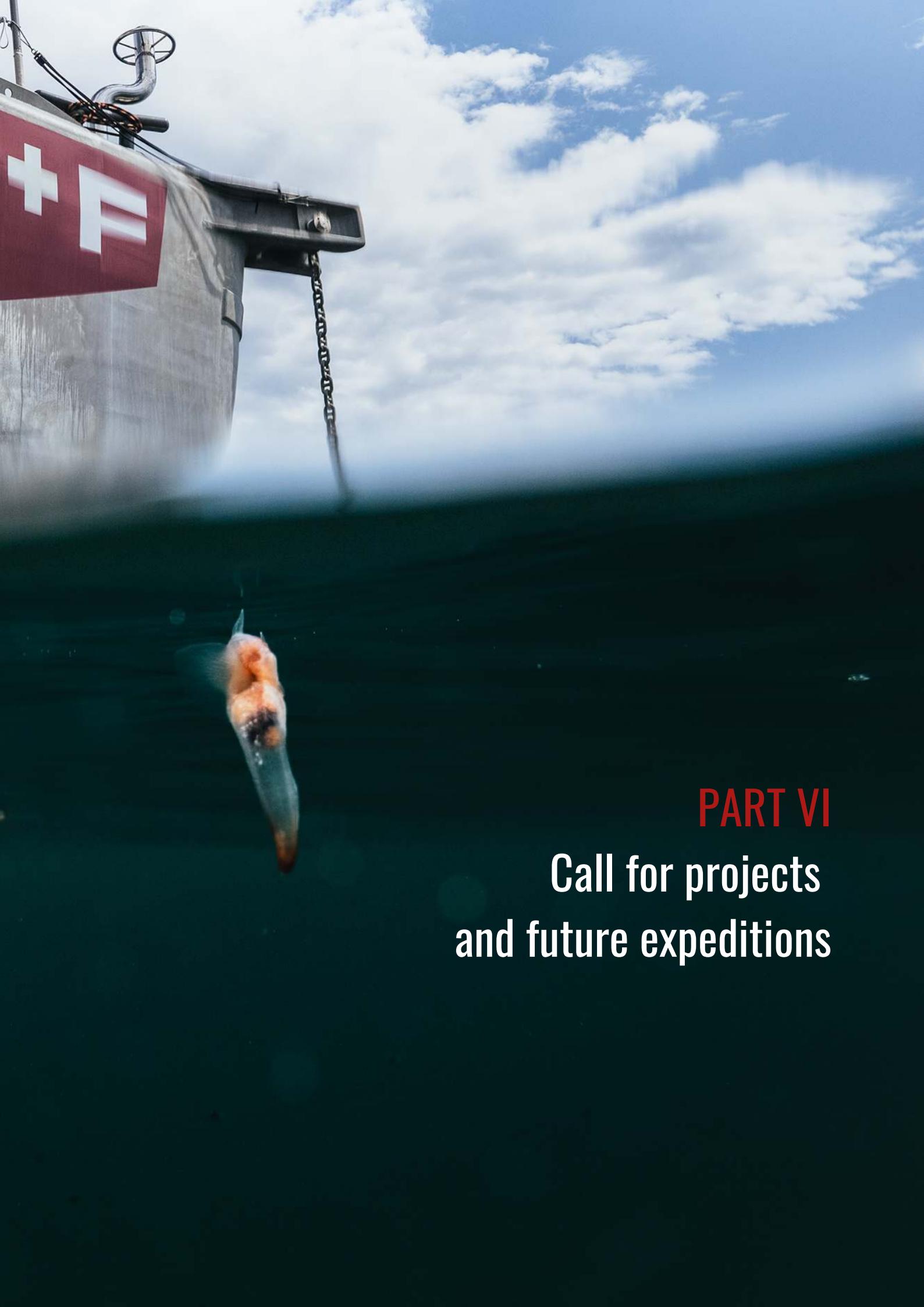


Illustrations @Lauriane Miara

- An exhibition set-up consisting of photographs, texts, and illustrations was designed to be easily transportable aboard FOREL and displayed during stopovers in France and abroad. First presented at the Mondes Polaires Festival organized by the Association Dernière Escale avant l'Amérique in Porspoder (April 25–27, 2025), this exhibition was then installed in Quebec City and displayed for several days in Narsaq (Greenland). Translated into French, English, and Greenlandic, it provides effective and accessible mediation for all audiences.



@Stéphane Aebischer



PART VI
Call for projects
and future expeditions

Given the logistical implications on the one hand, but also in order to take into account the schedules of the various polar research funding bodies, the planning of expeditions for the coming years accelerated in 2025.

In particular, FOREL has been involved in the CASCades project, a joint initiative of the Institut Nordique du Québec (INQ), the Swiss Polar Institute (SPI), and the Institut Paul-Emile Victor (IPEV) aimed at promoting scientific collaboration between the scientific communities of Switzerland, France, and Canada.

This international project will focus on three interrelated research themes that underpin the functioning and transformation of the climate link between Baffin and Labrador, with the aim of understanding the fundamental processes that govern it and their impact on marine ecosystems, meaning:

- Interactions between the atmosphere, glaciers, and oceans at the local scale;
- Coastal circulation as a factor in melting and a vector for freshwater and matter;
- Sea ice formation and upper ocean dynamics during the freeze-up period.

The CASCades expedition will focus on the coastal region of western Greenland, Baffin Bay, and Ellesmere Island. The FOREL-CASCades expedition will focus solely on the west coast of Greenland (June 15 to July 15, 2026).

FOREL's participation in the CASCADES program led to a call for projects for the 2026 summer mission. The projects received were evaluated by an independent scientific committee appointed by the Swiss Polar Institute. They were deemed logistically and technically feasible by the Association.

Once the CASCADES program is complete, FOREL will conduct an independent campaign and focus its scientific work on the less frequented areas of eastern Greenland (July 15 to September 15, 2026).

In addition, initial discussions were held in 2025 regarding the expedition program for 2027-2028, with the support of the FOREL Scientific Advisory Board and in consultation with potentially interested research communities.



@Stéphane Aebischer

PART VI

Conclusion



Conclusion

Following the major work carried out between June 2023 and May 2024, the year 2024 saw the validation of the FOREL platform's suitability for its mission and the objectives of the Forel Heritage Association, created in January 2024.

Building on this initial experience and following a new, less extensive shipyard operation from January to May, FOREL's 2025 scientific mission was planned around two expeditions, the first to Canada and the second to the west coast of Greenland.

First in Canada, where FOREL sailed in the estuary and Gulf of St. Lawrence, as well as in the Saguenay Fjord. The four research programs fully achieved their objectives. The knowledge gained during this Canadian leg of the FOREL 2025 expedition will contribute significantly to the conservation of subarctic marine ecosystems and support the management of marine protected areas, while advancing understanding of the impacts of climate change on coastal environments and fjords.

An international multidisciplinary research program was then successfully conducted in the coastal environments of western Greenland. This program consisted of two campaigns: a study of the northwestern coast of Greenland and the GreenFjord/EPFL project in the southwest. Throughout the mission, a wide range of scientific equipment was deployed. Of particular note was the deployment of a tethered balloon (Helikite) with sample collection, marking a first in the deployment of this type of equipment from a sailboat. In addition, new autonomous technologies, such as the MEDUSA aerial and aquatic robot, were also tested in areas influenced by glaciers, demonstrating their potential for sampling in extreme and difficult-to-access environments.

Through these various projects, strong collaborations have been reinforced with partners such as Laval University, EPFL, ETHZ, and UNIL, and expanded to include the University of Toulouse and the University of Cape Town. Significant engagement with the local communities of Uummannaq and Narsaq has fostered mutual exchange, with residents invited to participate in the scientific process on board as well as in outreach and educational activities.

This Greenland expedition once again confirmed the operational and scientific capabilities of the FOREL research platform in polar regions. The 2025 program brought together researchers from leading academic institutions and innovative technologies aboard FOREL to address pressing issues related to climate change, biodiversity, glacial processes, ocean biogeochemistry, and community perceptions. The knowledge gained will contribute significantly not only to our understanding of Arctic fjord ecosystems and their transformations, but also to considering remediation approaches in the context of ongoing climate change in polar regions.

Thanks to the support of its newly created Scientific Advisory Board and as part of a concerted strategy, FOREL can now look ahead with confidence and plan expeditions for the years to come.



@Richard Mardens

PART VII

Acknowledgements



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As part of the 2025 mission, the Association would like to thank Global Affairs Canada for granting permission to navigate and conduct research in Canadian waters (No. IGR-1648). We would also like to thank the Swiss Embassy in Ottawa for supporting our application.



@Julien Girardot

We would like to thank Fisheries and Oceans Canada (Quebec Region) for allowing us to conduct scientific research in the Gulf and Estuary of the St. Lawrence River and for issuing us a scientific fishing permit (QUE-SCIENTIFIQUE-046-2025). We would also like to thank Parks Canada and the Saguenay-St. Lawrence Marine Park for granting us permission to conduct research and collect samples in the marine protected area (SAGMP-2025-46181). Finally, we would like to thank the Saguenay-St. Lawrence Marine Park for allowing us to use a drone in the park (SPÉ-2025-012).

We would like to thank Canada and its people for their warm welcome and for giving us access to their territory. We also thank the indigenous communities of the Gulf of St. Lawrence for allowing us access to their traditional territory.

We would like to thank the Danish Ministry of Foreign Affairs for granting us permission to sail and conduct research in Greenlandic waters (JTHAV No. 25/11007), including territorial waters (3 Nm; 2025/053195). We would also like to thank the Swiss Embassy in Denmark for supporting our application. We are grateful to the Government of Greenland and its Ministry of Industry and Energy for allowing us to conduct scientific research along the southwestern coast of Greenland and for granting us non-exclusive licenses for the use of Greenland's genetic resources (No. G25-038 and No. G25-055). A flight permit for a Helikite and a MEDUSA drone was also obtained from the Civil Aviation Department.

We would like to thank Greenland and its inhabitants for their warm welcome and for giving us access to their territory.

Finally, we would like to thank all the professional sailors, researchers, and students for their involvement and active contribution to this project. We would also like to thank our partners for their help and support in this project.

Major partners and sponsors



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Communication & outreach partners



Technology partners



Appendix

Crew and team 2025

Shipyard operations

& navigation

(in alphabetical order)

AEBISCHER Stéphane, DELBOT Brieuc, GIRARDOT Julien, GUARIN Virginie, LE GARS Erwan, LE BRAS Steven, LEVASSEUR Jean-François, LOOTEN Nicolas, LUBRANO LAVADERA Julien, PLUS QUELLEC Jean, REAUD Yvan, REGNIER Baptiste, TISNE Lou, ZYSSET Nitya

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