Advanced Field School on Arctic Sea Ice: Tracking Changes Across Scales

Field report/Travel log

April 9-18, 2025, Qikiqtarjuaq, Nunavut, Canada

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Foreword

Under the leadership of the Sentinel North program of Université Laval (Quebec City, Canada) and the UAK international initiative, this advanced field school on arctic sea ice offers students a unique opportunity to engage with leading scientists and experienced professionals through a transdisciplinary, cutting-edge training program. Taking part in an actual ocean research program, participants will gain a better understanding of sea ice changes in the Canadian Arctic, from microstructures to icy landscapes, and explore their cascading impact on ecosystems, northern communities and global climates.

Hosted at the Qikiqtarjuaq Research Station (Nunavut, Canada) (67° 33′ N, 64° 01′ W), this field school provides an integrative learning experience across a wide range of disciplines including optics-photonics, Arctic marine biology and ecology, marine physics, biochemistry and remote sensing. Participants will also have the opportunity to interact with community members of Qikiqtarjuaq, gaining insight into the richness of Inuit knowledge and perspectives on sea ice and the challenges northern communities face in relation to climate variability and change.

School overview

The program addresses three primary topics, focusing on different scales to study sea ice, and the interdependence between these scales :

- **Micro scale:** Structure of sea ice and the life it supports
- **Meso scale:** Importance of sea ice for marine biodiversity, wildlife and coastal communities
- **Macro scale:** Links between polar ocean functioning and global change

Scientific team

Marcel Babin, oceanography, marine optics, Takuvik/Université Laval

Rémi Amiraux, marine biogeochemistry, Takuvik/Université Laval

Jens Ehn, physical oceanography, University of Manitoba

Joannie Ferland, biological oceanography, Takuvik/Université Laval

Marie-Hélène Forget, science coordinator, Université Laval

Maxime Geoffroy, bioacoustics, Memorial University

Matthieu Huot, marine biology, Takuvik/Université Laval

CJ Mundy, biological oceanography, University of Manitoba

Stein Sandven, physical oceanography, NERSC

Participants

15 students in 9 Academic institutions :

- University of Bergen, Norway
- University of California – San Diego , USA
- Université Laval, Canada
- University of Manitoba, Canada
- Laboratoire Physiologie Cellulaire & Végétal, Grenoble, France
- Université de Bretagne Occidentale, CNRS, France
- McGill University, Canada
- Dartmouth College, USA
- Duke University, USA

Torbjørn Wigum Arbo

I'm Torbjørn Wigum Arbo from Trondheim, Norway, currently in my fourth year of an integrated master's in Ocean Technology at UiB (University of Bergen). I've recently developed an interest in Arctic oceanography and optical measurements. My motivation for the Arctic Sea Ice School is to gain hands-on experience with field measurements and instruments while working alongside experts. I hope to see firsthand how these techniques are applied and explore whether this could be a future path for me. Additionally, I'm eager to learn about the food and hunting culture in Qikiqtarjuaq and how the ice has traditionally been used. Outside of academics, I enjoy bouldering, hiking, and snowboarding.

Florence Beaudry

I am Florence, a Ph.D. student in Atmospheric and Oceanic Sciences at McGill University. I completed my undergraduate in Physics and a Master's in Atmospheric Sciences, both in Montreal, Canada. My research focuses on sea ice dynamics, particularly how models represent sea ice deformations, and I am also involved in fieldwork. Outside of research, I enjoy skiing, hiking, camping, knitting, and spending time with friends. I am excited to attend the Arctic Sea Ice School to deepen my understanding of sea ice across different disciplines and to learn from Inuit knowledge. This will be my first time in the Arctic, making the experience even more special!

Rory Burke

I'm Rory, a 29-year-old postdoctoral researcher from Dublin, Ireland. I originally trained as a plant molecular biologist, carrying out my PhD at University College Dublin. I am currently employed at the Laboratoire Physiologie Cellulaire & Végétal (LPCV) in Grenoble, France, where I am working on an HFSP funded project titled 'Trapped In Ice'. This project aims to use a range of combination of purpose built sea-ice chambers and microfluidics platforms alongside molecular biology techniques to uncover the molecular and cellular responses that enable diatom colonisation of sea ice. Outside of work, I enjoy running, particularly in the mountains, and playing music.

Elliott Chartrand

I'm currently enrolled at Université Laval as a Ph.D. student in oceanography. I completed my bachelor's degree in biology with a focus on marine science while my master's degree focused more on environmental chemistry. Combining both is what prompted me to study sea ice diatom biomarkers in the arctic marine sediments for my Ph.D. thesis. Outside of research, I usually spend my time listening to music, playing video games, and reading. I expect to learn much about the dynamics between different physical and biological processes which are responsible for primary production. I'm looking forward to meeting with the other participants and learning with them in the arctic weather.

Karl Arvid Fritze

My name is Karl and I am currently studying Ocean Technology at the University of Bergen, specialising in measurement technology. Next semester, I will begin writing my master thesis, where I will look at solar radiation in the Arctic Ocean and the light transmittance and reflectance of snow and ice. In my free time I enjoy making and eating good food, bouldering and spending time outdoors. During my time at the Arctic Sea Ice school, I am eager to learn more about Sea Ice and the Arctic Ocean from an interdisciplinary aspect, as well as getting some hands-on experience with field research and taking measurements.

Mathilde Guillaume

My name is Mathilde Guillaume and I have 2 masters degree. My first master's degree is in Engineering, with a specialisation in Mining and Geology, and my second is in Environmental Sciences and Management. I have a passion for traveling, reading, and food. I also have a great interest in polar environments. I am hoping with this field school to deepen my knowledge on the biodiversity within the Arctic sea ice and the interactions between the atmosphere, ocean and sea ice. I am eager to connect and collaborate alongside leading scientists and experienced professionals in the field.

Julie Landier

I am a PhD student at LEMAR in France, holding a Master's degree in Marine Biology from the European Institute for Marine Studies (IUEM) at the University of Western Brittany in Brest, France. My research focuses on Arctic ecosystem dynamics, particularly the structure, function, and resilience of trophic networks in the Last Ice Area. Passionate about marine ecology and polar environments, I am excited to join the Arctic Sea Ice School to deepen my understanding of sea ice processes and their ecological implications. Beyond research, I enjoy traveling, hiking, and exploring remote landscapes. I look forward to exchanging knowledge with fellow participants and gaining hands-on experience in Arctic fieldwork.

Linda Latuta

I am a PhD candidate in physical oceanography at the Geophysical Institute, University of Bergen, studying Disko Bay in Greenland. I have a diverse background from my studies in environmental and aquatic science, and now physical oceanography, alongside a brief employment as a meteorologist. I am keen to immerse myself in this interdisciplinary course and particularly look forward to learning about optics and biogeochemistry, which are quite new to me. While I enjoy fieldwork and being outdoors, I love exploring new cities, sampling local foods, visiting museums and markets, and finding hidden jazz venues. My latest favourites are Santiago and Seattle.

Anjali Narayanan

Anjali is a PhD candidate at the Scripps Institution of Oceanography, UC San Diego (SIO/UCSD) where she uses optical properties and phytoplankton pigment concentrations to study phytoplankton community composition in the western Arctic. Her research interests include phytoplankton bio-optics and ecology, polar oceanography, ocean color remote sensing, and anti-colonial approaches to scientific research. At the Arctic Sea Ice School, Anjali hopes to learn more about sea ice optics and how sea ice relates to phytoplankton communities and the marine ecosystem. She is also excited to engage in fieldwork and discussions with Qikiqtarjuaq community members. Anjali has a B.Sc. in mathematics from McMaster University and an M.S. in oceanography from SIO/UCSD. Outside of research, Anjali enjoys reading horror books, playing video games, and spending time with her two cats and dog.

Khashiff Miranda

I'm Khashiff Miranda, a 4th year PhD. Candidate at Université Laval. I come from India where I used to work in the educational sector in the Himalayas and in the tourism sector as a PADI Divemaster. While conducting my BSc. at the University of Chicago, I was introduced me to the world of research in the intertidal life on the American West Coast, during which time I also completed a MSc. in Computer Science. These days, I'm conducting my doctoral research on the effects of sea-ice on intertidal life - an understated food source for Inuit communities in Ungava Bay. This research merges traditional ecological techniques with drone and remote sensing data to glean a peek at intertidal trends across space and time in the Canadian Arctic. I look forward to learning far more about sea ice at the School in Qikiqtarjuaq!

Torunn Sandven Sagen

My name is Torunn, and I am a PhD student in physical oceanography at the Geophysical Institute, University of Bergen. My research interests are fjord and coastal oceanography, and the topic of my PhD project is deep-water renewals in Norwegian sill fjords. My motivation for participating in the Advanced field school on Arctic Sea Ice is to get the chance to learn about Arctic coastal systems from both scientists and local communities, participate in a multidisciplinary investigation, and get more experience with different sampling methods in a wide range of disciplines through hands-on fieldwork. The fjords I typically work with are ice-free, so I am eager to learn how sea ice impacts fjords (and similar coastal systems) and what implications ocean physics, including ocean optics, has for biogeochemistry and the marine environment in coastal systems. I have many interests and hobbies that I enjoy (and too little time to dedicate to all of them), and some of them are running, hiking, singing, reading, knitting, and meeting friends!

Anna Haarsaker Olaussen

I am currently in my fourth year of an integrated Master's program in Ocean Technology, with a focus on measurement technology and instrumentation. For my master's thesis, I will be working on optical technologies, an area I am eager to explore further and deepen my understanding of. Outside of my studies, I love spending time with family and friends, especially outdoors. Whether it's a hike, a game night, or just some playful competition, I always appreciate activities that bring people together. I am particularly interested in understanding the effects of climate change, and the Arctic Sea Ice School seems like a great opportunity to explore this further. I also see this as a chance to strengthen my research skills, as I still have a lot to learn in that area. I am excited to take part, gain new knowledge, and connect with others who share the same interests.

Ana Stringer

I am a PhD student and NSF GRFP Fellow at Duke University's Department of Earth & Climate Sciences. Growing up in Barrow, AK, I developed a deep connection to the Arctic that inspires my work. My research focuses on Arctic sea ice dynamics using remote sensing techniques, with a special interest in how environmental changes impact marine subsistence hunting access for Inuit communities. Outside of academia, my hobby is kickboxing, which keeps me active and focused. I look forward to participating in the Arctic Sea Ice School to advance my research and collaborate with experts in this field!

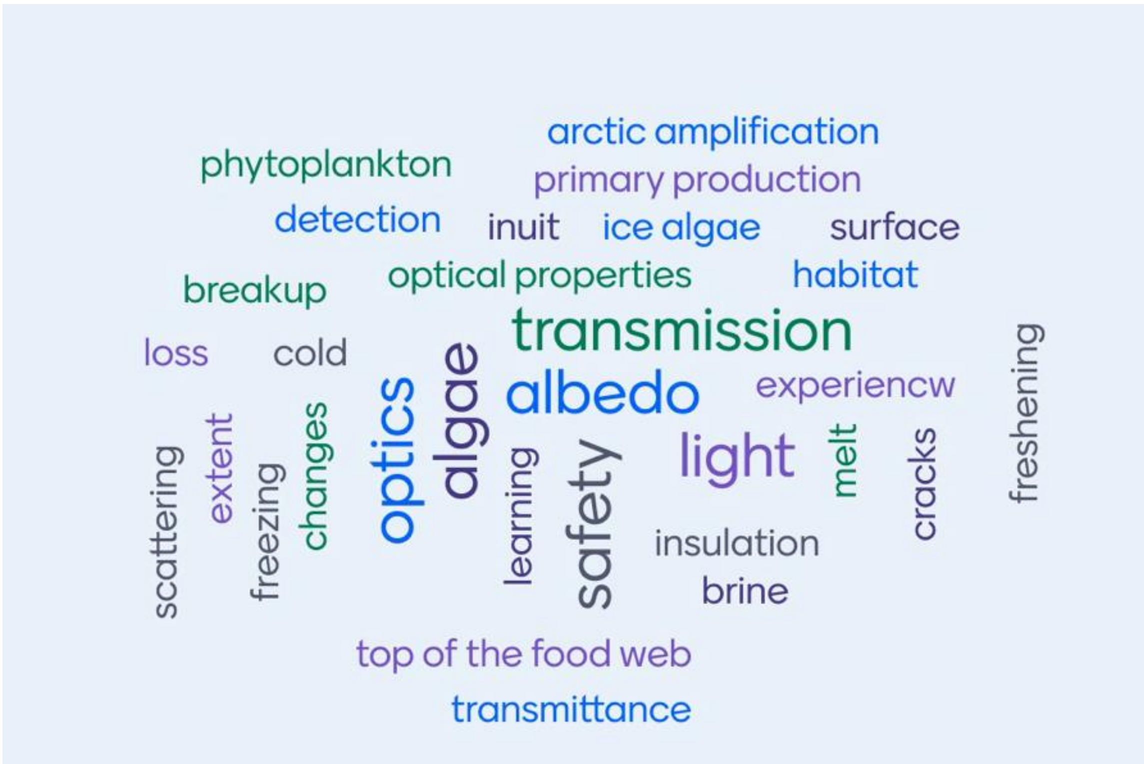
Bryce Troncone

My name is Bryce Troncone and I am a second-year PhD student in Engineering Sciences at Dartmouth College, having graduated from Rutgers University in 2023. Some of my hobbies include playing music with my band, sports such as soccer, swimming, and skiing, and playing a game of chess. Currently, I am designing thermal melt probes to study chemical and biological sea ice signatures in situ for Earth or extraterrestrial icy environments, which bears direct relevance to understanding sea ice dynamics and implementing accurate sampling methodologies. I am ecstatic to participate in the Advanced Field School on Arctic Sea Ice and obtain insight into the cutting-edge techniques used in sea ice modeling and observation!

Sara Wergeland

I'm a master's student in marine technology at the University of Bergen, specializing in marine instrumentation and optics. With a background in production electronics, I love problem-solving and working with practical solutions. Outside of my studies, I spend as much time as I can taking photos, skiing in the mountains, and surfing. I also enjoy playing guitar and DJing. I'm looking forward to diving into fieldwork in the Arctic, experiencing the environment firsthand, and learning from the people around me. I know this will be an invaluable experience for my master's thesis and future research.

Keywords related to their research on sea ice

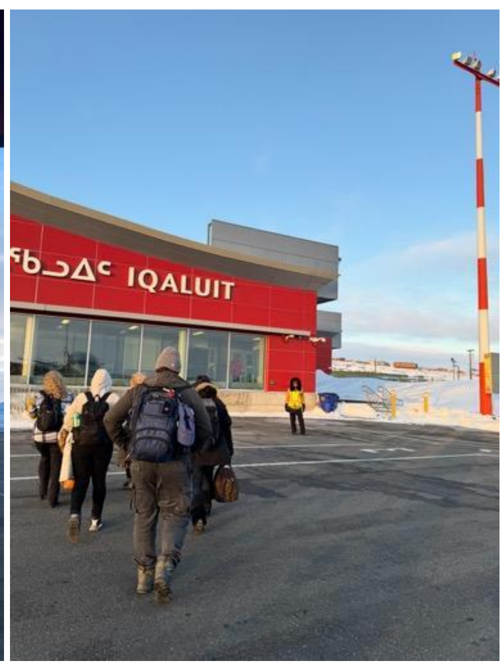


Itinerary and travel log

9 Wed	10 Thurs	11-13 Fri to Sun	13-18 Sun to Fri	18 Fri
Arriving at Ottawa	Winter gear equipment Transportation from Ottawa to Iqaluit	Lectures in Iqaluit Meeting with DFO Toonik Tyme Festival	Fieldwork and lab in Qik Activity with the School and cultural activity	SmartIce presentation Travel back to Ottawa

April 9 – April 10

The adventure begins! School kicked off in Ottawa on April 9, where we all met for the first time and got to know each other through an icebreaker activity (Who dived in Malawi?). The next day, we headed to the PCSP warehouse to gear up for fieldwork in the Arctic — pants, winter parkas, boots, mittens, goggles (so we could all look like red Minions!). Then it was off to the airport for our flight to Iqaluit and the official start of our adventure!



April 11

By Mathilde Guillaume and Anjali Narayanan

At 8am, we met at the Black Heart coffee to have a good breakfast with patisseries and great drinks such as latte and hot chocolate. The baristas drew a heart on them with the milk! It was really lovely. After that, we took a short walk to the Nunavut Research institute to have some presentations to learn more about sea ice, its ecology, and the water circulation in the Arctic Ocean. Chris and Jari, who work for DFO came to talk about the outreach they are doing in Nunavut and how they engage the local community to the baseline project. At lunch, some of us went to participate at a BBQ event for the Toonik Tyme festival. They have a game where you need to throw a dice and get a value of 6 to win the chance to plant nails into a wood plank until someone else takes your place.

April 12

By Linda Latuta and Torunn Sagen

Three days after landing in Canada, the jet lag kicked in for Torunn, and she did not sleep more than 2 hours and 27 minutes (according to her watch). Linda, however, kept nicely overcaffeinated with the help of the Black Heart café, which treated us to a fantastic breakfast each day in Iqaluit. So, the day started very differently for the authors of this post.

Our second day of lectures at the Nunavut Research Institute in Iqaluit was split into a morning and afternoon session, leaving time to explore Iqaluit and the Toonik Tyme festival in the middle of the day. The morning session covered topics such as remote sensing of sea ice, sea ice formation and optics, as well as an introduction to sea ice ecology.

During our long and sunny break, we split into groups; some went to see the Toonik Tyme festival activities like the Igloo building competition, and others walked around the city, visiting the Nunatta Sunakkutaanigt Museum, the ice-covered beach, and local crafts shops. After the refreshing walk (and a short nap at the hotel), we gathered again for the afternoon session on Arctic pelagic ecosystems and sympagic benthic coupling processes.

We concluded the day at the bar of the Frobisher Hotel, where burgers, nachos, and onion rings were on the menu. For us Norwegians, the final class of the day awaited at the bar – we got a proper introduction to Canadian hockey culture with a very successful match for the Winnipeg Jets. Excitedly, we headed back to the hotel, hoping that tomorrow the weather would be kind to us and we would make it to Qikiqtarjuaq.

April 13

By Rory Burke

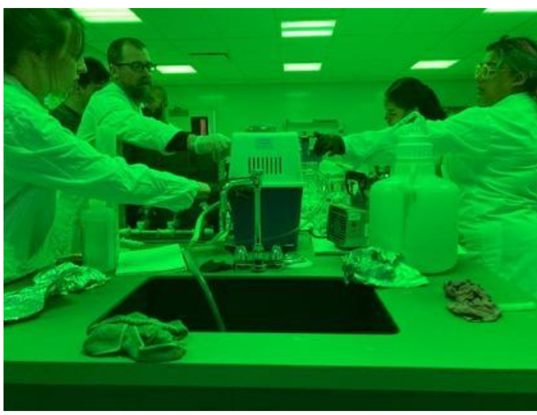
Today was another ‘travel’ day for the travel log! First call of the day was squeezing all of our bags into the storage cupboard at the Capital Suites. After a round of breakfast burritos at the Black Heart Cafe, we made our way to the Nunavut Research institute for our last lectures in sea ice ecology and acoustics. Thankfully it seemed the earlier cloud in Qik was clearing, so we piled into the taxis and made our way to the airport. This time we seemed to be a well oiled machine at check in, and we made our way to the gate with plenty of time to enjoy another massive feed from the Black Heart. This didn't stop a few of us from leaving it until the last possible second to go to the ATM and having to run back to board on time!

The descent into Qikiqtarjuaq was even more beautiful than most of us were expecting. Once we had moved our bags to the hotel and research station there was just time for us to take a walk up the hill to get our first proper look at the sea ice. We returned to a feast that I think none of us expected, but was very much appreciated after a long day's travel!

April 14

By Khashiff Miranda

We got our field work in Qikiqtarjuaq up and running on Monday! Split into two groups, our group began the day with a leisurely lab session with CJ with the goal to learn how to filter melted sea-ice and sea-water to better characterize the phytoplankton and diatoms at this time of the year. We were lucky because we were in the beginning of the diatom bloom! I say lucky because if we weren't, we would have probably spent 6+ more hours sampling enough water for us to detect diatom concentrations! After lunch, CJ took us out to the ice shelf just in front of the research station where we got to practice our sampling techniques for the day after. The ice was well over a meter thick and was perfectly enigmatic of the ice-profiles we learnt about the previous few days in Iqaluit. We saw our first ice core, licked our first sea-ice diatom (umami!) and practiced our sea-ice sawing. All prepared for the next day of sampling a DFO Baseline station!



By Bryce Troncone

Today, I took my first ever ice core with CJ from the sea ice near the station. In fact, it was my first time even walking on sea ice… a moment I will never forget, walking on the ocean! Another memorable experience from the day was looking at Remi's ocean catch from the other group's field day. He put a beautiful inscription of my name amongst the diatoms.

April 15

By Anna Haarsaker Olaussen and Sara Wergeland

April 15 was a quiet but productive day for our group. While half the group was out in the field, the rest of us held down the fort in the lab. After lunch, we took the opportunity to test Sara's instrument outdoors while waiting for the field team to return. The day wrapped up with something we'd all been looking forward to: Taco Tuesday!

Into the Light

Poem by Sara Wergeland

Never seen white like this before
Blinded by light
energy embraces us
The path there feels familiar,
Yet distant.

Neighbors greet,
Wave,
Smile.
The dogs too
watch over us
follow us home.

seek shelter in wet rooms
a green glow
fills everything.
Filtering out
the outside world
behind the door hides
a pink sky.

phantom feeling of missing
Tall boots
And a sunburn
tucked beneath
cold-bitten cheeks

Ski-doo here,
Ski-doo there—
we slip from reality
Shine draws us in
We vanish
just a little more
disappearing

April 16

By Karl Fritze and Torbjørn Wigum Arbo

Another day out on the sea ice, riding in the qamutiik. Today we went to Station 3, the original Green Edge site! On arrival, Noah showed off his eagle vision, spotting a seal way off in the distance. To us it was just a tiny speck far away, you can try to spot it yourself in the picture. We did our planned measurements and samples, just like the previous day out in the field. Maxime deployed his moored acoustic instrument, which was quite a large and heavy setup. Good luck to those who have to retrieve it. To get it below the ice, we made four holes with the auger that were supposed to overlap, but they didn't. Luckily, Jens brought his Finnish ice saw, so we could make easy work of the remaining ice. The saw cut through the sea ice like butter!

On the way back, we got to do some sightseeing and visited a cave filled with salty icicles hanging from the ceiling, and cobweb-like ice covering the walls.

April 17

By Florence Beaudry and Julie Landier

On April 17, part of the group headed out to the field, where activities were divided into four sub-groups. Some focused on ice coring and ice algae sampling, others conducted acoustic or optical measurements, and a few had the opportunity to test and deploy their own research equipment. On the way back, the field team made a stop to admire some massive icebergs, took group photos, and enjoyed the breathtaking Arctic scenery. Meanwhile, others remained at the research station for morning filtrations. Traditional Norwegian and Québécois music echoed through the halls, and we tasted classic Norwegian Easter snacks: chocolate and oranges.

Later in the day, we joined an outreach activity on the ice with local high school students, which included an ice coring competition (spoiler: it's way harder than it looks!). Back at the station, we gathered for maple taffy and a meaningful moment with a community elder, who demonstrated how to light a qulliq. The evening continued with a mesmerizing throat singing performance, and we wrapped up our last night in Qikiqtarjuaq sledding down the hill beside the station - laughing, cherishing the memories, and already feeling a touch of nostalgia.




April 18

It's already the end… Our last day began with a visit from David Iqqaqsaq at the Qik research station, where he came to meet us and share his knowledge about the SmartIce program. The students were eager to learn more about this monitoring program that integrate Indigenous and local knowledge of ice. After this enriching moment, it was time to pack our bags, take one final walk through the village, and board our flight to Iqaluit. We spent several hours waiting there (long lives the card games!), before catching our second flight to Ottawa. Late that night, we said our goodbyes—an emotional moment after such an unforgettable journey.

Lectures

- Large scale ice-ocean interaction in the Arctic system | Jens Ehn
- Sea ice morphology | Jens Ehn
- Sea ice remote sensing | Stein Sandven
- Light and optical properties in the atmosphere - ice - ocean system | Marcel Babin
- Sea ice general ecology | CJ Mundy
- Some key processes controlling Arctic coastal primary production | CJ Mundy
- The role of Arctic primary production in SPB coupling: Carbon export dynamics | Rémi Amiraux
- The role of Arctic primary production in SPB coupling: Food web dynamics | Rémi Amiraux
- Arctic pelagic ecosystem | Maxime Geoffroy
- Bioacoustics | Maxime Geoffroy

Fieldwork/Labwork

We did a transect for the Baseline program in Qikiqtarjuaq including stations 1 (April 14), 2 (April 15) and 3 (April 16), the GreenEdge icecamp. On April 17, another station near the village was sampled.

Work package 1 : Sea ice ecology

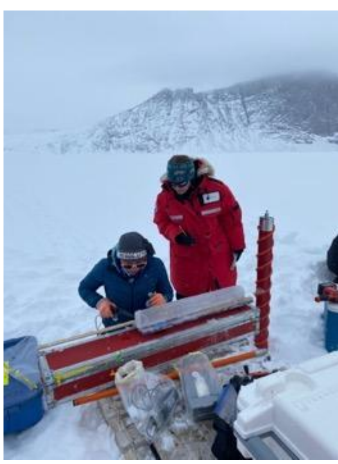
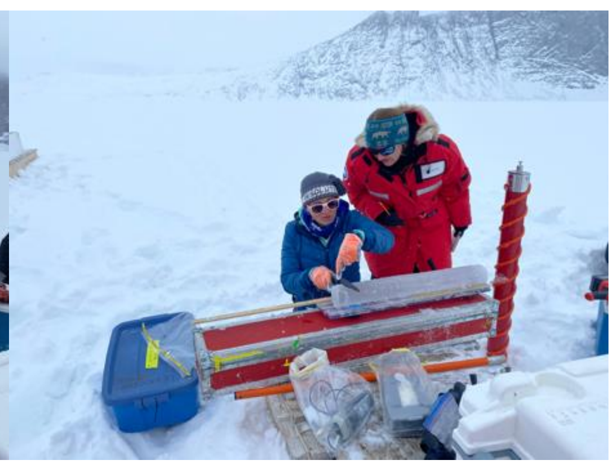
The sea ice ecology portion of the fieldwork was led by CJ and Joannie. This part of the fieldwork focused on sampling sea ice to examine its biological contents like the organisms living at the bottom of the ice. To do this, we collected ice cores using a mechanical ice corer. Once we had arrived at the sampling site, the first objective was to choose a suitable location on the ice to drill. We aimed for a location with a minimum of snow cover, as this would result in more light penetration to the bottom layer of ice, and thus a higher concentration of ice-algae. Once we had chosen a suitable location on the ice, we cleared the area of snow to expose the ice surface, and drilled vertically downwards to extract a cylindrical section of ice, typically about 1 meter long. The major challenge associated with this step was to ensure that the drill was kept straight to ensure an even core, and to gently remove to core in order to preserve the delicate bottom section. This lower portion of this core (generally about 3cm) was of particular interest, as this is the part that exists at the ice-sea interface and tends to have the highest concentration of algae, microorganisms, and other biological material.

This bottom segment was removed from the rest of the core using a hand saw and placed into a plastic bag and brought to the research station for further processing. Depending on the observed concentration of algae at the base of each core, multiple cores per sampling location were collected. The goal was to analyze the concentration of biological material in the ice by melting the ice and filtering the resulting water.

At the station, the core samples were allowed to melt overnight before filtration. Different volumes of melted ice were filtered to obtain samples for several subsequent analytical tests including chlorophyll a concentration, particulate organic carbon content, and nutrient analysis. These samples could then be stored in the refrigerator or freezer until analysis. By filtering the bottom sections of sea ice cores in this way, we could look at the biological productivity and compare it across sites and time. It also allowed us to compare the results from the ice-coring with other measurements done at the same location.





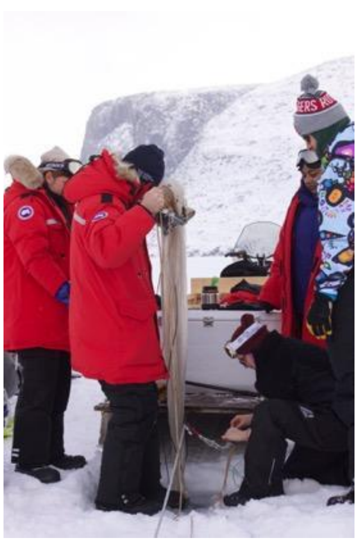
Work package 2 : Biology and bioacoustics

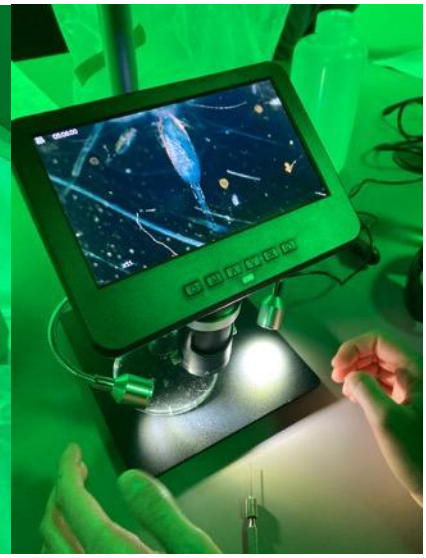
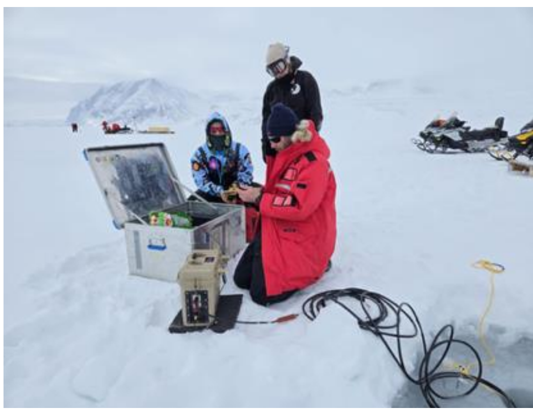
The part of the fieldwork and lab analysis that focused on studying marine life beneath the sea ice was led by Remi and Maxime. We learned field techniques for using both a zooplankton net and a portable echosounder. In the lab, we carried out preliminary analysis and processing of the acoustic data. The zooplankton net allowed us to collect and study species living beneath the ice, providing detailed biological samples. The echosounder was used to investigate the vertical distribution and potential movement of organisms, which is information that the net sampling does not provide. Together, these two methods offer complementary insights.

The zooplankton net was carefully lowered through a hole drilled in the sea ice (the same hole used for the CTD; see description in WP4). It was then slowly retrieved, capturing zooplankton from different depths in the water column in a small recipient attached to the end of the net. By using this method, we gathered a concentrated sample of the local plankton community beneath the sea ice at the study site.

The portable echosounder was deployed through another drilled hole in the ice, fastened and secured, and left to collect acoustic data for a few hours, until all planned samples (including all WPs) had been completed. The echosounder emits sound pulses downward into the water and records the time and intensity of echoes reflected by organisms or particles in the water column (i.e. backscattering). Analysis of the acoustic signals can reveal the presence, depth, and relative abundance of marine organisms. In the field, we could visualize the live signal on the echosounder monitor, giving us a real-time sense of organism abundance and depth.

Back in the lab, we examined the collected zooplankton samples using microscopes to sort and identify the various species. We were also introduced to the basics of acoustic data processing and visualization using the EchoView software, and processed the acoustic data collected at the study site in a workshop.




Work package 3 : Optical measurements

The optics portion of our fieldwork was demonstrated by Matthieu and Marcel. When we arrived at our research station, the optics team was situated at a location about 200 metres from the rest of the fieldwork. The collection of optical data was at a slightly different location from the rest of the group because we required a rather even surface of snow and ice that did not redirect sunlight that was redirected from the surface. An even surface would ensure that the radiometric measurements of incoming sunlight as well as transmission through the surface were as close to the natural conditions as possible. Once we were happy with the location, the optics team was careful to not disturb the surface as much as possible as we set up the instrumentation.

First, a tripod to hold up the downwelling irradiance sensor was set up far enough away from the rest of the optics data collection. This sensor would continuously measure the amount of sunlight coming down to the surface, integrated over a half hemisphere at multiple wavelengths. While this sensor was operating, we began to focus on collecting the transmission data—i.e., the amount of sunlight that would be able to penetrate the snow and ice surface and persist through the water column below. The Compact Optical Profiling System (C-OPS) was used to measure this. Before we were able to use the C-OPS, we needed to drill a hole through the ice with an auger. We did our best to ensure the hole was no larger than it needed to be for the C-OPS instrument to limit the extra sunlight that would leak in and be detected by the instrument. Even when the hole was drilled, we filled as much of the edges as possible with snow to mimic the true natural condition. Finally, we were ready to drop in the C-OPS instrument. This instrument would measure the downwelling irradiance, upwelling radiance at a single direction (facing down or in the nadir direction), and photosynthetically active radiation (PAR) integrated over 400–700 nm; each measurement was taken at various depths throughout the water column to get a profile. The C-OPS data would later be compared to the downwelling irradiance sensor installed on the tripod. The information from this tripod-mounted sensor serves as a reference metric for the amount of incoming sunlight that would eventually penetrate the surface and enter the water column. This would be done back at the lab using the sensor-specific software.

Back in the laboratory, we were involved in collecting absorption and fluorescence data—optical data that would indicate the concentration and composition of various water constituents. Sample water would be collected and brought back to the lab. This water would be maintained until data collection in a specialized environment—with ice to keep the temperature low. For collection of absorption data, we needed to prepare sample filters that would be stored until analysis in a spectrophotometer. To create these sample filters, we needed to filter water through glass fibre filters such that any particulate material would be left on the sample itself. The amount of water that would be filtered through largely depended on the water itself; the indication that we had filtered enough water was manifested through a slight coloured tint on the filter. For example, sample water with a lot of algae would require less water to be filtered through to obtain a good sample filter whereas sample water with very little algae would require many litres of water to be filtered through. Once we collected the sample filters, we would note down the amount of water filtered through and store the samples in the freezer for later analysis.

To collect the fluorescence data, a Turner Fluorometer was used to measure the chlorophyll-a concentrations in previously prepared solutions. The solutions that were prepared were sample filters with a high volume of water filtered through in order to collect a sufficient amount of particulate matter on the filter itself. This was then added in a vial with 10ml of a solution of 90% acetone solution, causing the particulate matter to detach from the filter and this would give a measure of fluorescence that would provide an indication of the chlorophyll-a concentration in the sample water. The fluorometer can detect and measure the presence of specific substances based on their fluorescence. When a substance is exposed to UV or visible light, its compounds absorb that energy and re-emit it at a specific longer wavelength, which is called fluorescence. In our case, we were interested in the chlorophyll-a, which is a pigment produced by all primary producers, contained at different depths in the water column. Measuring its concentration helps us estimate the biomass in the water. To do this, the solution of acetone containing the filtered sample was analysed twice with the fluorometer to determine the concentration of chlorophyll-a before and after acidification. This step is important as the first measurement (before acidification) gives information on the chlorophyll-a contained in the sample but also on the concentration of phaeopigment, which is the product of chlorophyll-a degradation. The second measurement (after acidification) gives information on phaeopigment only, as the adding of acid (HCl in our case) leads to the degradation of all chlorophyll-a contained in the sample. The difference between the 2 measurements (before and after acidification) gives us the actual chlorophyll-a concentration in our samples. To improve accuracy, the analysis was performed twice, and the average value was used as the final value of chlorophyll-a concentration.

The chlorophyll-a value obtained in the laboratory will be used to calibrate the fluorometer sensor used on the field. Hence, we will get a vertical profile of chlorophyll-a concentration in the water column at different locations.

Work package 4- Physical oceanography

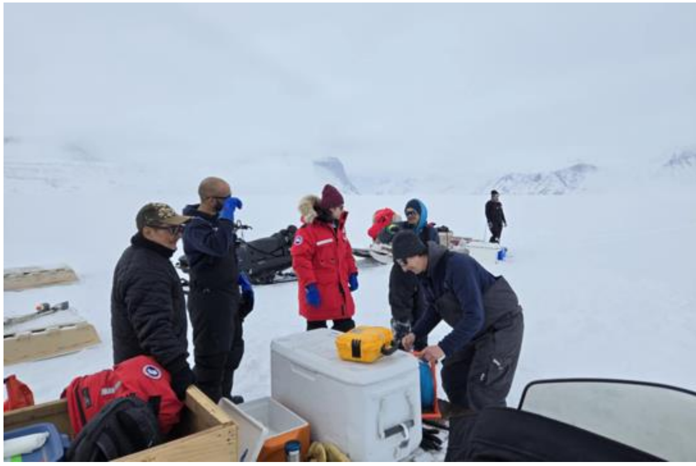
In the physical oceanography group, we had the opportunity to work with one of the most essential tools for understanding ocean physics: the Conductivity, Temperature, Depth instrument—better known as the CTD.

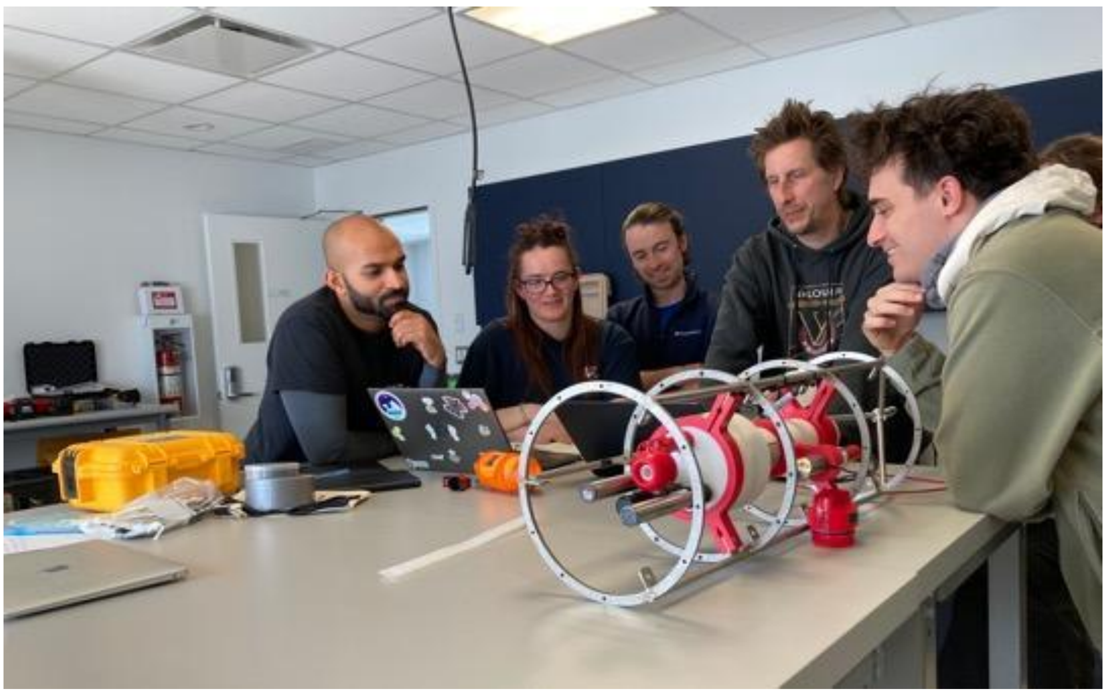
In the field, we tested different types of CTDs to examine their operational differences and the measurements they could provide. These instruments varied in size, weight, the number of variables they could measure, cost, ease of use, and accuracy. With guidance from Jens, we learned how to power and deploy them. Although it may seem simple—just lowering and raising the instrument through the water column to take profiles of temperature and salinity (derived from conductivity)—it actually demands considerable practical skill and experience, which Jens generously shared with us.

First, we had to cut a hole in the sea ice large enough to fit the CTD through. Then came the knots—an unexpectedly critical skill. When you're tying a CTD worth tens of thousands of dollars to a rope, you really don't want to get it wrong. Hauling the instrument, which weighs several kilograms, up and down through more than a hundred metres of water is no small feat either. That's when we learned a clever trick: to retrieve the CTD, you can attach the rope to a snowmobile and slowly drive away from the hole, gently pulling the instrument out. Finally, we had to master the art of packing hundreds of metres of rope in a way that prevents tangling—another surprisingly valuable skill.

Back at the station, we analysed the data we had collected. By plotting temperature and salinity against depth, we could visualise the ocean's vertical structure. Near the surface, we observed near-freezing temperatures, which allow sea ice to form. Beneath that, a relatively thick layer of cool, fresh water acted as insulation, separating the ice from the warmer, saltier waters found deeper down. In class, we had learned that this is a typical stratification pattern in the Baffin Bay region, where cold Polar Water overlays warmer Atlantic Water.

Some of the CTDs we used also measured additional properties like turbidity, oxygen, and light. This gave us a more complete picture of the underwater environment and helped us appreciate the complexity and richness of oceanographic data.





Extra Fieldwork

Albedo measurements - Sara Wergeland

I carried out a test of the setup I had built to measure surface albedo. It used an Ocean Optics spectrometer and a Spectralon plate. I had designed a mount that made it easy to rotate the fiber optic sensor between measuring upwelling and downwelling irradiance. My goal was to collect in situ albedo data to eventually evaluate the performance of the PACE satellite observations in fjord environments. Which is a part of my upcoming master's project

Beforehand, I expected the dark current measurement to be noisier than in earlier tests, due to cold Arctic conditions. Unfortunately, I had technical issues due to the damage to the fiber optic cable. This was not apparent at first. With help from our mentors, we tried to troubleshoot this problem in the field. After returning to the research station, I could confirm that the cable was faulty. Since I did not have a spare with me, I could not gather enough data for a full analysis.

However, the experience was very useful. I learned a lot about preparing for harsh weather and about dealing with practical challenges. It was rewarding to see the setup almost working. I got helpful feedback and saw several ways to improve the design. With this, I am thankful to have a lot of experience to take with me into my master's thesis.

Deployment of Thermal Melt Probe - Bryce Troncone

My current graduate research consists of studying the physics and chemistry of icy moons of the Solar System. One of my main projects within this scope is building thermal melt probes to assess the feasibility and accuracy of chemical and biological signatures within planetary ice. I am analyzing how the melt pocket evolves/compares to the surrounding ice as a result of the sampling. Arctic sea ice data is an analog to the floating sea ice lids found on these icy moons, albeit temperate in comparison.

With the equipment I brought to Qikiqtarjuaq, I was able to run the melt probe experiment two different days. We were able to take reference ice cores at each site, along with obtaining melt samples and a "sackhole" brine collection. This has helped my research greatly in understanding the fluid and thermodynamic processes happening in natural, open ice systems rather than a closed laboratory which I was previously limited to. For my first ever Arctic field work, it was a great success and I obtained data I will use in a future (soon) paper. A great memory was Jens and I looking at the setup and him asking me if it was going to work...I said "Well…it worked back home" haha.

A special thank you to Sophie for helping me organize the planning of this field work and of course helping my many boxes get through the airport! Another thank you to Jens and Matthieu for bringing me out for the first data collection after a long day that they had, and of course Marie for coordinating the excursion. Lastly, thank you to Noah for helping me the second day in the field.




Snowpit - Torbjørn Wigum Arbo

In addition to the main fieldwork activities, I took the opportunity to gain hands-on experience by digging a snowpit with Dr. Jens Ehn. My objective was to observe the different layers of the snowpack, which is important for light transport in the Arctic. The various shapes and states of snow crystals, such as depth hoar, wind packed snow and newly fallen snow, greatly change the optical properties such as albedo.

To create the snowpit, we used a regular shovel to dig out a square, then carefully removed each layer, resulting in a pit that resembled a staircase. This allowed us to examine the layers and feel their textures, which helped to tell the story of past weather, temperature, wind, and precipitation events. While not directly used in my master's thesis, this experience provided valuable practical insight into field methods and the direct link between a snowpack's physical properties and its optical characteristics, which I will take with me into my future research.

Advanced Field School on Arctic Sea Ice: Tracking Changes Across Scales

April 9-18, 2025, Qikiqtarjuaq, Nunavut, Canada