ARCTOS

Annual Report 2020

Annual ARCTOS activity report 2020

Rolf Gradinger, Paul Renaud, Ulrike Grote

With the members of the ARCTOS Secretariat

Cover pictures: Malin Daase/UiT

Table of Contents

Photo credit: Sofia Aniceto/UiT

Executive Summary

2020 has been a challenging year for ARCTOS as it has been for any other institution or network. COVID-19 regulations caused major disruptions for planned activities, specifically the planned in-person meetings and research activities.

The PhD Workshop in conjunction with Arctic Frontiers could happen as planned as it had been scheduled early in the year. The workshop was led by UiT and Akvaplan-niva and attracted 19 students from around the world. The 2020 ARCTOS Days were also scheduled just prior to the COVID-19 related closures, and the meeting was conducted with record-high participation from all member institutions with a focus on Polar Front systems. Jørgen Berge stepped down as ARCTOS leader and Rolf Gradinger took over. The re-organization of later meetings/ symposia to Zoom based activities proved to be successful within their limitations, and participation even increased. Major successful research activities in 2020 included the scientific development and preparation of the teaching and research cruise which had to be postponed to 2021 due to COVID-19 restrictions, the development and submission of an ARCTOS driven NFR proposal on the Polar Front system in the Barents Sea, and the successful ending of several large projects, such as FAABulous and Sea Patches.

Membership of students, post-docs, and researchers in ARCTOS continued to increase with a total increase by 2.5%. The Norwegian Polar Institute was the member institution with the strongest increase in membership, followed by the Institute of Marine Research and UiT, while Akvaplan-niva, UNIS and NORD University decreased slightly due to members changing affiliation and students finishing their projects.

In conclusion, ARCTOS navigated well the disruptions caused by COVID-19 and grew regarding science, education, and public outreach during 2020.

Mission statement

ARCTOS combines the expertise of north Norwegian and international institutions to achieve an integrated view of Arctic ecosystems, both locally and with a view across the Arctic. Investigations of biological, physical, and chemical drivers provide a holistic approach to marine ecosystems and across the food chain. In this way, we address critical scientific and management questions related to biodiversity, ecological processes, impacts of climate change, human induced and natural variability, system sensitivity and resilience. State-of-the-art research tools, modelling platforms scaled to a variety of levels and processes, and modern infrastructure provide a strong foundation for basic research and student training. ARCTOS has grown considerably since its foundation. It is now recognized nationally and internationally in the science community, as well as in industry circles, as a source of high-quality basic and applied research in Arctic marine ecology.

Organizational overview

ARCTOS leadership

The ARCTOS leadership consists of the ARCTOS leader group, ARCTOS Secretariat and ARCTOS Board.

The **ARCTOS leader group** is responsible for the day-to-day work, such as the preparation of meetings, agendas, and documents for the Secretariat and Board. It is also responsible for the execution of plans and decisions made by the Secretariat and Board.

ARCTOS leader group 2020	
ARCTOS leader	Jørgen Berge, UiT (01-03/2020) Rolf Gradinger, UiT (03/2020-)
ARCTOS co-leader	Paul Renaud, Akvaplan-niva
Secretary	Ulrike Grote

ARCTOS Secretariat 2020	
APN	Kjetil Sagerup Eva Leu
IMR	Ulf Lindstrøm Benjamin Planque
NORD	Henning Reiss
NPI	Philipp Assmy Haakon Hop
UiT	Karley Campbell Jørgen Berge
UNIS	Janne Søreide Anna Vader
Student representatives	Martí Amargant Arumí (UiT) Eric Jorda Molina (Nord)
Post-doc representatives	Elizabeth Jones (IMR) Benjamin Lange (NPI)

The **ARCTOS Secretariat** is responsible for the daily operation of the network and for student support. It consists of the leader and co-leader of ARCTOS, the secretary, 1-2 representatives from each ARCTOS institution, two student representatives, and two post-doc representatives.

The six ARCTOS member institutions are Akvaplan-niva (APN), Institute of Marine Research (IMR), NORD University (NORD), the Norwegian Polar Institute (NPI), UiT the Arctic University of Norway (UiT) and The University Centre in Svalbard (UNIS). The Secretariat met approximately monthly, and the minutes are available on the ARCTOS website.

The **ARCTOS Board** is responsible for the approval of budgets and financial reports, strategy and action plans, integration with member institutions plans and priorities, and decisions regarding institutional membership in ARCTOS. The Board consists of the leaders of the six ARCTOS institutions and the leader group. In addition, the dean and vice-dean of research at the faculty of Biosciences, Fisheries and Economics at UiT The Arctic University of Norway, as well as the leader of the department of Arctic and Marine Biology, have observer status in the Board. The Board met once in 2020.

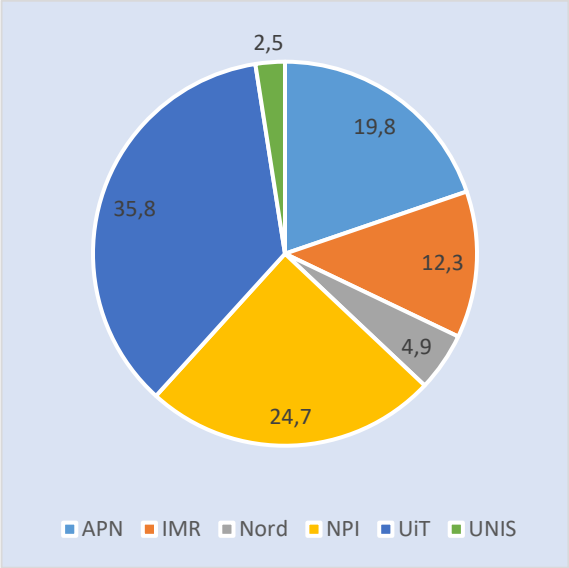
ARCTOS Board 2020	
Akvaplan-niva	Merete Kristiansen Anita Evenset
Institute of Marine Research	Sissel Rogne Maria Fossheim
NORD University	Hanne Solheim Hansen Ketil Eiane
Norwegian Polar Institute	Ole Arve Misund Nalân Koç
UiT The Arctic University of Norway	Anne Husebekk Kenneth Ruud
The University Center in Svalbard	Jøran Moen

ARCTOS membership

∑ members: 117 ♀: 57 % Post-doc: 19 PhD: 36 MSc: 4

We update membership once a year by asking members if they want to continue their membership (not student members). In 2020, five members ended their membership due to new positions at non-ARCTOS institutions, most of them post-doctoral researchers. Membership of five students who successfully defended their thesis, ended as well. Three PhD candidates discontinued their PhD. Overall, the number of ARCTOS members increased during 2020, as eighteen researchers and students joined the network, leading to a net increase of 2.5%.

Senior members and post-docs



At most ARCTOS member institutions, the number of members did not change significantly, apart from NPI with a net increase of one senior member and four post-docs by the end of 2020. For more information about some of the new members, see the boxes throughout the report.

Fig. 1 Composition of affiliation of ARCTOS senior members and post-docs (%)

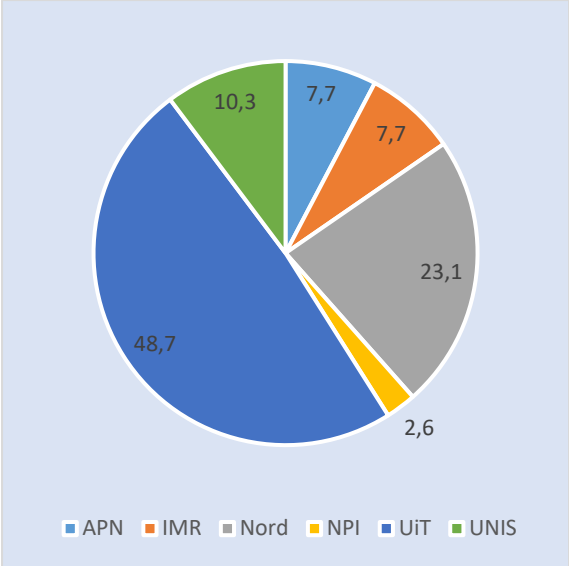
Mats Granskog – Senior Researcher at NPI

Mats has been working at the Norwegian Polar Institute since 2008. His work focusses on Arctic sea-ice energy and mass balance using process studies, autonomous observations, and modeling. He is especially interested in the role of snow in sea ice processes. Mats is also a part of the Nansen Legacy project, where he focusses on the marine optics of the Barents Sea. He is also working on the role of CDOM in the optical properties of sea ice and surface waters in the European Arctic.

Andreas Altenburger – Associate professor at UiT

Andreas moved to Tromsø in 2020 and started working as a curator of marine invertebrates at the Arctic University Museum in Norway. Andreas is interested in microalgae, marine invertebrates, and coastal ecology, with a special focus on meiofauna taxonomy, morphology, eDNA, and ecology. Groups of particular interest are brachiopods, kinorhynchs, scalidophorans, cryptophytes, ciliates and dino-flagellates.

PhD candidates and master students



2020 highlights:

- 36 student members by the end of 2020
- 2 Master defenses at UiT
- 1 PhD defense at IMR
- 1 PhD defense at UiT
- 1 PhD defense at UNIS
- 8 new student members

Fig. 2 Composition of affiliation of ARCTOS students (%)

Morgan Bender successfully defended her PhD thesis 'Polar Cod in a Changing Arctic: Toxicity of crude oil on sensitive life history stages of a key Arctic species' on June 12, 2020 at UiT, despite COVID-19 restrictions. Photo credit: Ulrike Grote/UiT

Major activities 2020

ARCTOS organizes several colloquia and workshops each year that are open to everyone and give students and members the opportunity to present and discuss their research. External speakers are often invited to participate. In addition, ARCTOS organizes an annual meeting for members only, called ARCTOS Days. ARCTOS is also responsible for a number of PhD courses at UiT. These include two cruise-related courses and the Arctic Frontiers PhD Workshop course.

While the Arctic Frontiers PhD workshop and ARCTOS Days were successfully organized in early 2020, many planned activities had to be cancelled or postponed due to the COVID-19 pandemic and resulting restrictions.

ARCTOS Colloquia changed to a digital format. Several external speakers were invited, and the colloquia were generally very well attended.

One of the main activities that had been planned since 2019 but was postponed to 2021 due to COVID-19 restrictions was the student and research cruise to the Polar Front in the Barents Sea in collaboration with the Nansen Legacy project.

Arctic Frontiers PhD Workshop

In 2020 ARCTOS organized its annual PhD workshop in conjunction with Arctic Frontiers after taking a break in 2019. 18 PhD candidates from nine different countries were selected and joined the workshop, first attending and presenting at Arctic Frontiers and then travelling for five days to Svolvær on the Lofoten Islands.

In Svolvær, the students attended lectures covering proposal writing, political and social science focusing on the Arctic and high North, Arctic marine ecology and climate, arctic entrepreneurship, and local art. The students had to prepare a cross-disciplinary research proposal for submission to an imaginary funding organization. During the workshop the students visited museums, an art gallery, an aquarium, and the coastal administration in Kabelvåg.

Paul Wassmann (professor, UiT) was the workshop leader, supported by Eva Leu (senior scientist, Akvaplan-niva) and Ulrike Grote (ARCTOS secretary).

In addition, Eva Ramirez-Llodra (senior scientist at NIVA, research coordinator for REV Ocean), Lars Otto Reiersen (senior advisor, UiT), and Berit Kristoffersen (associate professor, UiT) joined the trip to Svolvær, giving lectures and supporting the group work.

Marit Reigstad (professor, UiT), Alf Håkon Hoel (professor, UiT), Philip Steinberg (professor, Durham University), and Jasmine Nahrgang (professor, UiT) gave lectures during the time in Tromsø, while Karolin Tampere (visual artist and freelance curator) visited the group in Svolvær.

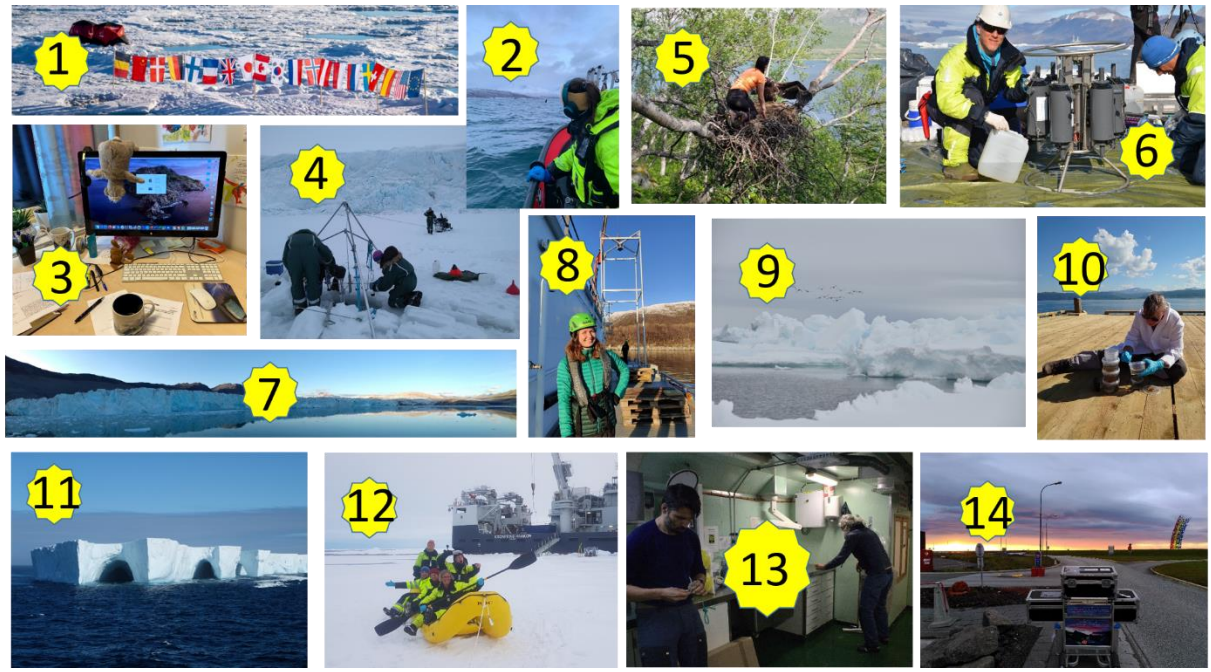
Participants of the PhD Workshop in conjunction with Arctic Frontiers at the Polar Museum in Tromsø.

ARCTOS colloquia

The outbreak of the COVID-19 pandemic and the following restrictions put a temporary halt to the traditional in-person colloquia that ARCTOS is usually organizing. After some time for adaptation, the colloquia were successfully organized digitally instead. In 2020, ARCTOS organized four digital colloquia on a range of topics:

'Nansen Legacy project'

The first colloquium took place June 10, with four Nansen Legacy PhD candidates giving their first presentation: Yasemin Bodur (UiT), Martí Amargant Arumí (UiT), Robynne Nowicki, (UNIS), and Christine Gawinski (UiT). The topics ranged from vertical flux and pelagic-benthic coupling to primary production, pollutants and mesozooplankton production and productivity in the northern Barents Sea. Organizer: Ulrike Grote



Contributions to the picture contest during the ARCTOS Christmas Lunch. 1) Jessie Gardner, 2) Sofia Aniceto, 3) Jasmine Nahrgang, 4) Tobias Vonnahme, 5) Elisabeth Hansen, 6) Philipp Assmy, 7) France Collard, 8) Muriel Dunn, 9) Karley Campbell, 10) Claudia Halsband, 11) Hanna Kauko, 12) Miriam Marquardt, 13) Estelle Coguiec, 14) Daniel Vogedes

'Ecotoxicology'

The second colloquium took place October 15, with the two PhD candidates Claudia Erhart (UiT) and Elisabeth Hansen (UiT) giving their first presentations about biological effects of crude oil on fish species in the Barents Sea and physiological and ecological effects of organic and inorganic contaminants in marine and terrestrial raptor species, respectively. In addition, we had two new post-docs present their research, France Collard (NPI) working on anthropogenic particles in the sediment of an Arctic fjord, and Igor Eulaers (NPI) talking about multiple stressor effects on ecosystem health. Organizer: Ulrike Grote

'Zooplankton'

The third colloquium took place November 30, with Jordan Grigor (post-doc, SAMS) as invited speaker talking about Arctic zooplankton surprises: vegetarian chaetognaths and clockwork copepods. In addition, ARCTOS members Marvin Choquet (post-doc, NORD University) presented his work on species boundaries in contemporary populations of *Calanus* in the North Atlantic and Arctic Ocean, while Estelle Coguiec (PhD candidate, UiT) gave her mid-way presentation entitled 'Zooplankton and seasonality: From community to behavior'. Kristin Heggland (PhD candidate, NPI) gave her first presentation investigating if Arctic *Calanus* can adapt to climate change. Organizers: Estelle Coguiec, Ulrike Grote

'Christmas lunch'

We could not organize our traditional Christmas lunch but had a digital one on December 9 instead. Rolf Gradinger summarized ARCTOS activities conducted during 2020 and provided an outlook for 2021. Ben Lange (post-doc, NPI) and Jessie Gardner (post-doc, UiT) reported about their experiences during the MOSAiC ice drift expedition and showed some impressive pictures and videos. Vanessa Pitusi (now PhD candidate, UNIS) gave a presentation about a very different field season at UNIS this year. Finally, all members were invited to submit their favorite picture(s) of this years or previous years field work or from the office or laboratory for a little photo contest. We received many great and funny pictures (see previous page). Organizer: Ulrike Grote

Kristin Heggland – PhD candidate at NPI

Kristin started her PhD project entitled 'Using local adaptation to infer future evolutionary responses of *Calanus* copepods to a changing environment' in April 2020. The Ph.D. project will investigate the potential of *Calanus finmarchicus* and *C. glacialis* to acclimatize and adapt to future climate changes. The project will focus on the climate effects temperature, pH, and salinity.

Markus Molis – Professor at UiT

Markus started his faculty position at UiT in August 2020 after working several years at the Alfred Wegener Institute in Germany. His main research interests are benthic community ecology, abiotic and biotic drivers of species interactions, chemically-mediated species interactions, and the role of phenotypic plasticity in modulating species interactions. Markus primarily uses manipulative experiments in the field and laboratory to address his research questions. He works mainly in intertidal habitats and predominantly on rocky shores.

Student Forum participants 2020. Photo credit: Estelle Coguiec

ARCTOS Days

Every year, ARCTOS invites all its members to its annual meeting called ARCTOS Days. It is a two-part meeting, which includes a 1.5-day workshop for the students, as well as 1 day for the post-docs, followed by two days for all members. In 2020, we were lucky to still be able to organize this meeting in person, March 8-11 on Sommarøy.

Student forum

Sixteen students attended the student forum March 8-9, 2020. Sunday afternoon they spent getting to know each other or catching up, hiking, and cooking dinner. The main PhD day started with an exercise on how to better manage stress in one's everyday life, with Anne R. Grini, a local yoga and meditation teacher. The students worked on how to create mindfulness and maintain energy throughout the day.

After that they had an engaging seminar with Jan Erik Frantsvåg and Lars Figenshou (UiT senior adviser and UiT senior academic librarian, respectively) on how to best navigate in the 'new world' of open science. They discussed open access publishing, the steps UiT has put in place for open access publishing, and what open data and science mean as we move forward in publishing our research.

After lunch they had another session with Anne and then joined the post-doc seminar by Kenneth Ruud (pro-rector at UiT) about how to build a successful career in academic science.

Group picture ARCTOS Days. Photo credit: Ulrike Grote

Post-docs

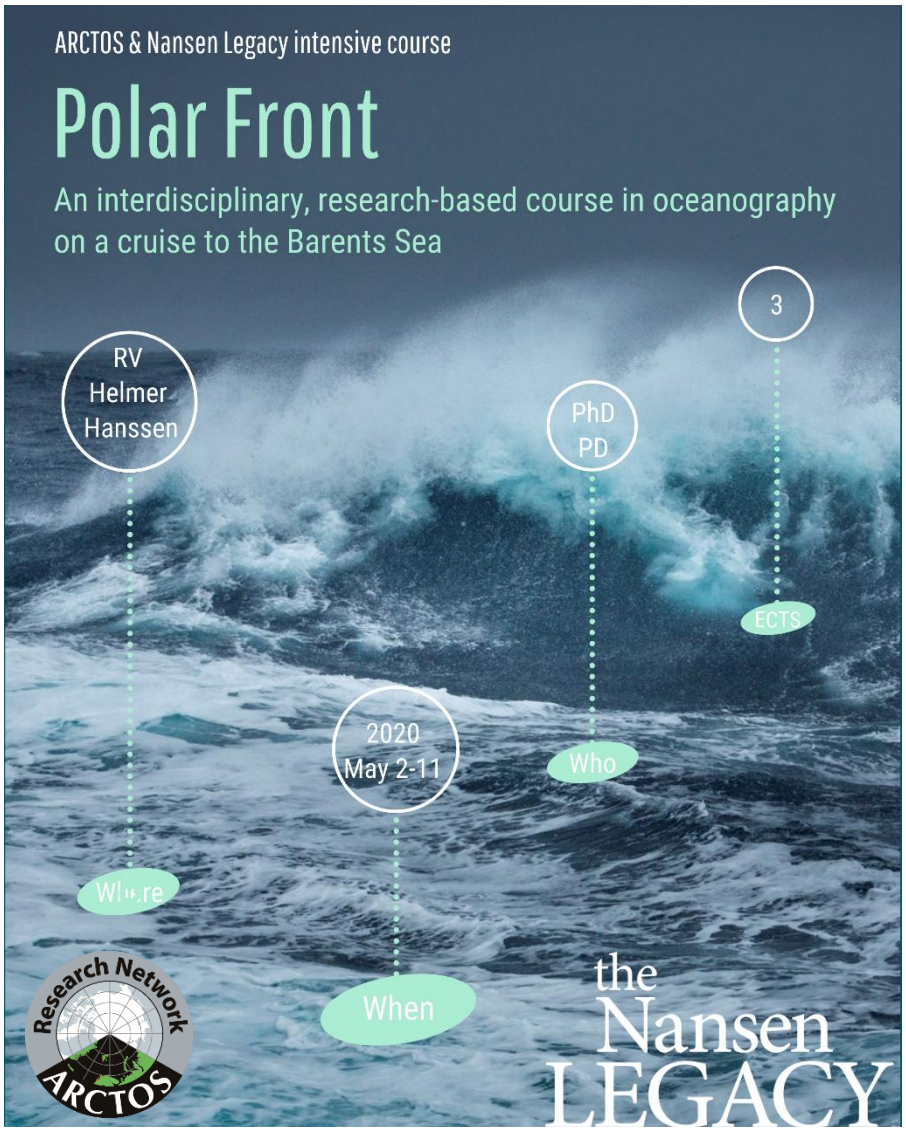
For the first time, the post-docs had the chance to gather and network before the actual ARCTOS Days started on Tuesday, March 10. Ten of them arrived on Sommarøya on Monday morning March 9 and started with an online presentation by Jon Iddeng from Forskerforbundet (The Norwegian Association of Researchers). The topic of this presentation was the post-doc as a position, the regulations, and challenges around it. The presentation was received as informative and interesting, and clarified both the role of the unions and the post-doc position in Norway. In addition, they had the chance to discuss and give feedback to the presenter on the union policies.

After lunch, the post-docs joined forces with the students and after a short yoga break, had a scientific career seminar with UiT pro-rector Kenneth Ruud. He talked about strategic choices when building one's career, such as finding your own niche, and about leadership in science. It was regarded positive that the presentation made visible the different steps when working within and building research groups i.e., the academic career.

All members

In total, a record high number of 46 members participated in the annual meeting March 10-11. After a round of welcome, introduction and some ARCTOS news, Jørgen Berge officially stepped down as ARCTOS leader and Rolf Gradinger took over. A big thank you from the whole network to Jørgen for is many years of successful leadership and a warm welcome to Rolf. Afterwards, five students presented their Master or PhD projects, while two post-docs and one senior member presented current research findings and newly started projects. In the evening we had a poster session followed by a nice dinner.

The second day we had a science session about the Polar Front in the Barents Sea with five different presentations followed by discussions and a meeting in preparation of the cruise planned in collaboration with the Nansen legacy project in May.



ARCTOS and Nansen legacy cruise

One action plan item in the ARCTOS Future report prepared in 2018 was a stronger focus on scientific activities within ARCTOS. Already in 2019, the ARCTOS Secretariat and the Nansen Legacy project management started the planning and preparation of a teaching and research cruise to the Northern Barents Sea.

The key idea behind the cruise was to compliment the Nansen Legacy program by carrying out a detailed characterization of the Polar Front using a combination of traditional and autonomous sampling platforms, techniques, and remote sensing.

The aim of the study was to describe how physical processes at different scales, influence ecosystem traits across the Polar Front. This included the characterization of the spring bloom at both sides of the front, in addition to standing stocks of phytoplankton, zooplankton, fish and benthos.

A main outcome planned for this cruise was a scientific publication co-authored by all participating students and scientists on the importance of the Polar Front for our standing of the Barents Sea. Due to the COVID-19 pandemic the cruise was postponed to 2021.

Workshops

ARCTOS supported the organization of an international online workshop titled: ***Environmental control of algal bloom phenology in a pan-Arctic perspective***, organized on behalf of the ARCTOS project FAABulous, together with the CAO projects (https://www.changing-arctic-ocean.ac.uk) EcoLight, Arctic PRIZE, and DiatomARCTIC (funded by RCN (FAABulous), and NERC/BMBF (CAO)). More than 50 researchers and graduate students from various European countries, Canada and the US participated in late October in the four-day workshop held in conjunction with the final meeting of the FAABulous project (https://www.mare-incognitum.no/faabulous/). Two days were used for discussing results from observational studies about Arctic algal blooms in sea ice and water in various Arctic systems, with invited speakers presenting their most recent work. More than 1/3 of all presentations were given by recently graduated PhD students and post-docs. One day was dedicated to presentations about light as a key driver for algal blooms (and other biological processes), including first results from the recently completed MOSAiC expedition. The fourth day was dedicated to modelling approaches of algal dynamics in a changing Arctic. The feedback from the participants was overwhelmingly positive, and the organizers have now started a series of online seminars in a similar format.

Member institution highlights

Akvaplan-niva

The ARCTOS affiliated project 'A transatlantic innovation arena for sustainable development in the Arctic (CoArc)', funded by the Norwegian Ministry of Foreign Affairs under the Arktis 2030 grant 2017, ended in 2020. CoArc initiated the development of a transatlantic arena to address a major challenge shared by Norway, Greenland, and Eastern Canada on how to access and develop the ocean's valuable resources in a sustainable manner. Specifically, CoArc addressed the gathering of knowledge about changing ecosystems connected to fisheries in northern Norway, Eastern Canada, and Greenland by an extensive study of historical data from the marine research institutes, the Canadian DFO (Fisheries and Oceans Canada) and the Norwegian IMR (Institute of Marine Research). Despite decades of monitoring and management, the challenge remains to understand divergent trajectories in the Newfoundland-Labrador Shelves (NL) and the Barents Sea (BS). Whereas the BS has experienced record high productivity of groundfish stocks, NL has undergone a collapse of these stocks in the past 2-3 decades, with only localized areas of recovery since. The CoArc project investigates mechanisms of observed ecosystem changes, including a combination of data compilation, novel analytical approaches, and ecological modeling to explain patterns, both at the individual ecosystem level and through comparative process studies. In addition, CoArc facilitated the development of commercial solutions for environmental monitoring and risk assessments with emphasis on the development of decision-support tools for improved environmental management. These innovation activities mobilized relevant actors from universities & research institutes, environmental service companies, and industrial stakeholders. In addition to the production of scientific papers and manuscripts, two post-docs engaged in the project were recruited to permanent scientific positions, one at IMR in Tromsø and one at DFO Canada.

Publication highlights:

Leu E, Brown TA, Graeve M, Wiktor J, Hoppe CJM, Chierici M, Fransson A, Verbiest S, Kvernvik AC, Greenacre MJ 2020. Spatial and Temporal Variability of Ice Algal Trophic Markers-With Recommendations about Their Application. J. Mar. Sci. Eng. 8. 10.3390/jmse8090676, https://www.mdpi.com/2077-1312/8/9/676

Andrade H, van der Sleen P, Black BA, Godiksen JA, Locke WL, Carroll ML, Ambrose WG Jr, Geffen A 2020. Ontogenetic movements of cod in Arctic fjords and the Barents Sea as revealed by otolith microchemistry. Polar Biol. 43: 409-421. 10.1007/s00300-020-02642-1, https://link.springer.com/article/10.1007%2Fs00300-020-02642-1

Havbrukstasjonen built AZKABAN, a 8 m high by 2m wide frame that will fit a large zooplankton and fish larvae prison for acoustic measurements. This picture was taken on the first test in the water to see if it was structurally strong enough. It was!

Photo credit: Muriel Dunn/ApN

Muriel Dunn – PhD candidate at APN

Muriel is a PhD candidate enrolled in Fisheries Science at the Memorial University of Newfoundland where she started in Sep 2019. Her project is in collaboration with Akvaplan-niva and in January 2020 Muriel relocated to Tromsø for the remaining 3.5 years of her PhD project. Muriel is interested in ocean acoustics and using active acoustics to effectively monitor Arctic ecosystems, such as the Barents Sea. The title of her PhD project is: 'Advancements of Autonomous Surface Vehicles (ASVs) equipped with broadband echosounders as survey platforms in the Arctic

Institute of Marine Research

14 scientists at IMR were ARCTOS members in 2020: 10 scientists, 2 PhD candidates and 2 master students. A large range of ARCTOS relevant activities took place at IMR also in 2020, including participation in the Nansen Legacy winter school (both lecturers and students) and NL research, and research and monitoring cruises to the Barents Sea and around Svalbard.

Sebastian Menze (PhD) defended his PhD thesis "Listening to the Polar Ocean - Monitoring and mapping marine ecosystems using passive and active acoustics" June 12, 2020, in Bergen. In his dissertation Sebastian shows how the use of both, passive and active acoustics can fill knowledge gaps about polar oceanography and ecology. In the first part of his thesis, he used a large dataset with acoustic measurements to map the flow of Atlantic Water off Svalbard and showed that there are several important branches transporting Atlantic Water into the Arctic Ocean. He combined the acoustic data with ocean current models to investigate the impact of Atlantic Water circulation on plankton and fish distribution in four major troughs cutting into the Svalbard shelf. The balance between throughflow and retention creates favorable habitats in the troughs for fish, benthic organisms, and marine mammals. In the second part of his thesis, he used passive acoustic data to study the sources and seasonal variation of ambient sound in the deep Southern Ocean. The data set with sound recordings from moored instruments showed that sound from e.g., Antarctic blue whales, fin whales, minke whales and leopard seals form a "marine mammal choir" on their respective frequencies. Sebastian developed a method that uses sound recordings to estimate the animals' spatial distribution and migration.

Elisabeth Jones – Post-doc at IMR

Libby started her post-doc already in February 2017 but decided in 2020 that she would like to join ARCTOS. Her research focusses on the carbon chemistry of polar oceans and sea ice, ocean acidification, and biogeochemical cycles in a changing climate. She is involved in several different projects e.g., at the Norwegian Environment Agency and Fram Centre, and she is part of the Nansen Legacy project.

Victoria Ollus – Master student at IMR

Master student Victoria Ollus joined IMR and ARCTOS in 2020. She is taking part in a study that explores the possibilities of utilizing Antarctic cruise ships as platforms of opportunity for collection observations on marine mammal and seabird abundance and distribution. Her thesis project will focus on the community structure and general seabird density across the Scotia Sea and Antarctic Peninsula. The distribution data will be related to different environmental variables to find the factors that describe the variation in seabird abundances and densities on a spatial as well as a temporal scale.

Publication highlights:

Jones EM, Renner AHH, Chierici M, Wiedmann I, Lødemel HH, Biuw M (2020): Seasonal dynamics of carbonate chemistry, nutrients and CO2 uptake in a sub-Arctic fjord. Elementa Sci. Anthrop., 8:41, doi:10.1525/elementa.438.

Menze S, Ingvaldsen RB, Nikolopouplos A, Hattermann T, Albretsen J, Gjøsæter H 2020. Productive detours – Atlantic water inflow and acoustic backscatter in the major troughs along the Svalbard shelf. Prog. Oceanogr. 188. doi.org/10.1016/j.pocean.2020.102447

NORD University

The main activities of NORD University within ARCTOS were centered around the ARCTOS Days in 2020. Most of the ARCTOS PhD students and post-docs at NORD presented their research there with topics ranging from genetic connectivity among *Calanus* species in the Arctic to benthic communities of sub-Arctic fjords. These events are invaluable especially for the PhD students to engage in networking and get feedback from the experienced senior researchers within ARCTOS. NORD PhD student Eric Jorda Molina has been appointed as student representative for ARCTOS in 2020 to foster student contribution within ARCTOS. Specifically, the zooplankton research at NORD has benefited substantially from the collaboration within ARCTOS. For example, Marvin Choquet presented his study on species boundaries in contemporary populations of *Calanus* in the North Atlantic during the Zooplankton Colloquium and an ARCTOS PhD student from the Norwegian Polar Institute was working in the NORD genomics lab within the framework of the EvoCal NFR-project, a result of an ARCTOS collaboration.

The participation of NORD members in colloquia and workshops gives room for improvement, and although remote participation was increasingly used during the pandemic, NORD is aiming at increasing the contributions to the ARCTOS Colloquia both in participation and organization in the future.

Publication highlights:

Sen A, Didriksen A, Hourdez S, Svenning MM, Rasmussen TL (2020). Frenulate siboglinids at high Arctic methane seeps and insight into high latitude frenulate distribution. Ecol Evol 10 (3), 1339-1351. https://doi.org/10.1002/ece3.5988

Skottene E, Tarrant AM, Altin D, Olsen RE, Choquet M, Kvile KØ (2020). Lipid metabolism in *Calanus finmarchicus* is sensitive to variations in predation risk and food availability. Sci. Rep. 10 (1), 1-14. https://doi.org/10.1038/s41598-020-79165-6

Norwegian Polar Institute

The NPI-led HAVOC (Ridges – Safe HAVens for ice-associated Flora and Fauna in a Seasonally ice-covered Arctic OCean) project is the Norwegian contribution to the international MOSAiC expedition and studies the role of sea ice ridges in the thinner ice pack of the Arctic Ocean. ARCTOS members from four ARCTOS member institutions (Akvaplan-niva, NPI, UiT and UNIS) are involved in the HAVOC project. Despite all the logistic challenges associated with COVID-19, HAVOC had its major field component in 2020 with 6 project partners from Norwegian research institutions participating in the winter (leg 2) and early summer (leg 4) legs of the MOSAiC expedition. ARCTOS member Benjamin Lange joined the leg 4 field team and gave a vivid presentation of the MOSAiC field highlights during the virtual ARCTOS Christmas colloquium on 9 December 2020.

The Kongsfjord research cruise was arranged with RV Kronprins Haakon 24 July – 2 August. The cruise followed the traditional transect with sampling for oceanography, water chemistry, phyto- and zooplankton, and we also did two trawl hauls with the Campelen 1800 demersal trawl. Fishes caught in the trawl will be part of the food web and ecotoxicology studies by ARCTOS post-docs France Collard and Igor Eulaers.

The Kongsfjord cruise is part of MOSJ (Environmental monitoring – Svalbard and Jan Mayen, www.mosj.npolar.no/), a program to monitor changes in the Arctic Ecosystem at Svalbard and Jan Mayen. The survey in Kongsfjorden - Fram Strait (KongHau), which has been conducted annually in July since 1996, is used by NPI to monitor long-term changes in phytoplankton and zooplankton as well as trophic structure of this ecosystem. Unfortunately, 2020 was the last year of this survey by research vessel.

Publication highlights:

Ardyna M, Mundy CJ, Mayot N, Matthes LC, Oziel L, Horvat C, Leu E, Assmy P, Hill V, Matrai PA, Gale M, Melnikov IA and Arrigo KR (2020) Under-ice phytoplankton blooms: Shedding light on the “invisible” part of Arctic primary production. Front. Mar. Sci. 7:608032. doi: 10.3389/fmars.2020.608032

Hop H, Vihtakari M, Bluhm BA, Assmy P, Poulin M, Gradinger R, Peeken I, von Quillfeldt C, Olsen LM, Zhitina L and Melnikov IA (2020) Changes in sea-ice protist diversity with declining sea ice in the Arctic Ocean from the 1980s to 2010s. Front. Mar. Sci. 7:243. doi: 10.3389/fmars.2020.00243

France Collard, Haakon Hop and Igor Eulaers (left to right) working up fish from a trawl in Kongsfjorden. Photo credit: Kristin Heggland /Norwegian Polar Institute

France Collard – Post-doc at NPI

France started her post-doc position at the Norwegian Polar Institute in 2018. Her field of interest is plastic pollution globally, and her current post-doc fellowship is focused on plastic pollution in the Arctic environment including sediment, sea birds and fish. France is involved in several projects, e.g., investigating plastic ingestion by Northern Fulmars from Kongsfjorden and ecotoxicology studies of demersal fish.

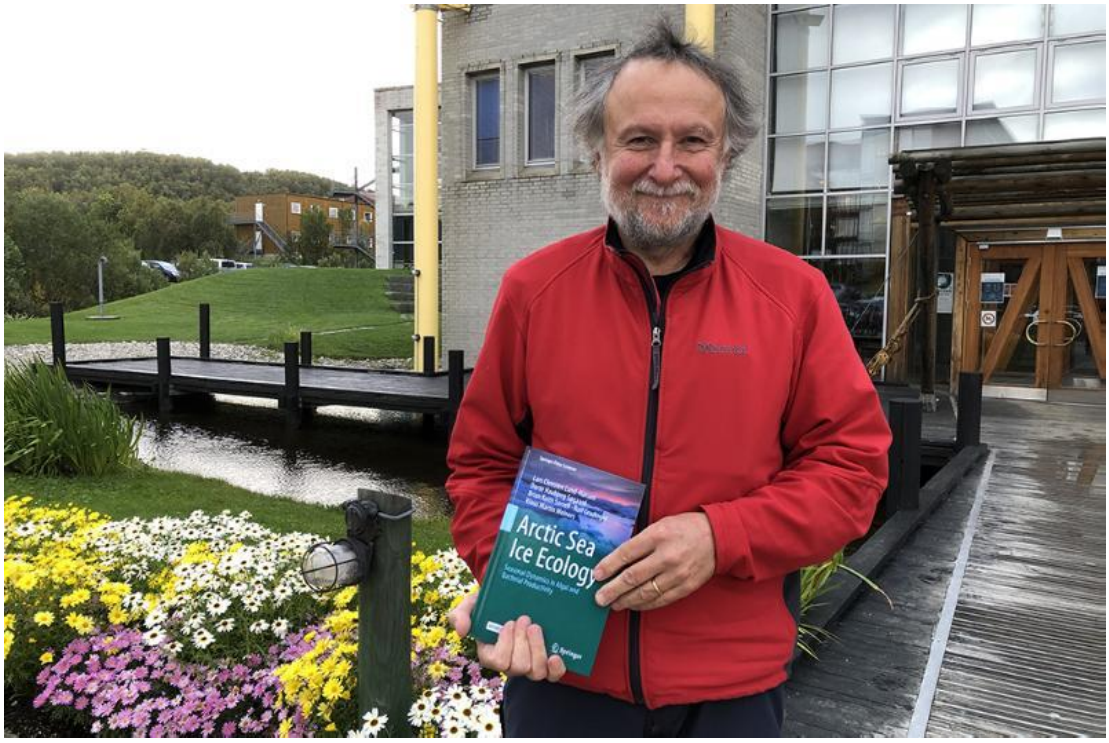
UiT The Arctic University of Norway

A total of 54 scientists from UiT were members of ARCTOS in 2020, including: 23 senior members, 9 post-docs, 18 PhD candidates, and 4 Master students. Three post-docs successfully finished their projects and changed affiliation, while two post-docs as well as two senior researchers joined the network. One PhD candidate discontinued the project, while two Master students successfully defended. Three PhD candidates and two Master students joined the network in 2020.

This past year ARCTOS members of UiT have led and participated in several research campaigns, including the Nansen Legacy project (lead M. Reigstad, AeN) and Arctic Seasonal Ice Zone Ecology (lead P. Wassmann; SIZE). UiT scientists continued their ARCTOS work affiliated with the AeN and ArcticSIZE projects. In 2020 two research cruises were completed as part of this work, in addition to numerous collaborations with the international MOSAiC campaign that took place 2019-2020. The Deep Impact project (lead J. Berge) is focusing on polar night ecology and kicked-off in October 2020. It employs two ARCTOS PhD students. Planning is presently underway for a winter cruise in January 2022. Sea Patches (lead S. Basedow, contributors M. Daase and S. Falk-Pedersen) was studying the occurrence of *Calanus* swarms in surface water habitats using remote sensing applications. The project was completed in 2020 with a final project meeting in Glasgow (February 2020). The project Physical drivers of ice algal HOTspots in a Changing Arctic Ocean (PHOTA; lead B. Lange, WP lead K. Campbell) is using hyperspectral imagery and oxygen sensors to study sea ice environments. This project began in 2020 and is ongoing with ARCTOS members from NPI, UiT, UNIS & Akvaplan-niva. Part of this work is MSc student (UiT) and new ARCTOS member Zoe Lulu Forgereau.

In 2020 two books have been published with ARCTOS members as editors. **Polar Night Marine Ecology – Life and Light in the Dead of Night** was edited by Jørgen Berge (ARCTOS), Geir Johnsen and Jonathan H. Cohen. Excerpt from the abstract: *The main ambition of this book is to present how key environmental variables, such as the light regime (intensity, color, and day length) are important cues for marine ecosystem dynamics, biodiversity, production and eco-physiology across different organism groups during the Polar Night*. Ten ARCTOS members from different member institutions have contributed to several chapters of the book.

The other book entitled **Arctic Sea Ice Ecology - Seasonal Dynamics in Algal and Bacterial Productivity** was written by Lars Chresten Lund-Hansen, Dorte Haubjerg Søgaard, Brian Keith Sorrel, Rolf Gradinger (ARCTOS), and Klaus Martin Meiners. Excerpt from the preface: *This book deals with sea ice ecology, with a focus on sea ice algae and other microbes such as bacteria and small metazoans (meiofauna) residing inside or at the bottom of the sea ice, all referred to as the sympagic biota of the ice. Sea ice also provides a habitat for a wide and ecologically important range of organisms including zooplankton, fish, seals, whales, walruses, birds, and polar bears. Some of these organisms are entirely dependent on sea ice for feeding, resting, and/or breeding but are not part of the sympagic biota. These organisms may also depend on the existence of the bacteria and ice algae which form the basis of the ice-associated Arctic food webs*.



Rolf Gradinger with the book 'Arctic Sea Ice Ecology'. Photo credit: Karine Nigar Aarskog/UiT

Publication highlights:

Kunisch EH, Bluhm BA, Daase M, Gradinger R, Hop H, Melnikov IA, Varpe Ø, Berge J (2020) Pelagic occurrences of the ice amphipod *Apherusa glacialis* throughout the Arctic. J. Plankton Res. 42: 73-86. https://doi.org/10.1093/plankt/fbz072

Berge J, Geoffroy M, Daase M et al. (2020). Artificial light during the polar night disrupts Arctic fish and zooplankton behavior down to 200 m depth. Comm. Biol. 3, 102. DOI: https://doi.org/10.1038/s42003-020-0807-6

Zoé Lulu Forgereau – Master student at UiT

Zoé started her Master project entitled: 'Photophysiological responses of marine microalgae to changes in salinity' in August 2020. She is going to work on the photophysiological responses of sea ice algae when exposed to conditions typical of sample melt. To complete this study, she will use 14C to carry out measurements of primary production, photophysiology, in addition to estimates of abundance and stress. This will be focused on culture-based experiments at UiT but will also include assessment of mixed algal communities from field sampling.

The University Centre in Svalbard

2020 was a special year for ARCTOS members at UNIS due to the COVID-19 lockdown in March and very strict travel regulations combined with the cancellation of courses and larger research cruises. However, since there were no detected COVID-19 cases in Longyearbyen, UNIS could open for some field and lab work for prioritized projects already by the end of April, but with strongly reduced number of personnel. UNIS managed to continue the mapping of ice algae and sympagic meiofauna in Svalbard fjords, which is part of the Fram Centre funded Ice-Free Arctic Ocean: Dead end or new opportunities for biodiversity and habitat Expansion (FADE) led by ARCTOS members from UNIS, UiT, NPI and NORD University. ARCTOS PhD student Cheshtaa Chitkara continued running the important monthly Isfjorden Adventfjorden time series station which was established in 2011.

The aim of this time series is to determine temporal drivers of changes in microbial and zooplankton communities, and to untangle natural year to year variation and long-term climate related alterations. In November 2020, ARCTOS PhD student Magdalena Wutkowska successfully defended her PhD thesis on microbial eukaryotes and their functional importance in the Arctic with data from this time series station. Further UNIS managed to continue the land to sea work in Adventfjorden in close collaboration with NIVA and UiT. ARCTOS PhD student Maeve McGovern (UiT, UNIS and NIVA) has intensively studied this catchment system during her PhD, studies which have been continued through the Fram Centre project Freshfate and the Biodiversa-Belmont (EU) funded project ACCES with strong involvement by several ARCTOS members and their master students.

Publications highlights:

Kvernvik AC, Rokitta SD, Leu E, Harms L, Gabrielsen TM, Rost B, Hoppe CJM (2020). Higher sensitivity towards light stress and ocean acidification in an Arctic sea ice-associated diatom compared to a pelagic diatom. New Phytol., 226(6), 1708-1724. doi: https://dx.doi.org/10.1111/ nph.1650

McGovern M, Pavlov AK, Deininger A, Granskog M, Leu E, Søreide JE, Poste AE (2020). Terrestrial Inputs drive seasonality in organic matter and nutrient biogeochemistry in a igh Arctic fjord system (Isfjorden, Svalbard). Front. Mar. Sci. 7, 15. doi: https://dx.doi.org/10.3389/ fmars.2020.54256

Snorre Flo – PhD candidate at UNIS

Snorre started his PhD project entitled: 'Mapping trophic interactions in small Arctic invertebrates' in October 2019. The overarching goal of his PhD project is to characterize the prey species composition of small Arctic invertebrates along a spatial and temporal gradient in the Barents Sea. Snorre will use the so-called dietary metabarcoding pipeline to characterize the species composition in the gut contents of these small invertebrates, during different seasons and at different latitudes.

A MICHAEL O. SNYDER FILM

INTO THE DARK

CHASING LIGHT IN EARTH'S DARKEST PLACE

COMING 2020

INTERDEPENDENT PICTURES AND UIT THE ARCTIC UNIVERSITY OF NORWAY PRESENT IN ASSOCIATION WITH VOX / GOPRO / SONY PRO USA
IN PARTNERSHIP WITH THE CHANGING ARCTIC OCEAN PROGRAMME PRODUCED BY ELI KINTISCH AND MICHAEL O. SNYDER 'INTO THE DARK'
MUSICAL COMPOSITION BY CHRISTOS ANESTOPOLOUS AND BIIAS SOUND PRODUCTION BY BARBARA OLIVEIRA WRITING FROM ELI KINTISCH
CINEMATOGRAPHY BY MICHAEL O. SNYDER / BARBARA OLIVEIRA / ELI KINTISCH DIRECTED AND EDITED BY MICHAEL O. SNYDER

Paul Wassmann (left) and Stig Falk-Petersen (right), who initiated ARCTOS together in 2002. Photo credit: Karine Nigar Aarskog/UiT

Stakeholder engagement

Social media

ARCTOS is present on Facebook (Arctos Research Network), Twitter (@ARCTOSnetwork) and Instagram (ARCTOS Research Network). However, activities on Twitter and Instagram were low in 2020, probably also due to low activities on these channels among ARCTOS members. On Facebook, activities were high, with 44 posts in 2020, of which some have reached >400 people.

Fram Forum

The Fram Forum is published once a year and disseminates different activities connected to the Fram Centre to an international and national audience. Fram Forum is published both digitally and on paper. In 2020, the Fram Forum featured an article about ARCTOS, how it was 'conceived', its focus and the advantages of such a network.

The article compiles interviews with several senior ARCTOS members and the three founders of the network, Paul Wassmann (professor at UiT), Stig Falk-Petersen (then senior researcher at NPI, now at Akvaplan-niva), and Salve Dahle (then director at Akvaplan-niva).

< To the left: The film 'Into the Dark' premiered at the International Tromsø Film Festival in 2020, following researchers including several ARCTOS members during the Marine Night project field campaigns.

Outlook 2021

Based on the successful year 2020, ARCTOS started with a flurry of activities into 2021. Early in January, ARCTOS organized an international digital workshop under the lead of UiT, focusing on Macroalgae in the high North.

The traditional PhD workshop in conjunction with Arctic Frontiers had to be cancelled due to COVID-19 restrictions. Under the lead of Martí A. Arumí, several ARCTOS students and members in collaboration with APECS Norway members organized three digital workshops for early career scientists instead, strengthening the network of Arctic biomarker researchers, exploring multiple outreach channels, and focusing on Arctic seaweed as a case study for stakeholder communication.

A major milestone in the increasing research focus of ARCTOS was the planning and successful execution of the joint ARCTOS/AeN research expedition into the Barents Sea with strong student participation tied to a UiT PhD level course BIO-8510. This had been a very challenging task given the COVID-19 regulations but proved to be highly successful.

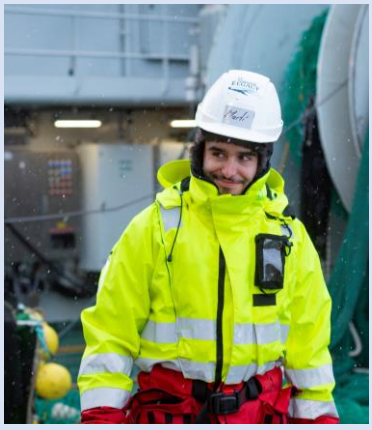
ARCTOS Days 2021 are delayed because of COVID-19 but are planned for November 2021.

Also in 2021 we had very reduced in-person meetings but continued successfully with online seminars/presentations as well as regular Zoom based Secretariat meetings.

ARCTOS scientists will participate in a joint AeN-ARCTOS workshop focused on the Barents Sea Polar Front in October. The focus on the Polar Front will continue based on the success in receiving funding for a three-year research project through NFR (with support from Equinor and ConocoPhillips).

Strategically, ARCTOS will aim to continue its success on the education and career development of early career scientists, while at the same time intensifying the network´s impact and relevance on research.

Martí Amargant-Arumí – PhD candidate at UiT



Martí started is PhD project in August 2019 and jointed the network early 2020. Martí is investigating the seasonal and latitudinal dynamics in the primary production of phytoplankton and sea ice algae of the Northern Barents Sea, aiming to establish new baselines in a changing Arctic. He is particularly interested in applying molecular techniques to assess the functional responses of individual species or strains to multiple climate change stressors. Martí is also one of the student representatives for 2020-2021.

Photo credit: Nellie Wullenweber

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