UNIS

The University Centre in Svalbard

ANNUAL REPORT 2020

Front page | May 2020: Performing drone fieldwork at Fridtjovbreen. Photo: Christina Hess.

Editor | Eva Therese Jenssen.

February 2020: Longyearbyen seen from Gruvefjellet.
Photo: Sil Schuuring/UNIS.

FROM THE DIRECTOR

With the outbreak of the Covid-19 pandemic, 2020 became challenging year for both staff and students. On 12 March all universities in Norway were closed down. UNIS had at that time 180 regular course students. Our main task became to ensure that all of our students would receive their study credits and maintain the planned study progress. The lectures and seminars went digital. Thanks to our skilled staff that quickly adapted to digital learning despite working from home. The exam success rate of 97% speaks for itself.

All courses at UNIS have a mandatory field component, meaning that the learning outcomes cannot be achieved without fieldwork. Due to infection control measures it was not possible to guarantee classes in the field, and UNIS decided to cancel all courses for the rest of the year. A health adviser with particular responsibility for infection control measures was hired to develop routines for all work tasks at UNIS, enabling us to maintain the research activity and supervision of higher-level individual students who were in the final stages of their work. Despite these circumstances, we had 299 individual students at UNIS in 2020, but the annual student production was less than half of a normal year.

Our pride is in providing high-quality teaching. We are partner in two different centres of excellences in education, one in bioscience (bioCEED) and the other in geosciences (iEarth). Research on education enable us to test and document the effect of new learning methods. For Norwegian students, a period of study at UNIS is easily accessible and, I would say, a convincing alternative to international exchange programmes. We offer an international study environment, all teaching is given in English, and we provide a social, safe, and good student environment. Thorough safety training on arrival enables our students to behave safely in extreme conditions, skills that are sought-after by future employers.

The climate is changing more rapidly in the high Arctic than any other places on earth. UNIS has a particularly favourable location for researching a wide range of climate and environmental indicators in order to document the climate effects on ecosystems and food chains, thawing of permafrost, erosion and landslides, glacier dynamics, natural gas resources and leakage through the permafrost, how the glacier melts impacts sea ice and fjord systems and the regional climate. Svalbard has also a unique location and serve as the world´s observation site to explore how the solar wind directly impacts on the Earth's atmosphere. Our scientists are developing research excellence with the mainland universities through strategic research collaborations. We are partner in the Research Centre for Arctic Petroleum Exploration, Birkeland Centre of excellence in Space Science, and the Norwegian Centre for Carbon Capture & Storage. We have a stable portfolio of major and minor research projects and in 2020 we had 157 articles published in peer reviewed journals.

Jøran Moen is managing director of UNIS.
Photo: Eva Therese Jenssen/UNIS.

UNIS contribute significantly to the understanding of environmental and societal consequences of rapid warming in the Arctic, and through both research and education we contribute to the knowledge needed to fulfil the UN´s sustainable development goals.

In 2020 three projects particularly motivated to serve local and global societal needs were funded:

- A pan-Arctic project to document Arctic coastal ecosystems.
- Risk governance, early warning, and climate change adaptation in the Arctic
- Develop research-based emergency preparedness tools to deal with thawing of permafrost

UNIS will provide the knowledge needed to develop new and sustainable businesses in Longyearbyen, and to support safe and sustainable family living in Longyearbyen. We have focus on further developing two knowledge areas to support business development in Longyearbyen: Arctic safety and Arctic energy solutions. The Arctic Safety Centre (ASC) has a particular responsibility to develop expertise and training for sustainable and safe development of businesses and in general life in the Arctic. ASC delivers key data to the snow avalanche forecast programme for Longyearbyen, and also develop innovative tools to monitor and forecast natural hazards with a high market potential, also outside Svalbard. Renewable Arctic energy solutions is another emerging field with potential for developing new businesses in Longyearbyen. The idea is to develop and test renewable energy solutions for cold climate and extreme weather conditions. The role of UNIS is to provide Arctic expertise and educate candidates to aid new businesses in Longyearbyen to develop and to become competitive in delivering green energy solutions in a global market.

I would like to thank the students and all the staff at UNIS, and our collaboration partners, who managed to deliver so much despite all the Covid-19 constraints. When we finally are through, we are better prepared than ever to focus on and further develop the skills needed for a better and safer life on our planet.

Jøran Moen
Managing director

EXCERPT FROM THE BOARD OF DIRECTORS' REPORT 2020

The University Centre in Svalbard AS (UNIS) is a state-owned limited corporation administered by the Ministry of Education and Research. The company's objective is to provide an educational provision and engage in research based on Svalbard's geographic location in the High Arctic and the special advantages this offers, by using the nature as a laboratory and arena for observations and collection and analysis of data. The educational provision shall be at university level and act as a supplement to the tuition offered at the universities on the mainland and form part of an ordinary programme of study leading to examinations at bachelor's, master's and PhD level. The educational provision shall have an international profile, and the tuition shall be given in English. There shall be a balance between Norwegian and international students. Through its activities, the company shall contribute to community development in Longyearbyen and Svalbard in line with the overarching objectives of Norwegian Svalbard policy.

March 2020: UNIS and the Svalbard Science Centre. Photo: Sil Schuuring/UNIS.

COVID-19 IMPLICATIONS

When UNIS was closed on 12 March, there were 180 students here. The staff needed to work from home and the Svalbard Science Centre remained largely closed for two months.

As the facilities for treating sick people in Longyearbyen are extremely limited, seriously ill patients need to be evacuated. Furthermore, local emergency preparedness requires that any case of infection leads to quarantine or isolation for anyone who has interacted with the infected person. For UNIS, this could quickly lead to the entire institution being shut down because of a single case of infection. Taking care of a large number of students and staff in quarantine and/or isolation would be demanding for the local community, as well as for the UNIS staff.

For UNIS, the main objective was to facilitate that all students had an opportunity to complete the semester and their courses in the best possible way by using a digital solution. This was a difficult time for many students. They experienced psychosocial challenges related to uncertainty about the situation and the possible duration, concerns about their family back home and the experience of being isolated, among other things.

The following are among the measures implemented:

- The teaching was changed from physical to digital, and the IT Section worked to put digital systems in place. Each lecturer has chosen their owns methods for staying in contact with the students.
- The students who wished to do so could travel home and complete their UNIS courses digitally. UNIS covered their travel expenses and two months' rent (the period of notice) for student accommodation at the Arctic Student Welfare Organisation.
- Temporary regulations were adopted that made it possible to change the form of assessment and grant exemptions from compulsory activities (fieldwork).
- An "open line" was set up to UNIS via study@unis.no and the student groups on Facebook where the students could contact student advisers.
- The Student Counselling Centre in Tromsø has a designated psychologist and counsellor who follows up UNIS students and offer consultations via digital solutions.
- Field work for guest students: A review was undertaken of what field activity was necessary and possible to implement. The goal was that the students should not experience delays in completing their studies.

In addition to the ordinary course evaluation, UNIS sent a separate Covid-19 student survey to all course students in June. The survey contained questions about the transition to digital teaching, student life and how UNIS handled the crisis. In general, the transition to digital teaching and examinations received favourable feedback, with some suggestions for improvements. However, when it came to feedback about student life and how UNIS had handled the situation, the responses were mixed. While many students were pleased with the financial support from UNIS and thought that UNIS had done its best in a difficult situation, others criticised UNIS for the way we communicated about and handled the situation.

All courses at UNIS have a compulsory field component, which means that implementing the field teaching is a requirement for achieving the learning outcome. With respect to admission to the summer and autumn courses, it became clear that it was not possible to guarantee field teaching. Consequently, UNIS decided not to admit new course students for the rest of the year. Naturally enough, Covid-19 has had major consequences for the institution's production target.

A health worker with responsibility for infection control was appointed from the early summer. During the autumn of 2020, thorough preparations took place to facilitate the admission of new students in January 2021. Infection control procedures for Covid-19 were drawn up for all types of duties and responsibilities at UNIS.

Taking care of the students and staff who remained at the institution, as well as the small number of guest students admitted in the autumn of 2020, became a high priority for UNIS. The risk of infection at UNIS was kept so low that it would be probable that the research activity and supervision of master's degree students who were in the final stage of their work should be able to be maintained.

Despite these circumstances, 299 individual students spent time at UNIS in 2020 and the annual production ended at 97 student-labour years. The Board of Directors wishes to extend a big thank you to students and all the staff at UNIS, who managed to deliver so much in these extremely demanding circumstances.

Covid-19 led to delays in research production for several reasons. Major field campaigns and research cruises were postponed by a year. Although some projects lost local fieldwork in the spring of 2020, it was possible to implement most in the summer and autumn. The work situation that entailed working from home has been demanding for many. Limited mobility because of travel restrictions has led to many not having access to the field and laboratories at UNIS, in Norway and abroad.

Six PhD candidates received a total extension of 9.5 months. However, postdoctoral fellows were the worst affected group due to strict restrictions regarding the extension of employment contracts. The nine postdoctoral fellows we had in 2020 lost research opportunities that cannot be recovered during their contract period.

The cancellation of courses mean low student production and lower course costs. The latter led to financial wiggle room. According to UNIS's statutes, any financial wiggle room shall be used for the purpose of the enterprise. The funds freed up in 2020 because of the Covid-19 situation have been used to invest in ICT solutions in preparation for receiving students in a way that is as normal as possible in 2021, with the possibility of a hybrid of physical and digital teaching.

ECONOMY

Funds for operation and investments at UNIS are appropriated in the budget of the Ministry of Education and Research. In 2020, the appropriations from the Ministry totalled NOK 142,463,000. In addition, UNIS received an allocation of NOK 1 million from the Ministry of Trade, Industry and Fisheries earmarked the Arctic Safety Centre, as well as a subsidy of NOK 609,230 from the Norwegian Tax Administration in connection with the challenges related to Covid-19.

Of the total allocation registered as income, NOK 3,311,936 was spent on investments in equipment. Furthermore, investments in technical-administrative and scientific infrastructure totalling NOK 15,921,799 were capitalized in the balance sheet.

Income beyond the above-mentioned allocations comprises NOK 52,852,493, of which NOK 38,110,328 is related to external project income for research and the remaining NOK 14,742,165 is income from rentals and other income.

After capitalization of purchased infrastructure, the accounts for 2020 show a surplus of NOK 22,592,903, of which the above-mentioned amount of NOK 15,921,799 is tied up in equipment investments and a digital boost for the company. The fact that the wiggle room was utilised strategically to catch up on a large backlog of necessary investments means that UNIS also gained something positive from a very demanding year.

See the detailed accounts and balance sheet on pages 10–11.

BOARD OF DIRECTORS AND ANNUAL GENERAL MEETING

The Board of Directors held four meetings in 2020. All the board meetings were held via Microsoft Teams owing to the Covid-19 situation. The Annual General Meeting was held in Oslo on 22 July 2019.

EDUCATION AND STUDENT STATISTICS

In 2020, 299 students spent shorter or longer periods at UNIS, including both course students and guest students. Starting from 2020, the credit production for guest students at bachelor, master's and PhD level will all be reported. Students from 32 countries were represented at UNIS in 2020. Norwegian citizens (43%) were the largest group, followed by students from Germany and the Netherlands in second and third place, respectively. Although the proportion of Norwegian citizens was 43%, 64% of the students came from programmes of study at Norwegian universities. This is a significant increase from previous years. The discrepancy between Norwegian citizens and students from Norwegian universities can be attributed to the fact that foreign nationals are admitted to ordinary programmes of study at Norwegian universities.

After the Covid-19 restrictions were introduced in March 2020, UNIS cancelled all the courses that had not started yet. Ongoing courses switched to digital teaching. The lecturers made an impressive effort to quickly switch from physical to digital teaching. The guest students could stay at UNIS, and a financial incentive was introduced for the guest master's students to maintain or increase the number in this group. Owing to the cancellation of courses, the number of students and the credit production in 2020 were significantly reduced compared to previous years. Consequently, some of the results from 2020 will not be comparable with results from previous years.

A total of 97 student-labour years were produced at UNIS in 2020, which is less than half the production target for UNIS of 220 student-labour years. Of these, 72 student-labour years were linked to credits (ECTS) from completed courses and 25 student-labour years to guest students. While naturally enough there has been a large decline in production at course level, the production from guest students increased significantly. In 2020, guest students accounted for 26% of the total credit production at UNIS.

The results from the final assessment of the courses was above average, with B as the average grade. However, owing to changes in the teaching situation during the spring, the grades were changed from the grading scale from A-F to pass/fail in some courses. The failure rate was still low (3%) but was somewhat higher than previous years.

UNIS had 25 PhD candidates in 2020, and five public defences were held.

RESEARCH AND ACADEMIC INITIATIVES – EXTERNAL FUNDING

In line with UNIS's new strategy, the institution is developing goals and organisational structures to strengthen research. Over the last two years, UNIS has aimed at larger and more long-term projects in strategically important areas. This means a more pan-Arctic approach to research issues, while at the same time clarifying UNIS's corporate social responsibility in Longyearbyen.

The research at UNIS focuses on local and global issues of relevance to climate, environment and sustainability. The temperature increase in Svalbard is stronger than elsewhere. UNIS has a particularly favourable location for researching a broad spectrum of climate and environmental indicators through developments in ecosystems and food chains in the sea and on the land, thawing of permafrost, erosion and landslides, movement and cracking of glaciers, natural gas and natural gas emissions from the ground, the impact of the North Atlantic Current and glacier melting on fjord systems and sea ice, and how all this relates to the Earth's geological development. Another field of research is how the solar wind affects the upper parts of the atmosphere that create disturbances to navigation and communication systems, how this can affect the ozone layer and thereby affect transport of energy through the atmosphere, and thus also the regional climate. UNIS is also conducting research on how to protect ourselves against natural hazards such as avalanches, traffic in and on sea ice, foundations in permafrost and renewable energy solutions.

During 2020, UNIS has received funding for several research projects. The Department of Arctic Geophysics (AGF) is leading a new Research Council of Norway project that will study magnetic pulsations caused by the interaction between the solar wind and the Earth's magnetic field, with partners from Russia and France. Within Arctic Safety (ASC), UNIS is heavily involved in the new project led by NTNU on risk management of climate-driven natural hazards *(Risk governance, early warning and climate change adaptation in the Arctic).*

March 2020: PhD candidate Robynne Nowicki has a lecture on zooplankton for the sixth graders at Longyearbyen school. Photo: Eva Therese Jenssen/UNIS.

In 2020, UNIS announced calls for proposals for a Strategic Pilot Project to stimulate inter-departmental collaboration at the institution to develop knowledge for solving specific societal challenges. The Board of Directors allocated a scope of NOK 6 million and a four-year PhD position funded by the Ministry of Education and Research to the project *PermaMeteoCommunity,* which will develop research-based emergency preparedness tools to manage thawing of the permafrost, which is expected to be one of the major climate challenges for Longyearbyen.

At the Department of Arctic Biology (AB), the major EU/H2020 project *FACE-IT (The future of Arctic coastal ecosystems – Identifying transitions in fjord systems and adjacent coastal areas)* has commenced. FACE-IT is a pan-Arctic project and AB has a central role in the marine sampling in Svalbard. Furthermore, the Department of Arctic Geology (AG) and AGF have begun with *iEarth (Centre for Integrated Earth System Education)*, a Centre for Excellence in Education led by the University of Bergen, which also has a significant research component.

Of all the projects, *The Nansen Legacy* is still the largest project at UNIS. AB (within marine biology and data management) and AGF (within oceanography) are both heavily involved. The *Birkeland Centre for Space Science* (AGF), which is a Centre of Excellence (CoE), still has significant activity but has now entered its penultimate year, while *ARCEx (Research Centre for Arctic Petroleum Exploration)* at AG is in its final year of operation.

The combined turnover from the externally funded projects in 2020 was approx. NOK 38,100,000.

Finally, we would like to mention two other major initiatives:

SIOS (Svalbard Integrated Arctic Earth Observing System), which has been organised as a subsidiary of UNIS through SIOS Svalbard AS since 2017, has as its main task to coordinate and further develop an international research infrastructure to explore regional effects of climate change. UNIS was one of the initiators of SIOS, and we are making an active contribution to developing SIOS for better coordination of national and international measurement programmes in Svalbard. The main task of SIOS is to integrate Svalbard into a pan-Arctic earth observation system for climate and environment. The total turnover of SIOS Svalbard AS in 2020 was NOK 31,200,000.

Arctic Safety Centre (ASC) received an allocation of NOK 1 million from the Ministry of Trade and Industry for 2020 to contribute to increased competence about sustainable and safe activity in the Arctic. This funding paid the salaries of two staff who worked during the year on concept development for an ASC knowledge centre including user development, marketing and recruitment of business partners, as well as developing practical safety courses for the business community.

STAFF

As of 31 December 2020, the faculty at UNIS comprised of 14 professors, 12 associate professors, two researchers, nine postdoctoral fellows, 15 PhD candidates and 40 staff with adjunct professor/associate professor attachments. The technical and administrative staff comprised 41.1 full-time equivalent work years. The proportion of Norwegian citizens in permanent positions at UNIS was 53%.

Women accounted for 39% of the faculty positions, 45% of the technical and administrative positions and 55% of the students. Five of the 11 members of the Board of Directors were women.

HEALTH, SAFETY AND ENVIRONMENT

Taking care of students and staff during the pandemic has been a priority task throughout the year. At the time of the outbreak, UNIS had an existing pandemic plan that was quickly updated and formed the basis of how the institution has dealt with the situation. In addition, internal operating procedures and infection control routines were developed throughout the year. Consideration to psychosocial conditions has gradually become more important and been given greater emphasis in this work. UNIS is represented on the local emergency preparedness council and, through this collaboration, has coordinated measures with the other, major institutions in Longyearbyen. No confirmed cases of Covid-19 were registered in Longyearbyen in 2020.

Despite having fewer students than in a normal year, 90 field safety courses involving a total of 1,039 people were held in 2020.

UNIS's location in the High Arctic, characterised by unpredictable effects of climate change, provides special challenges in the entire HSE spectrum. It is important to take a proactive approach in our responsibility for safe and careful travel by our students and staff in the Svalbard nature. Quality assurance of the planning and implementation of field-based projects is implemented in a structured manner with strict requirements for work procedures and methods.

UNIS has experienced that over recent years there have been more polar bears in the area around Isfjorden and Longyearbyen, which are the core areas for UNIS's field activities. Consequently, UNIS no longer allow the use of tented camps in areas near the sea, on or near sea ice, or in areas where we know from experience that polar bear encounters are common. Moreover, we have extended our compulsory safety training for polar bear safety from a half day to a full day. The main emphasis of this course now involves making good assessments to avoid close encounters and conflict situations with polar bears, as well as learning methods of operation that will contribute to students and staff being able to get out of difficult situations. We register and analyse all observations of and close encounters with polar bears to learn more, and we continuously adapt our safety training and behaviour in the field.

UNIS's internal regulations are based on the formulation of objectives from the Svalbard Environmental Protection Act, which states that in the event of conflict between the activity and the environment priority must be given to environmental considerations.

UNIS is unaware of its operations causing any direct contamination of the external environment locally. A new priority area for UNIS is research and education on energy solutions in the Arctic, and UNIS is involved in local projects focussing on renewable energy and measures to reduce energy consumption. Through field-based research and education, the staff and students acquire practical knowledge to manage and preserve the vulnerable nature and biodiversity. UNIS utilises this knowledge in a continuous effort to limit the environmental impact of our activities.

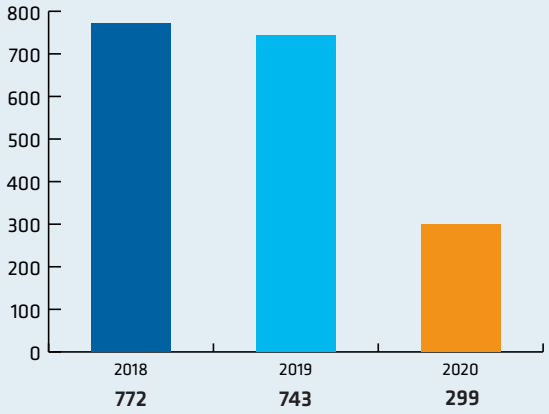
The Board of Directors would like to thank everyone at UNIS, students and staff alike, for handling the difficult Covid-19 situation in 2020 in such a good way. The measures implemented to safeguard the credit production of the students UNIS took responsibility for in 2020 were especially important.

LONGYEARBYEN, 18 MARCH 2021:

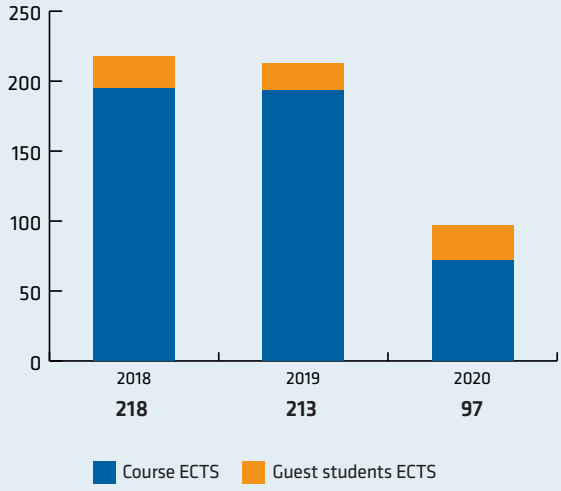
Chair of the Board Morten Hald (UiT The Arctic University of Tromsø); Deputy Chair Nina Frisak, Board members Robert Bjerknes (University of Bergen); Brit Lisa Skjelkvåle (University of Oslo); Øyvind W. Gregersen (NTNU); Siri Kalvig; Stein-Ove S. Johannessen (Longyearbyen Community Council); Hanne H. Christiansen, Elise Strømseng and Nina Kristine Eriksen (staff representatives); Simmen Karoliussen (student representative) and Jøran Idar Moen (Director).

STATISTICS

TOTAL NUMBER OF STUDENTS

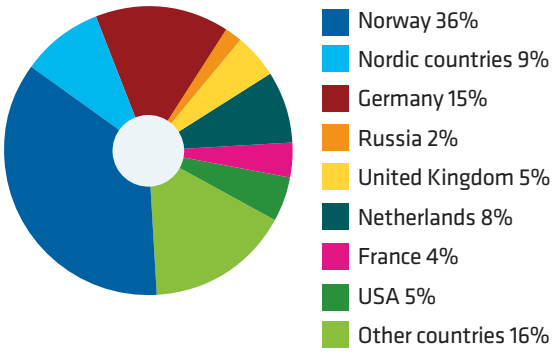


PRODUCTION IN STUDENT-LABOUR YEARS (1 YEAR = 60 ECTS CREDITS)

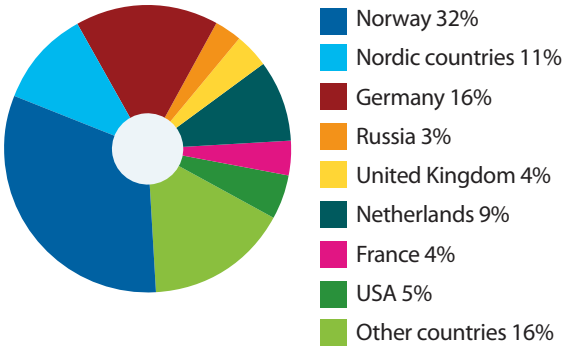


Note: UNIS registers ECTS by 1) course production and 2) guest students attendance

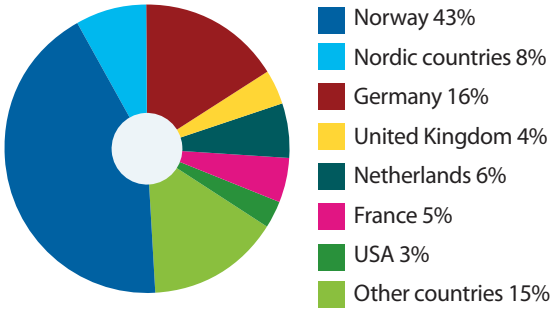
STUDENT NATIONALITY 2018



STUDENT NATIONALITY 2019



STUDENT NATIONALITY 2020



PROFIT AND LOSS ACCOUNT 2020

GROUP*			University Centre in Svalbard AS	
2020	2019		2020	2019
NOK	**NOK**	**OPERATING INCOME**	**NOK**	**NOK**
142 463 000	136 187 000	Operating grant from the Ministry	142 463 000	136 187 000
14 045 763	18 550 111	Other grants	1 609 230	6 000 000
0	-10 574 657	Appropriation for investments	0	-10 574 657
156 508 763	**144 162 454**	**Operating grant from the Ministry**	**144 072 230**	**131 612 343**
56 867 197	78 311 064	External project income	38 110 328	42 257 596
11 942 165	14 196 023	Other incomes	14 742 165	16 996 023
225 318 125	**236 669 541**	**Gross operating income**	**196 924 723**	**190 865 962**
50 452 452	70 791 691	Direct project expenses	31 736 057	34 738 223
174 865 673	**165 877 850**	**Net operating income**	**165 188 666**	**156 127 739**
		OPERATING EXPENSES		
78 816 689	79 274 862	Salary and related expenses	73 475 945	73 923 948
1 721 805	10 642 336	Fieldwork and cruise	1 721 805	10 642 336
39 487 003	36 679 589	Buildings	39 487 003	36 679 589
30 695 092	26 584 400	Other operating expenses	26 491 701	22 156 987
1 848 000	1 813 000	Depreciation	1 848 000	1 813 000
152 568 589	**154 994 187**	**Sum operating expenses**	**143 024 454**	**145 215 860**
22 297 084	**10 883 663**	**OPERATING SURPLUS**	**22 164 212**	**10 911 879**
		FINANCIAL INCOME AND EXPENSES		
987 770	1 220 888	Financial income	970 716	1 191 546
707 215	695 831	Financial expenses	542 025	675 532
280 555	**525 057**	**Net financial items**	**428 691**	**516 014**
22 577 639	**11 408 720**	**Net profit for the year**	**22 592 903**	**11 427 894**
		Information about appropriations to:		
		Transferred from/to other equity	22 592 903	11 427 894
		Sum transfers	**22 592 903**	**11 427 894**

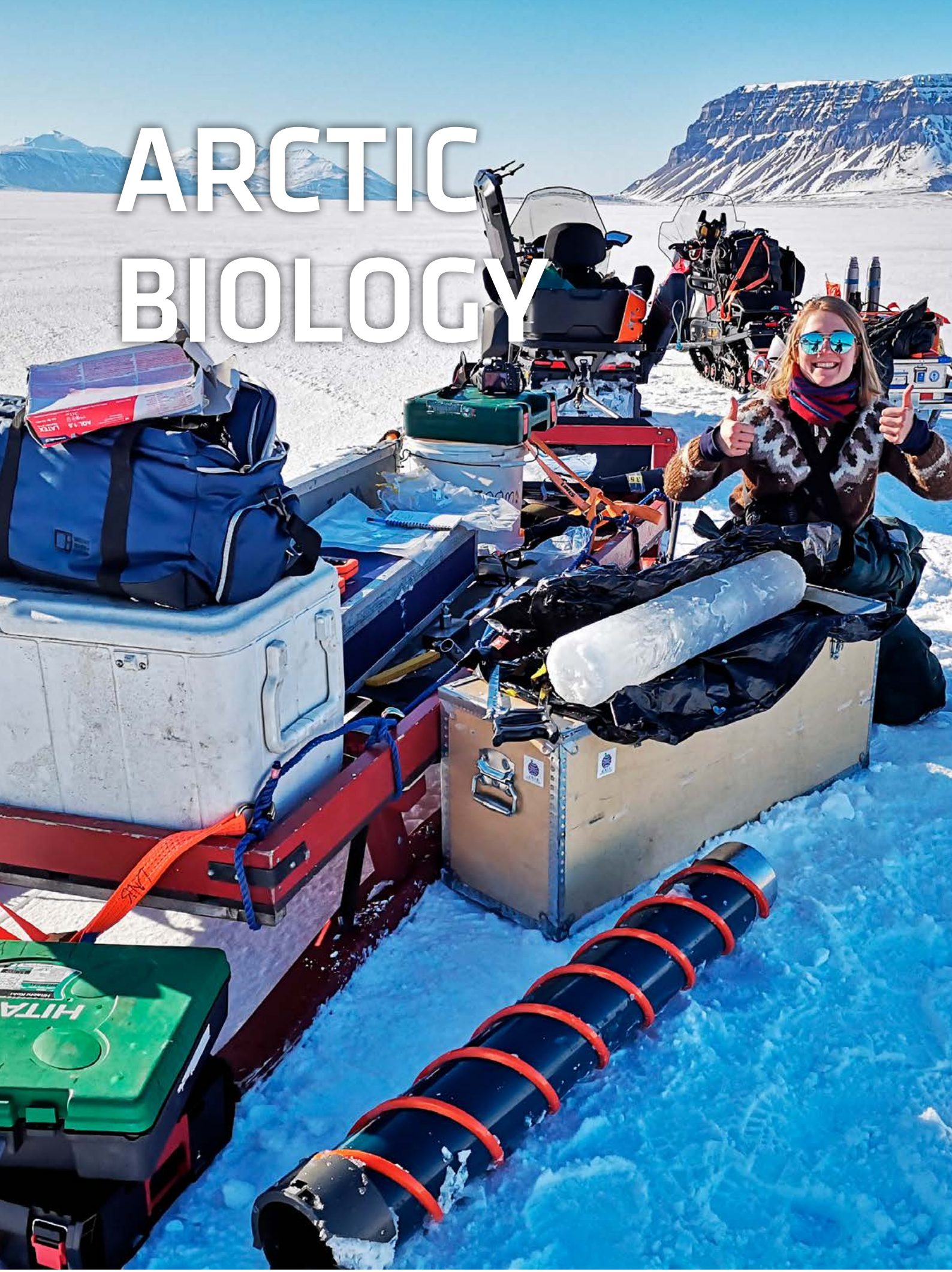
* The UNIS group consists of the University Centre in Svalbard AS and the subsidiary companies UNIS CO_2 lab and Svalbard Integrated Arctic Earth Observing System (SIOS).

BALANCE SHEET 31.12.2020

GROUP*			University Centre in Svalbard AS	
2020	2019		2020	2019
NOK	**NOK**	**FIXED ASSETS**	**NOK**	**NOK**
		Fixed assets (tangible)		
27 405 208	29 253 208	Buildings	27 405 208	29 253 208
15 921 799	0	Scientific equipment and infrastructure	15 921 799	0
43 327 007	**29 253 208**	**Sum tangible fixed assets**	**43 327 007**	**29 253 208**
		Fixed assets (financial)		
0	0	Investments in subsidiary company	175 000	175 000
0	0	Sum financial fixed assets	175 000	175 000
43 327 007	**29 253 208**	**Sum fixed assets**	**43 502 007**	**29 428 208**
		CURRENT ASSETS		
15 414 716	41 949 796	Accounts receivable	4 822 723	4 887 551
12 362 790	12 383 138	Other short-term receivables	11 436 282	12 919 856
78 520 012	44 428 647	Cash and bank deposits	68 354 526	43 418 608
106 297 518	**98 761 581**	**Sum current assets**	**84 613 531**	**61 226 015**
149 624 526	**128 014 790**	**SUM ASSETS**	**128 115 538**	**90 654 223**
		EQUITY		
		Accumulated equity		
100 000	100 000	Share capital	100 000	100 000
1 954 025	1 954 025	Other accumulated equity	1 954 025	1 954 025
2 054 025	**2 054 025**	**Sum accumulated equity**	**2 054 025**	**2 054 025**
		Retained equity		
51 001 014	25 023 374	Other equity	51 140 742	25 147 838
51 001 014	**25 023 374**	**Sum retained equity**	**51 140 742**	**25 147 838**
53 055 039	**27 077 399**	**Sum equity**	**53 194 767**	**27 201 863**
		LIABILITIES		
		Allowances for liabilities		
0	3 400 000	Provisions for liabilities	0	3 400 000
0	**3 400 000**	**Sum allowances for liabilities**	**0**	**3 400 000**
		Other long-term liabilities		
10 809 796	12 693 277	Housing loan	10 809 796	12 693 277
10 809 796	**12 693 277**	**Sum other long-term liabilities**	**10 809 796**	**12 693 277**
		Short-term liabilities		
27 643 679	42 137 581	Accounts payable	18 031 642	15 995 926
2 945 701	2 894 525	Public fees and duties	2 834 543	2 788 749
55 170 311	39 812 008	Other short-term liabilities	43 244 791	28 574 409
85 759 691	**84 844 114**	**Sum short-term liabilities**	**64 110 976**	**47 359 084**
96 569 487	**100 937 391**	**Sum liabilities**	**74 920 772**	**63 452 361**
149 624 526	**128 014 790**	**SUM EQUITY AND LIABILITIES**	**128 115 538**	**90 654 223**

* The UNIS group consists of the University Centre in Svalbard AS and the subsidiary companies UNIS CO_2 lab and Svalbard Integrated Arctic Earth Observing System (SIOS).

ARCTIC BIOLOGY



April 2020: Marine biologists took regular ice core samples throughout the winter. Here is a very happy research assistant Vanessa Pitusi with an ice core sample in Tempelfjorden. Photo: Janne E. Søreide/UNIS.

BY STEVE COULSON, HEAD OF DEPARTMENT

Arctic Biology (AB) provides a full one-year curriculum of undergraduate studies, as well as a range of master- and PhD level courses in biology. The department conducts research within biological climate effects, seasonality, and dynamics of species and ecosystems in space and time. Our strategy will strengthen our local, national, and international scientific role, founded upon curiosity driven, high scientific competence and year-round presence in Svalbard.

At the end of 2020, the AB department consisted of three professors, three associate professors, five PhD students, two postdocs, two staff engineers and eight adjunct professors. Two new PhDs and one post doc were hired during 2020.

EDUCATION

The course portfolio during 2020 was severely restricted due to Covid-19 and the cancellation of the autumn semester and many of the masters and PhD courses. Nonetheless, AB-202 and AB-203 were successfully completed although with adjustments for digital teaching and examinations.

Our aim is to be the primary study site for learning high Arctic biology through authentic experiences. Education at AB is research-based both in knowledge content and how we teach. Knowledge and skills are best mediated through student centred active learning and authentic research settings, and active involvement creates more motivated students and aid deeper learning. Based on this background AB has developed both a bachelor research project course (AB-207) and a bachelor internship course (AB-208). The courses give insight into research at AB and activities at external institutions that provide job opportunities after the students finish their education. This provides the students with more practical experience and generic skills that might improve learning outcomes in other courses and prepare them for later careers. The educational development in the AB department is to a large extent linked to the project *bioCEED*, the Centre for Excellence in Education (see separate chapter).

Our focus on educational development has also led to more research on education within the department. The goal of the inter-departmental project *FieldPass*, is to develop and research alternative forms of assessment suitable for field-related learning. FieldPass employed

June 2020: Purple Mountain Saxifrage *(Saxifraga oppositiofolia)*. Photo: Sil Schuuring/UNIS.

one postdoc and one technician in early 2020 but the first year of fieldwork was delayed due to the Covid-19 restrictions.

RESEARCH

The overall aim of the AB department is to remain a leading institution in high Arctic biological research with cutting edge methodology and infrastructure. Our goals embrace advancing fundamental knowledge on the ecology and evolution of Arctic species, formed by seasonal as well as long-term interactions with the biotic and abiotic components characteristic of the Arctic environment, including human impact. Our research covers three over-arching interlinked themes: *Climate change biology, Seasonal ecology* and *Spatio-temporal dynamics of species and systems.*

The department is partner in numerous projects, including largescale projects that embrace several research aspects and many faculty staff. On the marine side the Nansen Legacy project was one of the departments' major activities in 2020. The project has already led to several new external positions at AB.

The large EU project *FACE-IT: The future of Arctic coastal ecosystems - Identifying transitions in fjord systems and adjacent coastal areas*, started in November 2020. The four-year Horizon 2020-project, led by University of Bremen, includes 11 European partners in addition to partners in the U.S., Canada, and China. The total research budget is approximately 90-100 mill. NOK, and the project will focus on the effects of climate changes in polar fjord systems, including the consequences for marine biodiversity and the social challenges and benefits; for example, food provision and nature-based tourism. The research from the AB team will include Isfjorden and Storfjorden and will be compared with similar studies in Greenland and North America.

The departmental initiative *BIG – Bjørndalen Integrated Gradients,* expanded in 2020, including the purchase of a dedicated meteorological station with real time data delivery. BIG is an ecosystem concept that includes all faculty staff and all habitats along an axis from the terrestrial site in Bjørndalen outside Longyearbyen, to the nearby shore areas and the IsA (Isfjorden-Adventfjorden) marine time series station. Both BIG and the Nansen Legacy projects are attempts at increasing cross-disciplinary collaboration within and outside the department. In addition, BIG includes both educational and research approaches, including research on didactic topics such as field education.

Examples of ongoing BIG activities include collection of invertebrates at weekly basis and automated monitoring of plant phenology and plant-pollinator interactions with time-lapse cameras. This data collection is part of a larger circumpolar network aiming at using state-of-the-art machine learning and computer vision methods to study the role of climate in plant-pollinator interaction. Also, initiated through FACE-IT, the monitoring of arrival and breeding phenology of Common Eider *(Somateria mollissima)* have been added to the BIG monitoring program. The monitoring of eiders was started in 2015 and is now in its sixth year. Interestingly, the arrival of eiders in Adventfjorden apparently is influenced by

February 2020: Svalbard reindeer on the tundra. Photo: Sil Schuuring/UNIS.

the large-scale climate system, the Arctic Oscillation. In contrast, breeding initiating are determined by local snow conditions.

Polyploidy is an important driver for evolution and speciation, particularly in the Arctic. Using *Saxifraga oppositifolia* (Purple Mountain Saxifrage) as model species, the aim is to understand the evolutionary consequences of autopolyploidy by combining ecological-, physiological and genomic data. One PhD and two master's students are currently working on aspects of this system.

Permafrost in Arctic regions is under severe threat as a consequence of climate change. Vegetation, and especially mosses, which play an important role in insulating soils, is expected to significantly change with climate warming from moss types to vascular plant-dominated vegetation forms. Measurements of the active layer depth and accompanying abiotic parameters at the long-term monitoring sites in BIG and in Adventdalen were continued. New sites were established ranging from moss-and *Dryas octopetala*-dominated tundra to polygons in Adventdalen. Moreover, spatial grids with contrasting vegetation composition were investigated as part of an PhD study investigating vegetation, its corresponding trait composition, and their links to active layer depth. Frost tubes were installed to measure active layer depth, linking to the GLOBE program by NASA (https://www.nasa.gov/solve/feature/globe), a worldwide outreach program including scientists, students and citizens and promoting science.

The FRAM centre funded the project *Development of methods for monitoring effect of vegetation on active layer depth* which concentrates on investigating the effect of a reduced moss layer under a warming climate using open top chambers and artificially reducing moss cover.

In 2019, AB initiated a seasonal reindeer project in Bjørndalen as part of BIG. We know very little of how the Svalbard reindeer seasonally use the landscape. The reindeer in Bjørndalen are counted on foot every week as well as being recorded by an automated network of time-lapse cameras. The time-lapse cameras also record snowmelt and reappearance of the vegetation. In 2020, the Bjørndalen population increased from 21 animals in March to 101 in July. The spatial use of reindeer in Bjørndalen is initially determined through snow by avoiding areas with deep snow and ice layers. As spring and summer comes, emergent new high-quality forage influences the reindeer's habitat choice in Bjørndalen. Surprisingly, the analyses of time-lapse photos suggested that the number and spatial distribution of geese may be indexed from these photos.

The IsA (Isfjorden-Adventfjorden) high-resolution marine time series station is the marine endpoint of the BIG gradient. The station was established in 2011 and aims to determine temporal drivers of microbial and zooplankton communities and to monitor and predict climate induced ecosystem changes. Time-series stations, such as IsA, are essential to untangle natural year to year variation and long-term climate related alterations. Data on hydrography as well as diversity and community composition of microbial eukaryotes and larger plankton

July 2020: Field assistant Rebekka Ween hunts pollinating insects with a sweep net in Bjørndalen. Photo: Simen Hjelle.

September 2020: The UNIS marine biology team on sampling in Inglefieldbukta in Storfjorden. From left: PhD candidate Sil Schuuring, research assistant Vanessa Pitusi, PhD candidate Cheshtaa Chitkara, master student Daniela Walch and associate professor Janne E. Søreide. Photo: Helge Bjørnholm/The Norwegian Coast Guard.

is collected monthly. Analyses of biological data from multiple years show both recurring seasonal patterns of biodiversity and species composition, as well as large interannual variation linked to inflow of "warm" Atlantic water. In 2020, the IsA time series was expanded to also include marine bacterial communities, and the seasonal differences in the gene activities of microbial eukaryotes were investigated using metatranscriptomics. Cross-disciplinary collaboration at the IsA time series station also contributed to an extensive review of the Isfjorden hydrography, and the UNIS hydrographic database (UNIS HD). In 2020, an online "weather station in sea" was placed outside Bjørndalen by the department of Arctic Geophysics and AB took the opportunity to also place some biological (fluorescence) sensors in addition to the physical measurements (salinity, temperature, wave and tidal height and currents)

As part of FACE-IT, monthly time-series sampling was also commenced in Billefjorden (station BAB). While IsA is very much influenced by influx of warm Atlantic water, and thus can be regarded as a model system for a future "Atlantified" Arctic, Billefjorden has a sill limiting inflow and is normally ice-covered during winter and spring. AB will exploit this natural gradient to investigate possible differences in biodiversity and seasonal development between two contrasting Arctic "sea climate" scenarios. The Isfjorden Marine Svalbard Observatory (IMOS), comprising of hydrography and plankton data from three stations spread along Isfjorden was continued in 2020, as part of the Økokyst-Svalbard project, led by Akvaplan-niva and funded by the Norwegian Environment Agency. Økokyst-Svalbard, is a three-year project (2018-2020) where the applicability of the Water Management Regulations, which incorporate the EU Water Framework Directive into Norwegian law, is tested for Svalbard coastal waters.

Arctic coastal ecosystems are changing as climate changes and human activities increase. Thus, government managers, industries, conservation organizations and communities need timely biodiversity and ecosystem status data and, if possible, plausible projections of status of biodiversity and ecosystem services over the next decades. The AB focus on coastal ecosystems has led to several new projects which UNIS leads or is a major partner in.

Riverine impacts on coastal waters were also studied in 2020, despite of a delayed start due to travel bans. From June to September, monthly high spatial resolution sampling of hydrography, turbidity, and algae biomass was conducted in Adventfjorden as part of the ACCES project (see below) and the project *Freshfate: Freshwater inputs to Svalbard's coastal waters: Fluxes, fate, and implications for coastal ecosystems*. This study was further strengthened by SIOS and their ACCESS-call funding which supported flight hours to provide

hyperspectral images from Adventfjorden which equals Sentinel 2 satellite products. Adventfjorden has become a calibration/validation site for satellite imagery and the goal is to improve ocean colour algorithms to also be applicable for the highly dynamic coastal waters.

The multi-international project *ACCES - De-icing of Arctic Coasts: Critical or new opportunities for marine biodiversity and ecosystem services* (Biodiversa and Belmont forum), led by UNIS, had a busy year despite the Covid-19 pandemic. In February the annual project meeting was held in Longyearbyen in conjunction with a larger international workshop on "Sustainable Svalbard Coasts". This workshop resulted in a publication on the environmental status of Svalbard coastal waters. It also resulted in a large coastal observatory component in the large national infrastructure proposal submitted by SIOS in November. Field surveys were very restricted in 2020, but we managed within the project to do some nice sea ice biology studies in April. This was in conjunction with the Fram Centre funded project *FADE: Ice-Free Arctic Ocean: Dead end or new opportunities for biodiversity and habitat expansion*, also led by AB. In September, UNIS was granted a seven days cruise with the coast guard ship "Barentshav" where a coastal survey in the Storfjorden area was repeated after 30 years in addition to a cal/val satellite survey in Agardh-Inglefieldbukta with the Dornier flying over taking hyperspectral images. In September, AB also joined the physical oceanographers on a three week-long Nansen Legacy cruise to the Barents Sea mainly for zooplankton sampling. The other two Nansen Legacy biology cruises planned in 2020 were postponed to 2021.

GRADUATES 2020

PHD DEGREES:

MATTEO PETIT BON
Short-term tundra plant-community nutrient responses to herbivory and warming: New insights from Near infrared-reflectance spectroscopy methodology. *(UNIS and UiT - The Arctic University of Norway).*

MAGDALENA WUTKOWSKA
Microbial eukaryotes and their functional importance in the Arctic. A Svalbardian perspective. *(UNIS and UiT - The Arctic University of Norway).*

MASTER DEGREE:

TRINE CÆCILIE BRÆSTRUP ANDERSEN
Living with a Paradox: Negotiating Relations to the Environment, Sustainability and Mass Tourism amongst Guides on Svalbard. *(University of Copenhagen and UNIS)*.

LUCIE HELENE MARIE GORAGUER
Sympagic-pelagic coupling and vertical export in two seasonally ice-covered fjords. *(UiT - The Arctic University of Norway and UNIS).*

JØRGEN HAUGVALDSTAD
Perspectives on intended learning outcomes in the field course and their assessment. *(University of Bergen and UNIS).*

KJERSTIN BAKKEN HILMARSEN
Body mass growth in nestlings of Svalbard snow buntings *(Plectrophenax nivalis)* in response to seasonal variation in arthropod biomass. *(NTNU and UNIS)*.

ASTRID POLESZYNSKI HOEL
A year in the Arctic; Seasonal Dynamic of the Marine Prokaryote Community in Isfjorden, Svalbard. *(NTNU and UNIS).*

FRIGG SPEELMAN
Nest defence behaviour in breeding pairs is highly similar but only male behaviour determines nest survival. *(University of Groningen and UNIS).*

EMILIE HERNES VEREIDE
Seasonal zooplankton community patterns along a gradient from land to sea in Isfjorden, Svalbard. *(University of Oslo and UNIS)*.

ROBIN B. ZWEIGEL
A physically based approach to simulate sub-grid snow depth and ground surface temperature distribution. *(University of Oslo and UNIS)*.

bioCEED

BY TINA DAHL, BIOCEED ADVISER

bioCEED has continued to develop biology education to fill future needs in science and society, and to facilitate SoTL across higher education in Norway and beyond. Our activities are guided by our four focus areas: Learning culture, innovative teaching, practical training, and outreach.

The years of developing a learning culture, along with numerous digital tools, better positioned us to survive —and in many cases, thrive—when the pandemic hit, and education went largely digital from March 2020 onwards. Among our major accomplishments we note the following:

We published nine papers in peer-reviewed, international journals; we were involved in course and program redesign that will impact students across biology programs; we assessed and improved several digital tools and developed usage of these tools to support courses; we supported novel educational initiatives; sponsored seminar series; and communicated our work to relevant stakeholders.

Enhanced collaboration with iEarth, our new SFU at UNIS where we have coordinated activities and cooperate when possible (e.g. seminars/courses, student activities and projects like FieldPass).

BioCEED was bolstered by new initiatives. For example, a teaching assistant (TA) course was developed within bioCEED and iEarth to support PhD students, postdocs and master students across departments that teach in courses. Also, an academic writing workshop for PhD students was offered in 2020 to provide scientific training for PhD students when travelling to the mainland and attending workshops/courses were no longer feasible. At UNIS one postdoc and one technician have been hired withing the FieldPass project.

Due to Covid-19, different collegial meeting places for teachers were established to support teachers with their digital teaching through a dedicated MS Team channel as well as through online meetings. A UNIS web resource page on digital educational resources was developed to help teachers to set up a functional, temporary online learning environment for their courses.

"unisBREAKFAST" (former "bioBREAKFAST") is a student-led initiative, facilitating the exchange of knowledge and experience among students across all departments at UNIS. Challenged by the restrictions following the outbreak of the Covid-19 pandemic, the student representatives worked closely with bioCEED staff and the health advisor at UNIS to develop a safe alternative to the former format. Three meetings have been arranged with 25-30 participants in each meeting and have been an important contributor to students networking opportunities during pandemic times with few possibilities for student-student interactions.

March 2020: Hiking up Lindholmhøgda. Photo: Stina Skånhoff.

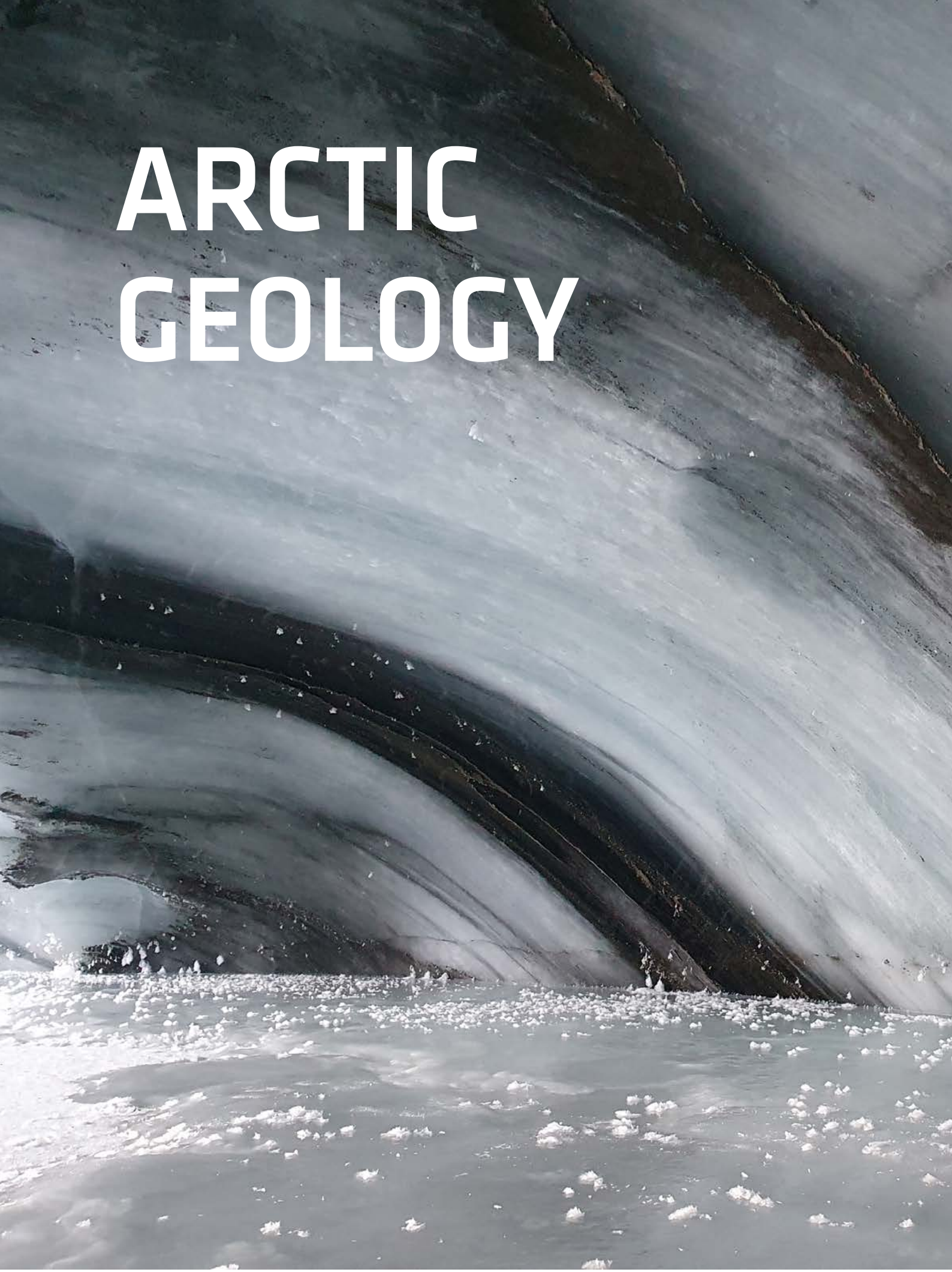
The 15 ECTS bachelor course AB-208 "Internship in Arctic Biology" at UNIS is now a well-established course, and five new students were doing internships at different workplaces in Longyearbyen during spring semester 2020. In monthly seminars, the students met and shared experiences and discussed what they had learned. Seminars were also used to train work-related skills, like applying for jobs and doing job-interviews through e.g. role plays. Students shared their experiences to the public through videoblogs or written blogs. AB-208 is usually combined with a 15 ECTS course focused on research practice (AB-207 "Research Project in Arctic Biology"), so students have the possibility to have a full-time practical semester.

ABOUT BIOCEED

bioCEED is a Centre for Excellence in Biology Education, led by the University of Bergen in collaboration with UNIS, the Institute of Marine Research and other partners.

More on https://bioceed.w.uib.no/

ARCTIC GEOLOGY



February 2020: The students in AG-325/825 on excursion to Drønbreen. Photo: Andy Hodson/UNIS.

BY HANNE H. CHRISTIANSEN, HEAD OF DEPARTMENT

The Arctic Geology (AG) department's research and education is focused on the geological evolution of Svalbard as recorded in spectacular geological sequences spanning from the Precambrian to the Cenozoic and overlain by Quaternary glacial and interglacial deposits. Easily accessible outcrops make it possible to do research in the interplay of continental drift with tectonic, glacial, periglacial, coastal, fluvial and marine sedimentary processes.

The close proximity of present-day geological, glacial, periglacial, marine, and terrestrial processes provides an exciting field laboratory as the basis for our research and education within three main areas: Arctic Basins, Marine and Quaternary geology, and the Cryosphere.

During 2020 the department had nine full time faculty positions, which were filled by four professors, four associate professors and one vacant position. One new PhD student and three new postdocs joined the AG in the beginning of the year. The end of 2020 also marked the end of an era as long-term Arctic Basins member Snorre Olaussen retired and left the island. Thankfully, he continues actively as ever as UNIS' first Professor Emeritus!

EDUCATION

Due to Covid-19 only four courses were taught in our department in spring 2020, due to the cancellation of all courses from April to December. From March onwards, the majority of the Arctic Basins team ensured that the courses running at the time of the lockdown were completed through means of digital teaching. It was not easy but through a real team effort it was possible. The use of digital outcrops, openly shared through the Svalbox portal developed at UNIS, contributed greatly.

The AG department was responsible for 28 % of all student production at UNIS in 2020, despite that we only were able to actually produce around 30 % of the course student production.

A record number of guest students in 2020 was on account of scholarships offered by UNIS. We successfully increased the total number of bachelor-, master and PhD thesis research-based projects by these guest students.

The DIKU funded project *A Digital Learning Environment for field-based geoscience teaching* led by Maria Jensen

June 2020: The pingo in Moskuslaguna across the fjord from Longyearbyen. Photo: Eleanor Jones/UNIS.

is exploring the use of digital platforms in geology education and focus on integrating classroom and field teaching in a seamless way using Ipads and an in-classroom Smartboard. As physical teaching was cancelled for most of 2020, this project got a one-year extension to allow for working with the digital tools in practice through spring 2021.

In June 2020 the *Centre for Integrated Earth System education* (iEarth) was started. This is a centre of excellence in education, with the UNIS AG and AGF departments as one of four national partners in the 5-year project.

We are involved in the DIKU funded multi-departmental project *FieldPass* led by the AB department, to further develop the field education at UNIS. The project was put on hold in 2020 due to Covid-19.

RESEARCH

The department has three specialised research groups, presented below with their different main activities. We also collaborate with other UNIS departments and partners nationally and internationally.

Arctic Basins

The Arctic Basins group had – as virtually everyone else in the world – many of its field campaigns and courses disrupted by Covid-19. The year 2020 started positively – with Aleksandra Smyrak-Sikora's PhD defense on extensional growth basins in late February.

Two new members joined the group before the pandemic hit – Gareth Lord started as a postdoc in the *Research Centre for Arctic Petroleum Exploration* (ARCEx) project on shallow reservoirs, while Anders Dahlin started as a PhD candidate in the Suprabasins project. In addition, Aleksandra continued at UNIS as an ARCEx funded postdoc, contributing to the synthesis efforts of the centre, in particular with respect to Carboniferous basin development on the Barents Shelf.

Peter Betlem and Kim Senger continue to build up the Svalbox database, an online portal integrating existing geoscientific material with new virtual outcrop models collected by UNIS. A new UArctic-funded project (Svalbox2020) was awarded in September 2020 – the project will run until August 2022 and constitute a major upgrade to the Svalbox portal allowing additional data sets and storylines. You can already check-out 360-degree imagery and virtual field trips at www.svalbox.no.

The summer field campaign – using a local sailboat as a base – exceeded all expectations. Covid-19 adaptions apart, PhD students and postdocs alike managed to acquire critical data in the field, from Hornsund in the south to the Billefjorden Trough in the north. We also focussed on acquiring more digital models for Svalbox and marketed this portal to both industry and partner universities. The highlight of the Svalbox-data acquisition was the digitization of the renowned Festningen profile in September – we can now access 300 million years of Svalbard's geological evolution digitally – anytime, anywhere. This was done as an iEarth-funded internal project.

Maria Jensen was on sabbatical during 2020 and spent time developing international collaboration to develop methods to retrieve high-resolution palaeoclimate proxies from coal seams on Svalbard. Covid-19 also put constraints on this work as planned laboratory visits, talks and a visit to the US were cancelled, but contacts were developed with partners in Denmark, Canada, and the US.

Malte Jochmann was working on his PhD project compiling data from large number of coal exploration boreholes and outcrop fieldwork in the Firkanten formation at the base of the Central Tertiary Basin. This work is providing a new high-resolution 3D understanding of the basin development.

The *DynaCoast* project, coordinated by Maria Jensen, was completed and for the first time a detailed morphological map of the coastal zone in Isfjorden is presented. Data are made available through the *Svalcoast Science HUB* platform (https://svalcoast.com/). The platform will serve as a gateway to data from the *MovingCoast* project, where we work on establishing methods for InSAR analysis of coastal movements in the Svalbard area on a centimetre scale. Fieldwork for the MovingCoast project was carried out in the Isfjorden area, although collaborators from University of Caen, France were not able to travel to Svalbard due to the travel restrictions.

Marine and Quaternary geology

Riko Noormets' research focussed on the geological evolution and processes of the eastern and northern Svalbard margins. New results were published on the role of oceanographic processes during the deglaciation of the Barents Sea, in collaboration with international partners. Research on glacial and climate history in previously unmapped fjords continued in the western as well as eastern Svalbard. A grant from the ASIAQ project enabled development of a prototype Multi-purpose Autonomous Surface Platform for polar marine research (MASP) that uses machine learning algorithms for acoustic seafloor mapping in collaboration with colleagues from the KTH Royal Institute of Technology and Stockholm University. Trials are planned in Svalbard for the first time in 2021.

During 2020, Mark Furze's research focused on the geomorphic and geochronological signal of regional deglaciation and sea-level changes in western Svalbard. This included leading a successful internationally collaborative field campaign on the Erdmannflya peninsula constraining rates of Holocene coastline emergence and imaging raised beaches using terrestrial laser scanning and UAV photogrammetry with colleagues from the Geological Survey of Norway and Bangor University (UK).

May 2020: Hyperittfossen in De Geerdalen.
Photo: Peter Betlem/Svalbox.no.

Adjunct professor Martin Jakobsson led the work on release of a new bathymetric compilation of the Arctic Ocean (International Bathymetric Chart of the Arctic Ocean), IBCAO v4. This is an important milestone in achieving the ambitious goals of SEABED 2030 (www.seabed2030.org) of fully mapping the ocean floor globally by 2030.

During the year, several external PhD and MSc students started or continued their thesis work at UNIS on various aspects of Arctic marine, glacial, climate and environmental evolution and processes. All these students are supervised by AG staff.

The cryosphere

Members of the Cryosphere research group were involved in two new projects funded by the RCN and led by Andy Hodson: *Blue Ice Oases of Microbial Life on the Antarctic Ice Sheet* (BIOICE) and *Climatic forcing of terrestrial methane gas escape through permafrost in Svalbard* (CLIMAGAS). In the BIOICE project, the year began with the 260 km transport of six short ice cores, water samples and snow from the Norwegian Troll Station in Antarctica, across numerous crevasses to the margins of the Fimbul Ice Shelf, before shipment to the UK. These samples, collected

September 2020: Kapp Schoultz, Tempelfjorden. Photo: Svalbox.no.

by Aga Nowak and Andy Hodson, only just made it to the laboratories before they were closed for the rest of the year by the Covid-19 pandemic. Back in Svalbard, the CLIMAGAS team were mapping and sampling all perennial groundwater springs in Nordenskiöld Land, finding more than 100 sites where gas-rich water discharges even during the winter. The CLIMAGAS team later published two companion papers in The Cryosphere describing the hydrogeological and geochemical processes that make pingos in Adventdalen particularly important sites for methane emission.

The cryosphere group is also active in the *Svalbard Integrated Arctic Earth Observing System* (SIOS) - Infrastructure development of the Norwegian node, InfraNOR, funded by the RCN and led by Hanne H. Christiansen. This project had all its 2020 field activities put on hold due to Covid-19.

UNIS led the project *Permafrost core data with ground ice information and overview of drilling equipment in Svalbard* (PermaSval), funded by SIOS, updating the regional analyses of the permafrost ECV (essential climate variables) observations, and adding information about ground ice content and available permafrost drilling equipment in Svalbard into the third SESS report contribution. Hanne H. Christiansen coordinated this work with Italian, Russian, Polish, German and Norwegian partners.

Another project funded by SIOS and led by UNIS is the *SvalHydro* project, which compiled 50 years of long-term hydrological and hydrometeorological data from Svalbard, presenting for the first-time climate change effects upon freshwater discharge from across the island. It was discovered that catchments with rapidly receding glaciers have been producing decreasing amounts of freshwater for over a decade, while deglaciated catchments and those with large polythermal glaciers show the opposite behaviour. Aga Nowak coordinated this work with Norwegian, Polish, Russian, UK and Czech partners.

The first UNIS Strategic Pilot Project *Developing a permafrost and meteorological climate change response system to build resilience in Arctic communities* (PermaMeteoCommunity) was funded in December. It is coordinated by Hanne H. Christiansen, and with participation from Aleksey Shestov (AT), Marius Jonassen (AGF) and adjunct Graham Gilbert (AG) in addition to Longyearbyen Community Council, Telenor Svalbard, and the Norwegian Water Resources and Energy Directorate among the partners.

PhD student Sarah Strand worked on collecting permafrost ground thermal data and active layer observations from the UNIS monitoring infrastructure. PhD student Holt Hancock worked on research to characterize the broad-scale atmospheric circulation patterns leading to regional avalanche cycles in Nordenskiöld Land.

The department also worked on the DRIVA snow sensor project in collaboration with the Arctic Safety Centre and Telenor Svalbard to integrate data from the low-cost snow depth sensors developed in this project into

avalanche forecasting and risk management efforts both in Longyearbyen and on the Norwegian mainland.

The Cryosphere staff also supervised several external PhD students and guest master students on a range of topics including erosion studies, the Foxfonna ice cap, thermal changes in winter snow accumulation, and geochemistry of winter glacier drainage, to name a few topics. The accomplishments of these visiting students were outstanding, given the logistical constraints imposed by the pandemic.

RESEARCH ADMINISTRATION

UNIS has had the presidency (Hanne H. Christensen) and secretariat (Sarah Strand) of the International Permafrost Association (IPA) over several years, but on 1 July 2020 this function was formally handed over to Canada. Due to Covid-19 the International Conference on Permafrost, to be held in China in June, was postponed to 2022.

Kim Senger is leading the University of Arctic (uArctic) Thematic Network on Arctic Geology, a platform for circum-Arctic collaboration on outreach, education, and research efforts.

Maria Jensen participates in the Kongsfjorden flagship group under the Ny-Ålesund Science Managers Committee (NySMAC), and is involved in collaboration between terrestrial and marine biologists, geophysicists and onshore geoscientists studying land-sea transects in Kongsfjorden and the influence of long- and short-term sediment dynamics on ecosystems.

GRADUATES 2020

PHD DEGREES:

ALEKSANDRA SMYRAK-SIKORA
Development of extensional growth basins: A field-based study, Svalbard, Norway. *(UNIS and the University of Bergen).*

MASTER DEGREE:

ARMIN DACHAUER
Aerodynamic Roughness Length of Crevassed Tidewater Glaciers from UAV Mapping. *(Swiss Federal Institute of Technology Zurich and UNIS).*

JODIE ALICE SCRUPPS GELDARD
The production of a Quaternary Geological map of Endalen, Svalbard, and assessment of Holocene geomorphic processes. *(University of Sheffield and UNIS).*

ERIK SCHYTT HOLMLUND
Rapid temperature rise may have triggered glacier surges all over Svalbard. *(UiT – The Arctic University of Norway and UNIS).*

JULIAN JANOCHA
Structural and depositional evolution of the Fortet karst collapse outcrop in inner Billefjorden, Central Spitsbergen, Svalbard. *(University of Potsdam and UNIS).*

JACOB BERG LOFTHUS
Snow avalanches on Svalbard - Investigating changes in despositional patterns and their palaeocliamtic significance. (NTNU and UNIS).

KAROLINE HELEN LØVLIE
Structural deformation and mineralogy of the Agardhfjellet and Rurikfjellet formations in central Spitsbergen, Svalbard. *(University of Oslo and UNIS).*

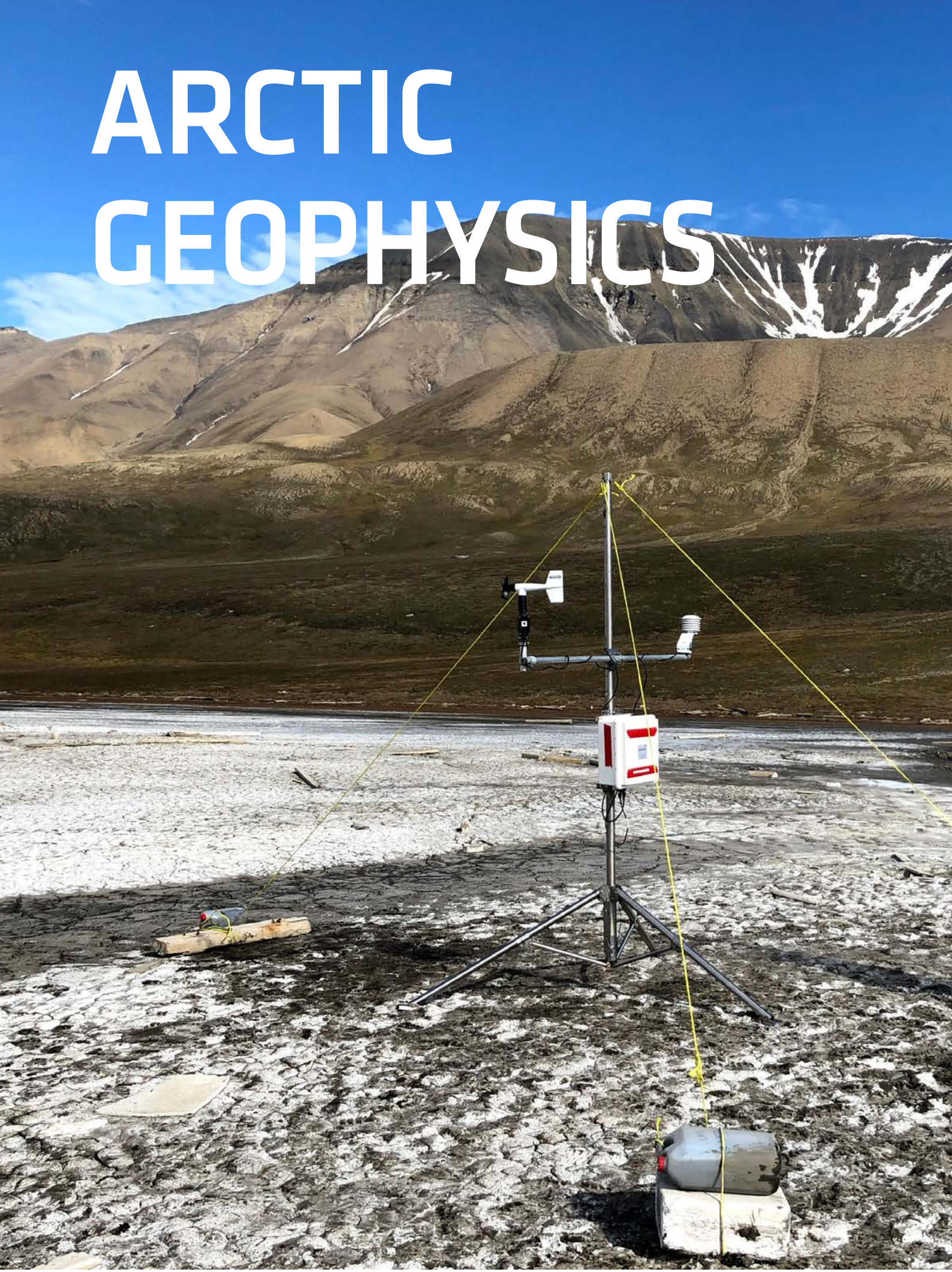
JASPER LEONARD MAGERL
Evidence of methane release into Arctic fjords through subglacial discharge and pockmark seepage. *(University of Oxford and UNIS).*

LISE NAKKEN
Structural evolution of the lower Agardhfjellet Formation, in Central Spitsbergen: Implications for caprock integrity. *(University of Oslo and UNIS).*

CHRISTIAN FRIGAARD RASMUSSEN
High Resolution Holocene Climate and Paleo-environmental Reconstructions from Adventdalen, Svalbard based on OSL dating of loess. *(Aarhus University, Technical University of Denmark, and UNIS).*

INGER MARIE FAUSA AASBERG
Paleoclimatic reconstruction from laminated lake sediments, Bødalsvatnet, Nordenskiöld Land, Svalbard. *(Norwegian University of Life Sciences and UNIS).*

ARCTIC GEOPHYSICS



June 2020: Master student Lukas Frank with the weather mast in Moskuslaguna in Adventfjorden. Photo: Marius Jonassen/UNIS.

BY DAG A. LORENTZEN, HEAD OF DEPARTMENT

The Arctic Geophysics departments' two research groups conduct research and education in the column from sub-sea to near space.

The department had at the end of 2020 eight full time faculty in the fields of oceanography, meteorology, and space physics. The department also had three postdocs, 11 adjuncts and four PhD candidates. In addition, two engineers are working in the department.

EDUCATION

Courses are offered in all the research fields within the department. For the spring semester 2020, three bachelor courses were given as well as three master/PhD courses. Although the Covid-19 pandemic started in March 2020, all the spring courses were able to continue, with lecturing occurring through Zoom and Teams. Thus, despite Covid-19, the students all managed to finish their courses and degrees successfully. All summer and autumn courses at UNIS were cancelled, reducing drastically the overall ECTS production in the department. AGF has several courses running biennially, hence the comparable year to 2020 would be 2018. Thus, compared to 2018, the department saw a reduction in the ECTS production of 63% throughout 2020. On a positive note, the guest master student-year production went up compared to previous years.

RESEARCH

Space physics

The space physics group is part of the *Birkeland Centre for Space Science* – a centre of excellence in space physics which is based at the University of Bergen. The space physics group operates two large scale research facilities, the Kjell Henriksen Observatory (KHO) and the SuperDARN radar. The activity at KHO has been low after the outbreak of Covid-19. No rocket campaigns carried out and no visits from our instrumental partners. On the other hand, the situation has given us more time to focus on upgrades, instrumental work, and new camera constellations. The observatory has been fully operative since the start of the optical season in November. Plans for the rebuild of the SuperDARN radar antenna arrays continued, after it broke down due to heavy ice and wind loads in autumn 2018. All new parts except guy ropes are now in place in Svalbard, and this project is moving along as planned.

The ionosphere/magnetosphere team of the space physics group received funding for a new project from the RCN through the INTPART project. This will be a follow-up from the completed RCN PolarProg project (which was completed in 2019). The project will continue to focus on modulations in ionospheric parameters (such as temperatures, densities and auroral brightness) caused by various coupling mechanisms, such as that

June 2020: Fixing a radar antenna at the Polish Polar Station in Hornsund. Photo: Mikko Syrjäsuo/UNIS.

which occurs between the Earth's and Sun's magnetic field (the interplanetary magnetic field). Data from a variety of instruments across Svalbard (including the KHO) will be used, along with supporting satellite datasets. A short, 5 ECTS masters/PhD course will also be developed. Collaborating institutions are in Russia and France.

The PRIDE *(Polar Research Ionospheric Doppler Experiment)* was started in August 2020. A low power (20W), single frequency HF transmitter, was deployed at the Polish Polar Station in Hornsund. It will transmit a signal into the ionosphere, where it is reflected at an altitude of ~200km, before being received at KHO. The reflection altitude will change depending on various ionospheric processes and will serve as a diagnostic tool for wave processes in the atmosphere and ionosphere. The project is in collaboration with the Polish Academy of Science and is still undergoing a testing phase. The data will be freely available online.

Master student Markus Floer designed and built a new ionosonde HF system which was test deployed up on the Breinosa mountain. The instrument will provide continuous measurements of ionospheric electron density up to 300 km altitude. The instrument is expected to be deployed permanently in 2021 with the data freely available online.

A chapter in the 2020 SIOS State of Environmental Science on Svalbard report was dedicated to space physis in Svalbard (https://sios-svalbard.org/SESS_Issue3). The chapter provides an overview of Norwegian owned instruments (or instruments which Norwegian scientists have access to) in Svalbard with a focus on the Svalbard SuperDARN radar.

The middle atmosphere team of the space physics group focuses on detection and characterisation of particle precipitation, and studies of the effects of high-energy particle precipitation on the Earth's atmosphere. In 2020, the focus was on pulsating aurora, which is a type of diffuse aurora known be associated with high-energy electron precipitation. A fresh review paper on this topic was conducted as an international effort. At UNIS the first statistical electron energy spectra were constructed

and used as input in ionospheric chemistry model. The model reproduces the ionization of the atmosphere for a given input and follows its chemical consequences in the atmosphere. For energetic particle precipitation these are typically production of odd hydrogen and odd nitrogen gases, which may lead to catalytic ozone depletions in the stratosphere and mesosphere. Our results showed that the median spectrum corresponds to earlier reports on mesospheric ozone depletion during pulsating aurora, while the upper envelope spectrum related depletion is stronger, and the lower envelope spectrum causes no chemical changes. A follow-up study demonstrated that the morphology and the temporal evolution of the pulsating aurora can be used as an indicator of the chemical impact in the mesosphere. How well the new observations are described by the current climate models remains to be investigated in the future.

Air-Cryosphere-Sea Interaction (ACSI)

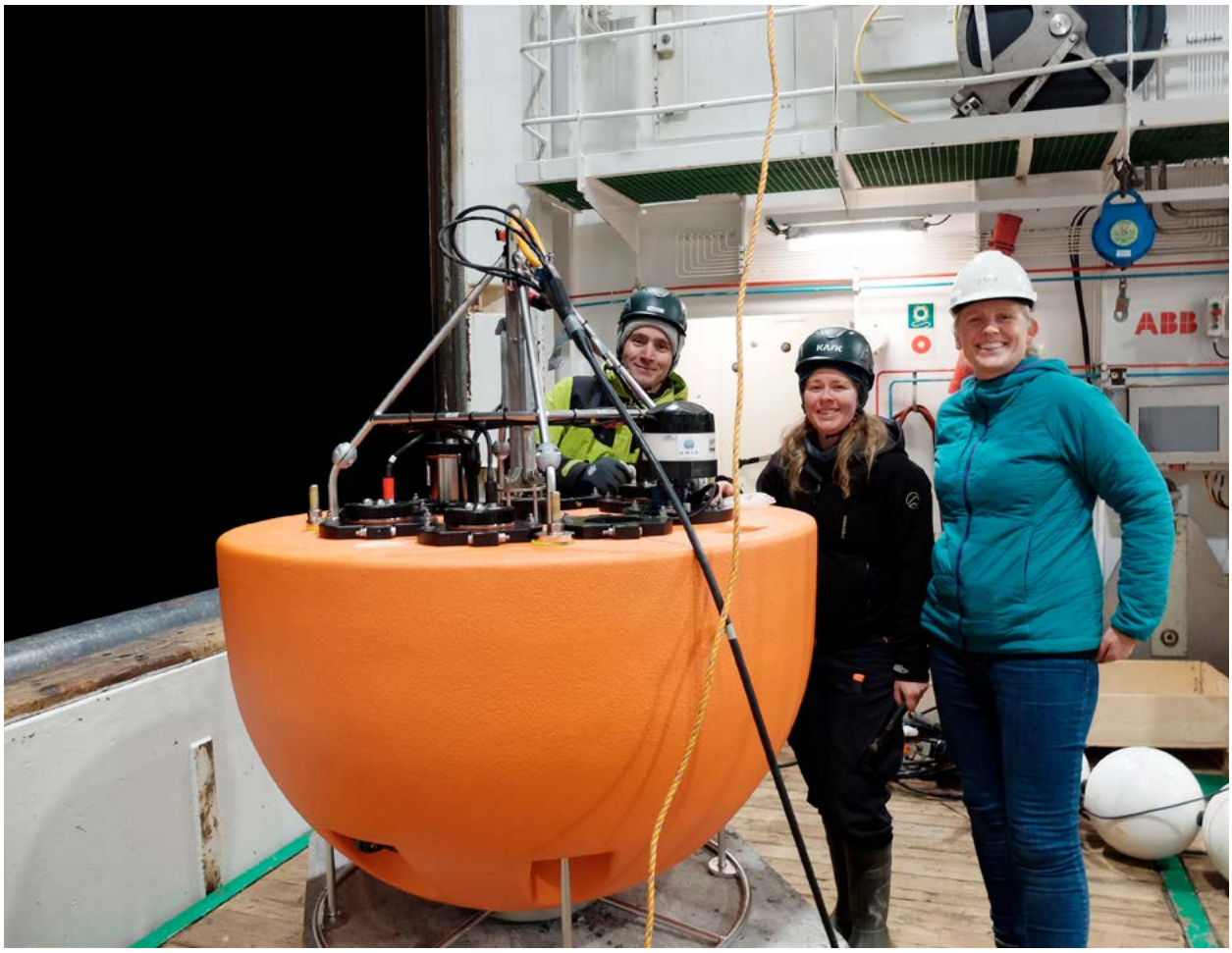
The meteorology team of the ACSI group leads a work package on the newly funded four-year RCN project *Risk governance of climate-related systemic risk in the Arctic* (ARCT-RISK). The primary objective of ARCT-RISK is to develop knowledge and tools to make sense of and deal with effects of climate change on society's ability to protect the life and health of its citizens and to maintain critical infrastructure and function. The project's starting point is the key role the Arctic plays in understanding and mitigating the challenge of climate adaptation, as the climate already is changing more rapidly in these regions than anywhere else in the world. This means that successful risk governance strategies developed in response to destabilized climate conditions in Arctic locations serve as important guidance for future climate change adaptation in mainland Norway and other relevant parts of the world. The project has funding for one PhD position, one researcher position and one postdoc position, all of which will have UNIS and the Arctic Safety Centre as their workplace.

The meteorology section also leads a work package in the newly funded UNIS strategic pilot project *Developing a permafrost and meteorological climate change response system to build resilience in Arctic communities* (PermaMeteoCommunity). The project combines permafrost research and engineering application, as well as modelling and field observations to create new knowledge and innovation. The climate response system will provide guidance for local authorities in planning and making decisions related to permafrost changes. The model will have transfer value to other Arctic settlements and can act as a standard for local and regional decision making on short and long-term scales. The project has funding for one PhD position and one technician position.

On 19 May 2020, Siiri Wickström defended her PhD thesis. This was the first defence to be held digitally at UNIS. In her thesis, Siiri studied the regional changes in the atmospheric flow pattern in the high latitude North Atlantic and their impacts locally over Svalbard. The ongoing climate change is amplified at the high latitudes and Svalbard is a hotspot of warming, especially in the winters, she concludes in her PhD thesis.

October 2020: The oceanographic mooring was deployed in Isfjorden. Photo: Algot Pettersen.

The oceanography team of the ACSI group is deeply involved in the *Nansen Legacy* project. The team's main delivery into the project is to provide data sets from year-long moored instruments and process cruises around Svalbard, and to study the processes contributing to the ocean heat input into the region north of Svalbard and the northern Barents Sea. On the first Nansen Legacy cruise after the Covid-19 lockdown and cancellations, focus was on processes that control position and variability of the polar front in the northern Barents Sea and the distribution of Arctic and Atlantic water masses. These processes are crucial for the Barents Sea and affects, among others, the sea ice conditions, the freshwater distribution, what water mass is dominant (Arctic or Atlantic), and how much nutrients are available for planktons. Most of the warm Atlantic water enters the Barents Sea from the south, flowing further north- and eastwards towards the Arctic Ocean. We define the area where the Atlantic and Arctic waters meet as the Polar Front. Advanced research platforms like ocean gliders and an Autonomous Unmanned Vehicle (AUV), armed with oceanographic instruments, were deployed to find, and measure the Polar Front. In addition to new technology, traditional instrumentation was used to measure the front, the water mass distribution and ocean



October 2020: Happy UNIS staff on the first Nansen Legacy cruise after the Covid-19 lockdown. From left: Head engineer Marcos Porcires, PhD candidate Kjersti Kalhagen and associate professor Ragnheid Skogseth. Photo: Eva Falck/UNIS.

current. Moorings were deployed in strategic positions capturing the front and inflow of warm Atlantic water, and CTD (conductivity, temperature, and depth) and current profiles were collected in repeated sections and over time at specific stations across the front and across important currents flowing in the Barents Sea.

New national marine infrastructure has been developed through the RCN funded SIOS project *Svalbard Integrated Earth Observing System – Infrastructure development of the Norwegian node* (SIOS-InfraNor). The interdisciplinary oceanographic mooring combining physics, biology, and chemistry, have been designed in collaboration with Aanderaa Data Instruments AS and was deployed in Isfjorden in October 2020. This mooring, together with a surface buoy, makes it possible to reveal some of the controlling forces and possible weather conditions for warm water intrusion into the Isfjorden system. Measurements of the water column in Isfjorden during winter and spring months are necessary to evaluate the potential danger for weak sea ice and melting sea ice due to warm water intrusion. Moreover, the interdisciplinary sensor design makes it possible to monitor e.g. the spring bloom development and possible energy extraction form surface gravity waves.

Other research activities are the long-term measurements of the exchange flow between the shelf and Isfjorden by the Isfjorden moorings, one at the mouth of Isfjorden and one further inside. These oceanographic time series are a part of the fieldwork in the bachelor course AGF-214 "Polar Ocean Climate." Due to Covid-19, the student cruise was cancelled in 2020. However, to ensure continuation of the oceanographic time series in Isfjorden and on the shelf outside, UNIS provided a three-day research cruise in September 2020 where hydrographic and current profile data were sampled along specific transects in Isfjorden and across the shelf outside. Unfortunately, the mooring at the mouth of Isfjorden, which has delivered valuable data sets of hydrography and current since 2005 (with a few missing years), was lost due to trawling activity. New oceanographic instruments for the Isfjorden mooring time series were provided during 2020 through the UNIS infrastructure roadmap 2025 and will ensure continued research activities and time series in Isfjorden.

In addition to the mooring time series, standard hydrographic sections in Isfjorden and on the shelf outside have been maintained by annual UNIS student cruises since 1995 in the autumn and since 1999 in spring during the bachelor courses AGF-214 and AGF-211 "Air-Ice Sea Interaction I", but no data were obtained by students in 2020 due to Covid-19. However, these hydrographic sections were obtained without students in June and September. The collection of hydrographic and current

data obtained by UNIS in Isfjorden are published in the UNIS hydrographic database (Skogseth et al., 2019) and as separate data files for each mooring deployment in the Norwegian Polar Institute's dataset catalogue. During the last decades, a study by Skogseth et al. (2020) using all these data sets, finds that Isfjorden has experienced a dramatic climatic change with more inflow of warmer and saltier Atlantic water higher in the water column both in winter and summer, which has reduced the sea ice cover and increased the local air temperature in winter. This "Atlantification" of the West Spitsbergen shelf and fjords are partly explained by changes in the regional atmospheric circulation with more low pressure systems entering the Fram Strait instead of the Barents Sea than in previous decades, forcing the West Spitsbergen current to follow shallower depths and bringing Atlantic water closer to the shelf and fjords. The study also shows the general and tidal circulation at the mouth of and inside Isfjorden and how the current and tides seem to contribute to exchange of water masses between the shelf and Isfjorden and between Isfjorden proper and the sill-protected side fjords. When Atlantic water penetrates Isfjorden proper at levels above the sill of the side fjords, this warm water highly influences the sea ice conditions in these fjords in winter.

GRADUATES 2020

PHD DEGREE:

ELI ANNE ERSDAL
Ocean motion in the Yermak Plateau – tidal and air-ocean interactions. *(UNIS and University of Bergen).*

SIIRI WICKSTRØM
Warmer and Wetter Winters over the high-latitude North Atlantic – an atmospheric circulation perspective. *(UNIS and University of Bergen).*

MASTER DEGREE:

MIKKEL JELLE BREEDVELD
Predicting the Auroral Oval Boundaries by Means of Polar Operational Environmental Satellite Particle Precipitation Data. *(UIT - The Arctic University of Norway and UNIS).*

MARKUS FLOER
Design and Implementation of a Software Defined Ionosonde. A contribution to the development of distributed arrays of small instruments. *(UIT - The Arctic University of Norway and UNIS).*

LUKAS FRANK
Wind and Temperature Profiles in the Arctic Boundary Layer and their Representation in the AROME-Arctic Model. *(Universität Hamburg and UNIS).*

ARTHUR GARREAU
Validation and Application of Novel Wind Estimation Methods with Quadcopter UAVs in the Arctic. *(École Nationale de la Météorologie and UNIS).*

ERLEND SALTE KALLELID
Evolution in Cosmic Noise Absorption During Periodic Events *(NTNU and UNIS – 2019).*

LIDIA LUQUE
Multi-Instrument Investigation of Spectral Width in the Polar Ionosphere. *(NTNU and UNIS).*

ADRIËNNE ESMERALDA OUDIJK
Hyperspectral Data Cube Compression Techniques and Quality Assessments. *(Eindhoven University of Technology and UNIS).*

OCTAVE TESSIOT
Influence of the atmosphere on the hydrography of an Arctic fjord (Isfjorden). *(Université Toulouse III – Paul Sabatier and UNIS).*

ARCTIC TECHNOLOGY

September 2020: Towing experiment in Tempelfjorden. Photo: Aleksey Marchenko/UNIS.

BY ARNE AALBERG, HEAD OF DEPARTMENT

The Arctic Technology (AT) department offers courses and performs research within two main fields. Arctic Engineering concentrates on engineering problems related to settlements, structures and operations in the Arctic environment, foundations and structures in the frozen ground, loads from the physical environment, like waves, ice, and snow forces, material behaviours, rock fall, landslides and avalanches, Arctic offshore oil and gas exploitation, and safety issues connected to operations and infrastructure. Arctic Environmental Technology concentrates on current and potential pollution problems, environmental impacts, and feasible remediation techniques in Arctic areas.

In 2020, the department had two professors and one associate professor, one research associate, one PhD candidate, one manager of the Arctic Safety Centre, one staff engineer, and 13 adjunct professors.

EDUCATION

Our research activities support and motivate the education in the department's courses at all levels, by generating data and measurements series on physical and mechanical properties of ice and soil, time dependencies and failure modes of such materials, as well as pollution contaminants and concentrations onshore and offshore. This gives students the opportunity to study both the theoretical and practical aspects of Arctic technology, engineering and environmental technology, and further to benchmark analytical and numerical models and simulations, in order to provide better assessments and predictions for Arctic infrastructure and contribute to a sustainable environment. In 2020, the department offered two courses at bachelor level, and 17 courses on master- and PhD level, where only the spring semester courses were conducted. Fieldwork were performed on the sea ice in Svea (course AT-211), soil sampling at the NGTS test field near UNIS (AT-205), with subsequent soil characterization and soil strength testing in the UNIS laboratories, and field work and sampling campaigns in the vicinity of Longyearbyen in the environmental courses AT-331 and AT 330. The focus of the teaching in 2020 was to encourage master student to come to UNIS and to support their individual research

April 2020: Laser scanning of the sea ice formation in Isfjorden. Photo: Nataly Marchenko/UNIS.

projects. About 20 master students from all over Europe took courses and carried out parts of or the entire master research work at AT, including four students from the newly established Master in Cold Climate Engineering programme with NTNU and the Technical University of Denmark who all spent one full year at UNIS.

RESEARCH

The Arctic Technology Department conducted research in a wide field in 2020, within specific topics of ice and soil mechanics, offshore engineering, and environmental chemistry and toxicology.

Ice mechanics and offshore engineering

Field work was performed on land-fast ice in Svea with the bachelor course AT-211 and with researchers in the *Arctic Offshore and Coastal Engineering in Changing Climate* (AOCEC) project. The research in Svea focused on the vibrations' influence on ice strength, introducing a vibrating plate on the ice. Full-scale and small-scale uniaxial compression strengths of sea ice, collisional interaction of floes and generation of turbulence under ice, measurements of ice loads and deformations on the coal quay in Kapp Amsterdam were also investigated. Detailed experiments were done in the laboratory on sea ice rheology and thermal deformations to determine elastic constants in columnar and spray sea ice and measurements of longitudinal elastic waves speed in sea ice of different types. Other experiments were done for viscous properties of columnar sea ice in the vertical and horizontal directions, measurements of thermal deformations of natural sea ice and frozen soils caused by the changes of room temperature and freezing of water added inside the ice and soil samples.

Investigations on oceanographic conditions, including ice, were performed on Spitsbergenbanken, harvesting data of ice trackers deployed on the drift ice, recording data on sea water temperature, conductivity, and density and data of high frequency velocity and temperature measurement in the boundary layer below the drift ice. In the *Dynamics of Floating Ice* (DOFI) project, the dynamics of floating ice was the focus, and iceberg accelerations were measured by trackers deployed on small icebergs drifting near the southern tip of Hopen in May 2019.

Drifting icebergs are dangerous for the navigations and offshore development. In the Barents Sea, icebergs are formed due to the calving of outflow glaciers of Spitsbergen, Franz Josef Land and Novaya Zemlya. Drifting over big distances, icebergs may reach Bjørnøya and cross navigational routes. Knowledge of trajectories, dimensions, speed, and accelerations of drifting icebergs are important to estimate risks of collisions and potential damage to ships and offshore structures. Iceberg towing is one of operations used to avoid collisions offshore and has also been considered for fresh water supply for countries with water resource deficit.

Investigations of drift of a small iceberg was carried out in the Barents Sea (2019) and a towing experiment performed in Tempelfjorden September 2020 by Professor Aleksey Marchenko. In the towing experiment the tow line tension force and positions were measured by IMU and GPS sensors, with sensors installed on the iceberg. The experiments were performed with high frequency measurements of accelerations to identify wave induced motion of icebergs. The motion of tag boat and iceberg caused by changes of the towing direction was also recorded. It was discovered oscillations in the system of tag boat/tow line/iceberg at different frequencies related to the heave and roll of the ice. The data will be used for the formulation of 3D dynamic models of icebergs drift and towing.

The spring of 2020 was very interesting with respect to various sea ice phenomena in Adventfjorden and Isfjorden. Several interesting ice patterns and huge ice rubble formations occurred along the coast. Laser scans and time-lapse recordings were carried out to capture these remarkable phenomena for future analysis. The lagoon in Longyearbyen was re-scanned to capture the ongoing changes in the sand relief and ice regime. The lagoon is a very interesting research site in this respect. The deposited sand spit and the lagoon has moved 180 m towards the east since 2009. The sand spit head has become three times thicker and has moved eastwards since the scanning in 2019.

Researcher Nataly Marchenko continued on the online Geographical Information System (GIS) for the *Marine*

*Emergencies in the Arctic (*MarEmAr) project, which is part of the *Inter-organizational coordination of mass rescue operations in complex environments (*MAREC), concluded in 2020. The aim of MarEmAr is to improve the safety in the Arctic seas, strengthen the preparedness and response, and to provide a networking platform. The main ideas of the regional approach to risk assessment and the MarEmAr features were published as a chapter in the book "Crisis and Emergency Management in the Arctic: Navigating Complex Environments".

Infrastructure, Geotechnics and Energy

The installation of the test setup for piles in marine permafrost clay at the NGTS site east of UNIS was finished in 2020. Here we test pile tip resistance in the clayey marine soil. The testing will run for two years until failure or excessive settlements, to establish data for soil creep behaviour in the warming permafrost soil. Several master students have been and are involved in this work and contribute significantly to the improved knowledge of strength and thermal properties of the Longyearbyen underground soil. Together with Sintef we finalized the RCN funded project *Monitoring program for foundation settlements in Svalbard* (Monarc). The project has given valuable insight into settlement rates of foundations in the Svalbard settlements, providing us with a dataset for comparisons in the future.

At the hillside close to the shooting range in Longyearbyen we have since 2016 had a fixed installation with an instrumented wall where we measure the pressure from snow, temperature, and snow depth. As an example, the snow depth was 2,4 metres on 15 April 2020, and the load cell readings show a total push force of 70 kN (7 tons) on the wall. Measurements from this site give valuable reference data for developing and improving prediction tools for snow pressure on fences, barriers, walls, and masts, etc.

At our test installation in Adventdalen the research continues, investigating solar power production from regular and bi-facial panels, effects of environmental loads from wind, snow drift and accumulation. This activity is run together with NMBU and supported by Svalbard Environmental Protection Fund.

AT and Norconsult continued the ground temperature monitoring around the new Miljøstasjonen at Adventpynten. Temperature under the cooling plate foundation was studied to support work decisions during the building process. AT runs a master project for modelling the thermal regime in the permafrost under the cooling plate, accounting for heat transfer from the building and heat fluxes from the ground and the sea bottom, with the aim to minimize operation costs and energy consumption. Moreover, with the Longyearbyen Community Council we are looking into developing a concept utilizing solar-produced electricity for powering the active cooling plate foundation for Næringsbygget and rehabilitating ground temperature thermistors installed at the time the building was constructed. The two mentioned buildings plus the Coop store in town utilize active cooling to stabilize the permafrost foundation, which represents interesting cases for monitoring, modelling and analyses.

In 2020, the *Nordic Research Infrastructure Hub on Cold Climate Engineering* (COLDHUB) was funded via NordForsk, with Aalto University as the leading institution and NTNU, UNIS, and DTU as partners. Here collaborative research aims to solve the cold climate engineering problems we face with the warming climate. Coastal erosion and snowdrift issues are the main elements of the research and education in the project. Photogrammetry technique is utilized to monitor annual coastal retreat along the road to Bjørndalen and snow accumulation around our solar park installation in Adventdalen.

Several student projects have focused on issues related to renewable energy and energy use in Longyearbyen. Trial inspections on infrastructure's heat losses have been performed, studying one student barrack in Nybyen, the Huset building, and the city's water supply and sewage pipelines, applying thermal scanning and drones. A modelling of a future 2030 renewable energy system for Longyearbyen were done in collaboration with the Longyearbyen power plant. Based on today's electricity and heat demands, two scenarios were built: standard demands and lower demands, where we used the modelling tool EnergyPLAN, and investigated various

March 2020: The solar cell test plant in Adventdalen. Photo: Iver Frimannslund.

mixes of onshore and offshore wind combined with solar installations.

Environmental chemistry and toxicology

The research group has had activities in Longyearbyen, Ny-Ålesund and Barentsburg. In collaboration with the AARI Barentsburg chemistry laboratory and the Gdansk Technical University, the RCN funded project *Harmonising Environmental Research and Monitoring of Priority Pollutants in the Svalbard Atmosphere* (HERMOSA) was established in 2020. An international expert team will arrange a thematic workshop on Svalbard atmosphere pollutant monitoring in 2021 and conduct method testing subsequently during a Barentsburg based fieldwork campaign.

A pilot project on local sources for pharmaceuticals and personal care products (PPCPs) was carried out. UNIS and Sintef have collected a series of effluent samples from Ny-Ålesund and Longyearbyen for the PharmArctic project and are currently processed for analysis. In the project *Reducing the impact of fluorinated compounds on the environment and human health* all samples collected are prepared and quantified, and a comprehensive study on local pollutant sources of PFASs in the Adventfjorden area has been published.

As earlier studies indicated significant local air pollution in the Arctic, PhD student Tatiana Drotikova have focused on the evaluation of emissions after coal burning at the power plant, hypothesized to be the main potential source of pollution in Longyearbyen. Samples collected in the plant stack plumes were analysed for polycyclic aromatic hydrocarbons (PAHs), the major dangerous compounds emitted after fossil fuel burning. Dispersion of pollutants with distance from the source was investigated as well. Drotikova has compared the Longyearbyen power plant emission levels with the coal plants operated worldwide. For the first time, oxygenated and nitrated PAHs were quantified in the Svalbard air.

Adjunct professor Perrine Géraudie received a European grant to collaborate with the University of Occidental Britany (UOB) in Brest, France, to study the biological assessment of oil exposure under hydrostatic pressure. This project will help to understand the cumulative stress caused by hydrostatic pressure when a deep-sea oil spill occurred. This project chose to study the brine shrimp *Artemia salina.*

The Arctic molecular ecotoxicology activities have focused on completing collaborative projects with UiT - Arctic University of Norway, Akvaplan-niva, and Nord University. We are looking at impacts of oil pollution, mine tailings waste, climate change, and ocean acidification on key aspects of Arctic ecosystems including polar cod, Atlantic cod, and Arctic zooplankton. Using the excellent molecular laboratory facilities at UNIS, in particular the qPCR instruments, we are looking at gene pathways and individual gene responses in a variety of species and tissues. We are also developing a focus on genetic and epigenetic effects in order to understand how vulnerable Arctic organisms and early life stages (embryos and larvae) are susceptible to pollution and changing environmental conditions.

March 2020: The scientists received a surprising visit in the tent in Svea during an ice floe towing experiment.
Photo: Nataly Marchenko/UNIS.

Exposure levels and effects of per- and polyfluorinated substances (PFAS) in Svalbard glaucous gulls have been investigated and compared with levels in glaucous gulls in Greenland. The project is a collaboration between NTNU, UNIS, NPI, NILU and Aarhus University. The results show that concentrations of PFAS in livers of glaucous gulls caught in Adventfjorden were somewhat higher in 2018 than in 2017, and that in 2018 concentrations of PFAS were generally higher in East-Greenland (Scoresbysund) than in Adventfjorden in 2018. Effects of these compounds on thyroid hormones are being investigated. In another project, in collaboration with NTNU, NP and NILU, we are comparing levels and effects of organohalogenated (chlorinated and fluorinated) compounds in glaucous gulls at Bjørnøya and in Kongsfjorden.

Several master students have research projects at UNIS, investigating topics such as potential bias from local sources on studies of long range transported pollutants in Ny-Ålesund area; mercury release from permafrost, and chemical processes of mercury in Arctic soil; the role of migrating birds in transporting environmental pollutants to the Arctic and studying long-range atmospheric transport of inorganic and organic pollutants to the Arctic.

Geotechnical and environmental data

The AT department has during the recent years developed several systems for automatic collection of data from our different field test and instrument sites. The installations give unique opportunities to gather outstanding data from the Arctic environment, and to observe and analyse the continuous changes at the sites. East of UNIS we measure bearing strength and creep properties of pile tip foundations; in the hillside of Platåberget we measure static and glide-induced snow pressure forces on the 1,5 by 3,0 meter snow wall; at Platåberget we measure solar radiation; and in Adventdalen we measure solar radiation on plane of array and solar power production in single and double sided solar panels. Online data is available via the UNIS webpage.

GRADUATES 2020

MASTER'S DEGREE:

JEAN-GABRIEL DORVAL
Using local Svalbard rocks as a construction material. (NTNU, *UNIS and Technical University of Denmark).*

THEA JOSEFINE ELLEVOLD
Optical velocity measurements in the ocean using a remote operated vehicle (ROV). *(University of Oslo and UNIS).*

XUYANG JIN
Heat storage in rock and soil in permafrost conditions. *(University of Iceland and UNIS).*

DAVID VIEJO MARIÑO
Review of rock stability models, slope stability and rockfall assessment for a section of Vestpynten-Bjørndalen (Svalbard). *(NTNU, UNIS and Technical University of Denmark).*

PETER A. SHERWIN
An analysis of international, national, and local literature and the formulation of criteria, for the development of holistic sustainable Arctic coastal infrastructure. *(NTNU, UNIS and Technical University of Denmark).*

ALEKSANDRA VISICH
Thermal expansion of ice and ice loads on a quay in the Arctic. *(Moscow Institute of Physics and Technology and UNIS).*

ARCTIC SAFETY CENTRE

October 2020: Installation of Driva snow sensors for the coming winter season on the Sukkertoppen mountain.
Photo: Charlotte Sandmo/UNIS.

BY MARTIN INDREITEN, OPERATING MANAGER

In 2020, the centre has had a full-time operating manager, a part-time position related to administration and an adjunct staff of four professors. In addition, technicians at the section for operations and field safety have contributed as instructors on various safety courses.

The centre's main task is to offer research-based and practical knowledge and expertise related to safety for the local community, with businesses and other actors who conduct field activity on Svalbard. Focus areas are supporting field safety, societal safety, and emergency preparedness - all in an Arctic context with natural hazards and climate adaptations as important factors. The basis for the centre's activities is more than 30 years of experience from UNIS' field activities related to teaching and research. The government's "Strategy for innovation and business development in Svalbard" has been a guideline for the activity in the centre over the past year.

September 2020: The Arctic Safety Centre in collaboration with UNIS arranged a polar bear safety course for the locals in Longyearbyen. Photo: Eva Therese Jenssen/UNIS.

EDUCATION

In collaboration with the AT department at UNIS, the centre has four MSc courses in Arctic Safety. The courses are popular and were fully subscribed for the autumn of 2020, but unfortunately, they were cancelled due to Covid-19.

In the autumn of 2020, a further education course in Arctic Safety and Preparedness (7.5 ECTS) was arranged for the first time in collaboration with NTNU-Videre. The course received great interest in the local community, and the 25 study places were a hundred percent oversubscribed. The course had participants from local business, administration, emergency preparedness actors and internal participation from UNIS.

A two-day course in polar bear safety for the Longyearbyen public has also been arranged in autumn 2020.

RESEARCH

In the autumn of 2020, NTNU and the Arctic Safety Centre were granted NOK 12 million (plus NOK 5 million in-kind) for the project *Risk governance of climate-related systemic risk in the Arctic* (Arct-Risk). The project will start in 2021 and will run over three years. This project will have three full time employees in Longyearbyen: a researcher, a postdoc, and a PhD candidate working full time on this project.

SERVICES

The centre coordinates the local snow observation group, which provides weekly snow observations for the local avalanche warning system in Longyearbyen. The service is delivered to the Longyearbyen Community Council and is a key source of information for the avalanche warning system which is used to protect people and infrastructure in Longyearbyen. The centre has provided technical assistance in accident investigations related to field activity and has published a learning report related to the avalanche accident on the Fridtjovbreen in February 2020.

INNOVATION AND DEVELOPMENT

The centre has worked closely with Telenor Svalbard on the development of snow sensors in the last couple of years. The sensor technology uses IoT technology (Internet of Things) to send snow depth measurements in real time. These provide supplementary information about the snow cover that is used in local avalanche warning system. In 2020, a three-year project was started with Nordkapp municipality in mainland Norway. The project is based on the experiences from Longyearbyen and the same type of technology and sensors will be used in local avalanche warning system for exposed infrastructure in Nordkapp.

SCIENTIFIC PUBLICATIONS 2020

UNIS affiliated scientific publications in channels authorized in the Norwegian Register for Scientific Journals, Series and Publishers.

Adams, T. P., Black, K., Black, K., Carpenter, T., Hughes, A.., **Reinardy, H. C.**, & Weeks, R. J. (2020). Parameterising resuspension in aquaculture waste deposition modelling. *Aquaculture Environment Interactions,* 12, 401-415. doi: https://dx.doi.org/10.3354/AEI00372

Alexander, A., Kruusmaa, M., Tuhtan, J., **Hodson, A. J.**, **Schuler, T. V.**, & Kääb, A. (2020). Pressure and inertia sensing drifters for glacial hydrology flow path measurements. *The Cryosphere,* 14(3), 1009-1023. doi: https://dx.doi.org/10.5194/tc-14-1009-2020

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May 2020: A polar fox takes a nap in Bjørndalen. Photo: Sil Schuuring/UNIS.

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