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Summer School Final Report

Submission of Deliverable

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1. Abstract

ARICE and APECS enabled a unique in-person training opportunity on an icebreaking research vessel in the Central Arctic: The MOSAiC School, a "summer" school in the frame of the MOSAiC Expedition. The aim of the summer school was to provide the opportunity for practical hands-on and in-depth learning, as well as active exchange with peers and lecturers in order to educate the next generation of polar researchers as part of Task 3.2 in WP3 in the ARICE project.
As a result of the MOSAiC School 2019, all participants became MOSAiC Ambassadors for the remaining year of the MOSAiC Expedition, performing outreach projects in their home countries.

2. Introduction

The MOSAiC School 2019 took place from the 16th of September to the 28th of October 2019 onboard the Russian Research Vessel Akademik Fedorov, for the duration of the very first leg 1a of the MOSAiC Expedition (Multidisciplinary drifting Observatory for the Study of Arctic Climate). Twenty selected early career scientists (MSc. and PhD students) participated in the training programme. The RV Akademik Fedorov accompanied the RV Polarstern into the central Arctic sea ice where the RV Polarstern spend a year drifting with the sea ice to study the coupled Arctic climate system.

The aim of the MOSAiC School was to:

1. Train and educate the next generation of Arctic system science experts
2. Provide support to the MOSAiC teams and
3. Communicate and disseminate the newly gained knowledge and experience in MOSAiC Ambassadors' projects

This in-person training included lectures, practical exercises and workshops, as well as fieldwork training on the Arctic sea ice. Lectures onboard RV Akademik Fedorov covered all aspects of interdisciplinary research during MOSAiC, as well as training in science communication.
The MOSAiC School 2019 received additional support by the International Arctic Science Committee (IASC), Climate and Cryosphere (CliC) and Year of Polar Prediction (YOPP).

This report describes the planning and implementation of the MOSAiC School. The MOSAiC School was evaluated before, during and after the training activity. Results will be part of Deliverable D3.9 Training Assessment report."

2.1. Planning phases

The planning of the MOSAiC School started in summer 2018 when the MOSAiC Coordination reached out to APECS requesting advice and support for organising a "summer" school on one of the support icebreakers with free berths. The ARICE project just started earlier in the same year. As ARICE had planned a summer school on a smaller research vessel in the North Sea, the collaboration on a multi-week long in-person training on an icebreaking vessel was a perfect fit.
During the first planning phase until fall 2018, additional funding was acquired through an IASC cross-cutting proposal, as well through funds from CliC and support for participation of one modelling lecturer and one school participant through YOPP.
The announcement of the Call for Applications was published in the APECS News and on the ARICE Website on the 15th of November 2018, and distributed via social media and respective email lists. The deadline for applications was on the 22nd of January 2019. Reviews of the application were completed by the 19th of February 2019, the final ranking was finalized by beginning of March and successful

applicants were notified by the 16th of March. One applicant refused participations for private reasons and a replacement was notified according to the ranking. A first video call was organized for all confirmed school participants on the 29th of April 2019.
Following the video call, the MOSAiC School participants were asked to prepare a one-minute video presentation (so-called FrostByte) to present their research background. The Frostbytes were uploaded 6 August 2019 and submitted as ARICE Deliverable 3.5. The videos are available on the APECS Vimeo channel and ARICE website as a legacy of the MOSAiC School. Until fall 2019, many organizational and logistical procedures were accomplished, including ordering polar clothes for all participants through the AWI clothing stores, advising the submission of several documents and forms (medical questionnaire, personal questionnaire etc.), sending out invitations for visa if needed, informing on policies to be signed when boarding RV Akademik Fedorov (Multimedia Policy, Sexual misconduct policy, drug and alcohol policy), planning cabin occupancies and coordinating travel to and from Tromsø/Norway.

In parallel, potential MOSAiC School lecturers were contacted. The process of selecting lecturers was intensified after a large MOSAiC workshop was held on 15 March in Potsdam, where the concept of the MOSAiC School was presented and an APECS booth during coffee breaks provided room for all workshop participants to discuss and brainstorm lecturing ideas.
The actual lecture plan was continuously updated. In fact, even throughout the summer school lecture plans were updated, reflecting the nature of a polar expedition (e.g. it turned out that transfer of lecturer between both research vessels were logistical challenging).

2.2. Application, review and selection process

The announcement for applications for the MOSAiC School 2019 was published on the 15th of November 2018 on the APECS and ARICE website (see Appendix A) and distributed via all common email lists and social media channels.
Additionally, a Frequently Asked Question section was set up in order to limit email traffic between the APECS Office and potential applicants.

The applications received during the 9.5 weeks of the application period were handled via a google form linked to the ARICE and APECS websites (see Appendix B). Upon request, it was shared as word document in case the google was not accessible to the applicant.
A total of 255 applications from 35 countries were received (Figures 1 and 2).

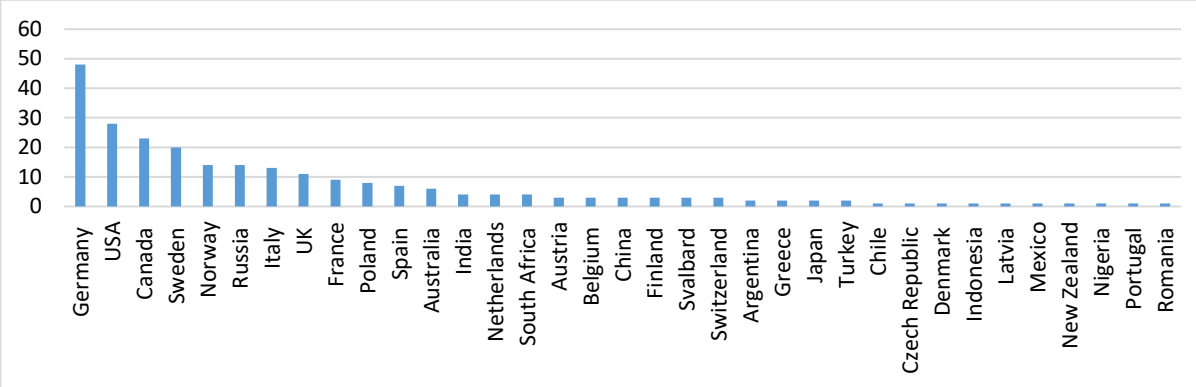

Figure 1: Applications for the MOSAiC School came from the following countries: Germany (47), USA (27), Canada (22), Sweden (20), Norway (14), Russia (14), Italy (12), UK (10), France (9), Poland (8), Spain (7), Australia (6), India (4), Netherlands (4), South Africa (4), Austria (3), Belgium (3), China (3), Finland (3), Switzerland (3), Argentina (2), Greece (2,) Japan (2), Turkey (2), as well as one each from Chile, Czech Republic, Denmark, Indonesia, Latvia, Mexico, New Zealand, Nigeria, Portugal and Romania.

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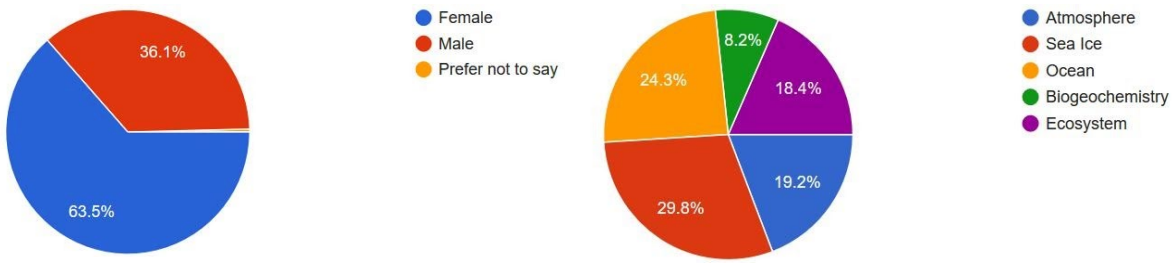

Figure 2: More than 2/3 of the applicants were female and applied for different MOSAiC teams. The selection of the successful candidates mirrored the ratio of applicants.

All applications were checked for eligibility (career status, science background etc.) and prepared by the APECS Office by adding an ID and removing personal information, such as name, residence, nationality, gender and current institution with the aim to allow reviewers an as unbiased review as possible. Each application was reviewed by two reviewers in a blind review based on a point system. Altogether, 30 junior and senior reviewers were involved, from APECS, MOSAiC and ARICE. All candidates were ranked according to their point scores. The MOSAiC School organizers then selected twenty candidates according to their point scores, national representation, MOSAiC team and gender balance. The latter was important for distribution of berth on the research vessel.

The names of the twenty selected candidates representing 11 countries were published on the APECS website (Figure 3). With a wide background of environmental research backgrounds in physics, physical geography, glaciology, oceanography, geochemistry, geology, climate sciences, applied mathematics, biology, hydrology, remote sensing and modelling, and being early in their career, for most of them it was their first experience in the Arctic or onboard an icebreaking research vessel.

Figure 3: Selected MOSAiC School participants as assigned to the MOSAiC Teams of Sea ice, Ocean, Ecosystem, Atmosphere and Biogeochemistry. Country of residence presented next to the name (country of origin as small flag above, if applicable).

3. MOSAiC School training plan – In theory

The MOSAiC School was scheduled to take place between the 15th of September to the 26th of October 2019 and planned in 3 phases, preceded by a „dry phase“ on land in Tromsø to accommodate the safety trainings, networking and first introductory lectures (Figure 4).

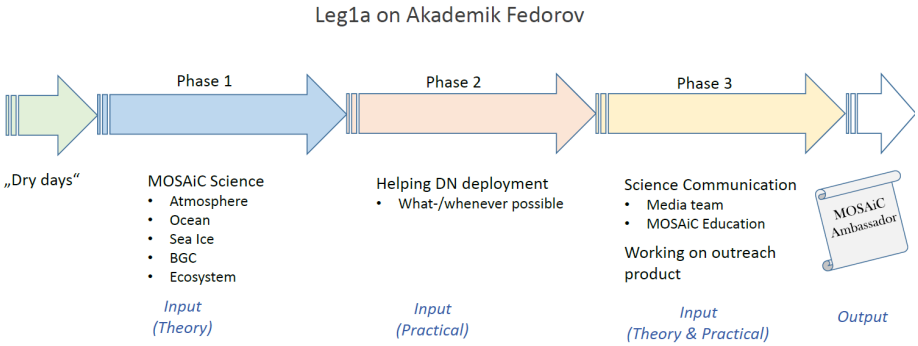

Figure 4: Concept of the MOSAiC School in three phases with different ratio of theoretical & practical input and planned output as MOSAiC Ambassador. Colour-code: blue = science lectures, red = practical field work, yellow = science communication.

During the journey into the Central Arctic (Phase 1) science lectures on the MOSAiC topics of Atmosphere, Ocean, Sea Ice, Biogeochemistry, Ecosystem and Modelling were planned. The Phase 2 was planned with more practical work experience, such as the set-up of the distributed network around the central MOSAiC floe. Once this mission was accomplished, the journey from the Central Arctic back to Tromsø was planned for science communication lectures and workshops and individual work on outreach projects and products with the aim to have 20 well trained and highly motivated young researchers acting as Ambassadors for MOSAiC during the remaining year of the MOSAiC expedition.

4. MOSAiC School training plan – Implementation in reality

Organizing a training program as part of a large polar expedition is a unique but also challenging task, as it asks for a lot of flexibility and good communication with cruise leads, team leads, lecturers and school participants. In fact, we were lucky and only a few modifications affected the training plan. This included:

- one day delay in departure from Tromsø harbour which resulted in impossible exchange of lecturers between RV Polarstern and RV Akademik Fedorov during the separated transit into the ice (phase 1). Instead, additional lecturers were recruited from the scientists onbaord RV Akademik Fedorov. In fact this solution resulted a perfect addition to the program.
- The topics of science communication were introduced earlier in phase 1 and additional science lectures were provided later in the program in phase 2 and 3 where unforeseen breaks in field work plans allowed further theoretical input.

Overall, the color-coded structure of Figure 4 was only slightly modified as seen in Figure 5. The final duration of the MOSAiC School was from the 16th of September to the 28th of October 2019.

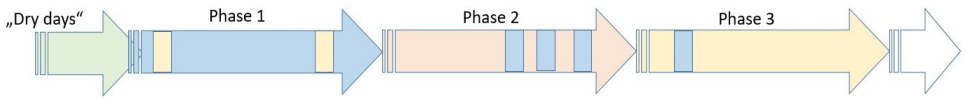

Figure 5: Slightly adapted MOSAiC School lecture plan.

Onboard, the daily schedule was presented to the MOSAiC school participants in daily check-in meetings, through a flip chart containing the daily plan and a large poster wall, which was used to communicate and visualize the overall, weekly plan to the MOSAiC School participants (Figure 6).

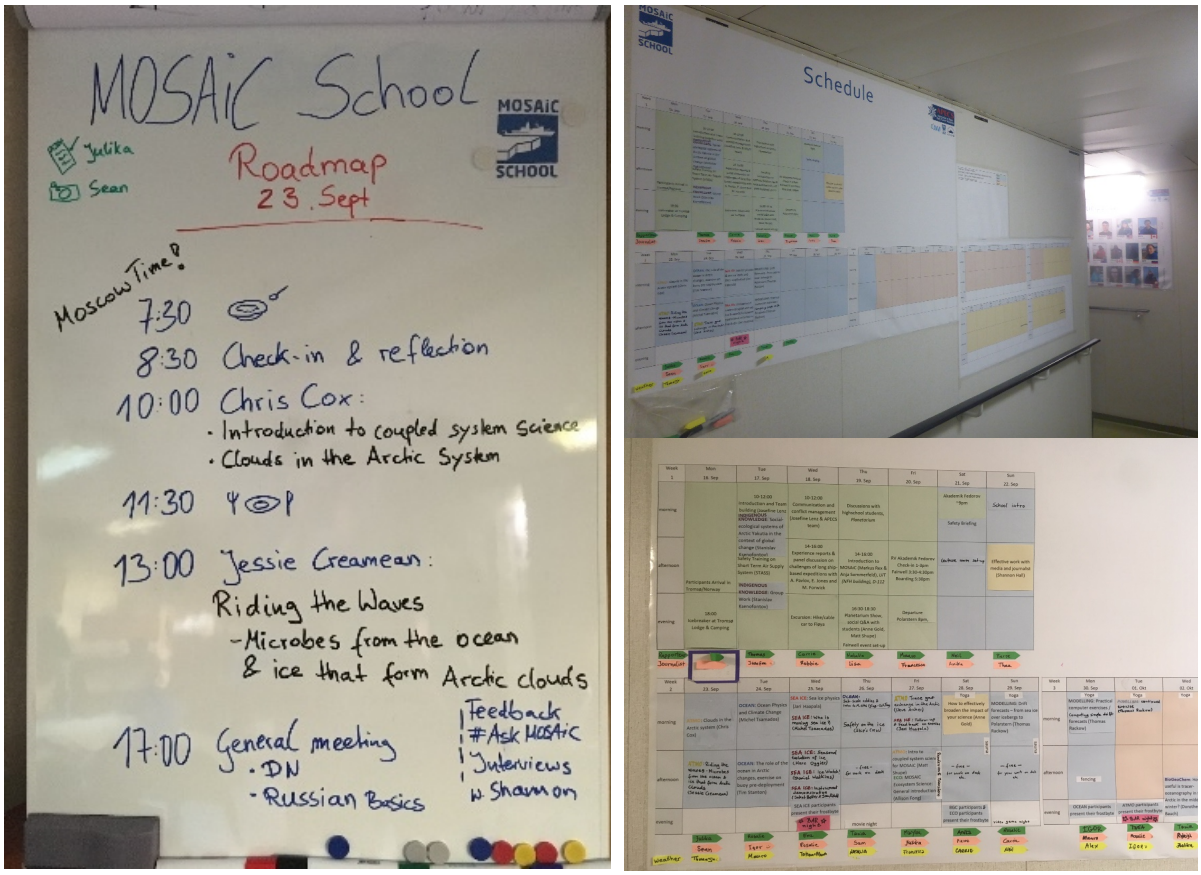

Figure 6: Example of a daily plan (left) and an overview plan of the MOSAiC School (right) developing over the full duration of the training program. Every day, one participant was assigned to be note taker (green mark), rapporteur (pink mark) and being responsible to prepare and present the weather forecast (yellow mark).

Lectures and exercises were provided on 21 days over the duration of the MOSAiC School, which made 35 lectures with more than 42 hours duration in total. The following lectures were provided in the MOSAiC School:

Date	Presenter	Title	Affiliation	Category
17. Sep	Josefine Lenz & Gerlis Fugmann	Welcome, introduction to APECS and the MOSAiC School	APECS, AWI	General
17. Sep	Stanislav Ksenofonotov	Social-ecological systems in the context of global change	Ammosov North Eastern Federal University	General
18. Sep	Josefine Lenz	Communication & Conflict Management	APECS, AWI	General
18. Sep	Andrea Schneider	Panel discussion on Challenges on long ship-based expeditions with Alexey Pavlov, Elisabeth Jones & Matthias Forwick	APECS, UiT	General
19. Sep	Markus Rex	Introduction to MOSAiC	AWI	General
19. Sep	Anja Sommerfeld	Management of MOSAiC	AWI	General
22. Sep	Shannon Hall	Working with the media + Interview training + #AskMOSAiC Interview Exercise	Freelancer, Scientific American and others	Media
23. Sep	Chris Cox	Clouds in the Arctic System	University of Colorado/CIRES	Atmosphere
23. Sep	Jessie Creamean	Riding the wave: Microbes from the ocean and ice that form Arctic clouds	Colorado State U	Atmosphere / Ecology

24. Sep	Michel Tsamados	Ocean physics and climate change	CPOM, UCL	Ocean
24. Sep	Tim Stanton	The Role of the Ocean in Arctic Change	NPS and MLMS	Ocean
25. Sep	Jari Haapala	Principles of sea-ice physics: thickness distribution – thermodynamics – dynamics + Group Exercise	Finnish Meteorological Institute	Sea Ice
25. Sep	Marc Oggier	Seasonal evolution of First-Year Ice Microstructure and physical properties	UAF, IARC	Sea Ice
25. Sep	Michel Tsamados	Sea ice dynamics	CPOM, UCL	Sea Ice/Ocean
25. Sep	Daniel Watkins	Introduction to Ice Watch	Oregon State U	Sea Ice
26. Sep	Tim Stanton	Introduction to L-Site plans	NPS and MLMS	General
26. Sep	Ying-Chih Fang	Introduction to M-Site plans	AWI	General
27. Sep	Stephen Archer	Trace gas exchange in the Arctic	University of Colorado/CIRES	Atmosphere
27. Sep	Allison Fong	Ecosystem Research in MOSAiC	AWI	Ecology
27. Sep	Matthew Shupe	Coupled System Science at MOSAiC + Group Exercise	University of Colorado/CIRES & NOAA	Atmosphere & General
28. Sep	Anne Gold	Broadening the Impact of your Science	University of Colorado/CIRES	Education & Outreach
29. Sep	Thomas Rackow	Drift forecasts – from sea ice over icebergs to *Polarstern* + Exercise	AWI	Modelling
02. Oct	Dorothea Bauch	How useful is tracer-oceanography in the Arctic in the middle of winter?	GEOMAR	BGC
08. Oct	Pauline Snoeijs Leijonmalm	Uncovering the largest blind spot on the map of the world's fish stocks	Stockholm University	Ecology
15. Oct	Michael Angelopoulos	Subaquatic permafrost and a brief introduction to planetary analogues	AWI	BGC
15. Oct	Sebastian Rokitta	Phytoplankton and how they interact with their environment -The basics of biogeochemistry	AWI	Ecology
16. Oct	Sebastian Rokitta	Cycling of biogenic elements	AWI	Ecology
18. Oct	Vera Schlindwein	Exploring seafloor spreading at Gakkel Ridge, Arctic Ocean	AWI	Geology
19. Oct	Friedericke Krüger	The Psychology of Learning	Integr. Gesamtschule Bothfeld	Education & Outreach
19. Oct	Falk Ebert	Understanding with your hands - Opportunities and limits of experiments in school + Group Exercise	Käthe-Kollwitz Gymnasium	Education & Outreach
20. Oct	Katie Gavenus	Understanding, Building From, and Honoring Students' Lived Experiences	PolarTREC/Center for Alaskan Coastal Studies	Education & Outreach
22. Oct	Daisy Dunne	How to take on climate sceptics and win	Carbon Brief	Media
23. Oct	Chelsea Harvey	Writing About Science for Non-Scientists	E&E News	Media
23. Oct	Josefine Lenz	Panel discussion on field work preparation with Thomas Krumpen, Anne Morgenstern, Vera Schlindwein & Tim Stanton	AWI	General
24. Oct	Martha Henriques	Panel discussion on story telling with Martha Henriques, Marlene Göring and Philipp Griess	BBC	Media
24. Oct	Martha Henriques	Ethics in Climate Science	BBC	Media
25. Oct	Ravenna Koenig	Using Social Media to Communicate Your Science	National Public Radio	Media
26. Oct	Anne Gold	Evaluation of Projects	University of Colorado/CIRES	Education & Outreach

In the following, each phase of the MOSAiC School is summarized and illustrated.

a. "Dry days"

During the "dry days" in Tromsø/Norway (16 - 20 September 2019), the focus was set on team building, logistical tasks and first input on the MOSAiC mission as well as discussions on challenges of ship-based expeditions.

The icebreaker event was held on the camping side near the accommodation of the school organizers and participants. It was organized as a BBQ and included a polar bingo game where participants had to find fellows with a certain interest or characteristic (completed bingo rows were awarded a MOSAiC School t-shirt). Opening remarks were given by Prof. Markus Rex as the overall MOSAiC project lead and Dr. Josefine Lenz as the MOSAiC School coordinator.

In the following days, first lectures were held on the mission of the MOSAiC project by Prof. Markus Rex and on management of MOSAiC by Dr. Anja Sommerfeld (Figure 7).

***Figure 7**: Markus Rex presenting the objective and mission of the MOSAiC Expedition.*

Dr. Stanislav Ksenofontov presented his indigenous view on social-economic impacts of Arctic Change and organized group-work to develop policy recommendations on this topic. Further, a panel discussion on challenges on long ship-based expeditions was held. As experienced polar researchers, we invited Matthias Forwick, Elizabeth Jones and Alexey Pavlov to discuss and give advice on issues of mental health and group dynamics on week-long journey on research vessels.

The "dry days" were also needed to complete logistical tasks, like testing and picking up polar clothes of AWI, attending a safety training on a short-term air supply system (STASS) needed for potential helicopter rides. Further, we went on a group excursion to the 421 m high mountain Floya and experienced the first snow of the year in Tromsø. Finally, a first science communication challenge was run by answering school kids' question in a MOSAiC planetarium show. A total of 365 pupils watched the show and met our MOSAiC School participants on this presumably last day before departure. However, departure was delayed for logistical reasons. We left harbour on 21 September 2019.

Figure 8: Impressions of the "dry days", MOSAiC School participants getting prepared.

b. Phase 1 – Journey into the ice

Phase 1 started when RV Akademik Fedorov left the harbour in Tromsø. Soon after all participants moved into their cabins, received a safety training and helped to prepare the lecture room, lectures started off with an introduction of the media team on board. Shannon Hall presented on how to work effectively with journalists and an individual interview training was performed with all participants. As an exercise, they contributed to the collection of #AskMOSAiC answers and interviewed scientists on board. For the next days of transit into the ice, various science lectures introduced and discussed topics on ocean physics, sea ice development and dynamics, gas fluxes and Arctic atmosphere phenomena (Figure 9). Prof. Tim Stanton, lead of the team responsible for setting up the distributed network around the central MOSAiC floe, and Dr. Ying-Chih Fang, introduced the planned observation systems and offered possibilities to get involved in preparing instruments. Group exercises included the planning of sea ice surveys guided by Prof. Jari Haapala and modelling approaches with Dr. Thomas Rackow, an invited YOPP modeller. Dr. Daniel Watkins introduced the Ice Watch Program and all participants were involved in performing ice observations while travelling in the sea ice. Participants also got involved in the daily routine of weather reporting.

Figure 9: Dr. Christopher Cox presenting the role of clouds in the Arctic System.

On 27 September, RV Akademik Fedorov and RV Polarstern finally met again near the edge of the Arctic sea ice. As scientific and logistical leads discussed expedition strategy with both vessels manoeuvred side by side, the occasion was used to get two additional speakers visiting for 2 hours: Prof. Matthew Shupe, co-lead of MOSAiC, presented on coupled system science at MOSAiC and challenged the participants to design their own coupled system science project. Dr. Allison Fong, Ecosystem Team lead, presented planned ecosystem research in MOSAiC.
The following days were characterized by the search of a suitable ice floe for the central observatory. Once the ice floe was found, the exchange of expedition participants between both ships enabled the introduction of new lecturers. While RV Akademik Fedorov was now searching for suitable ice floes for smaller observatories around the central floe, participants got prepared to do field work on the ice.

Figure 10: Soon after boarding and completing safety training, lectures and exercises started on the way up North. At 85° N, first sights of polar bears certainly got everyone excited, before RV Polarstern and RV Akademik Fedorov met again shortly before entering phase 2.

c. Phase 2 – On the Arctic sea ice

In search for suitable ice floes for the distributed network, RV Akademik Fedorov entered its key phase, which was an exciting but partly stressful situation for cruise lead and researchers. Finding multi-year ice with sufficient thickness and stability was surprisingly difficult. At the same time, days already got shorter and concerns arose that the set-up of the distributed network could end in a race between sufficient daylight and good weather windows (plus leaving the Central Arctic before the ice reaches a critical thickness for RV Akademik Fedorov to break the ice). By the end, it worked out perfectly with only one day too windy for ice work. All MOSAiC School participants were extremely eager to go out into the field and help with setting up the distributed network. For the school organisation it was now crucial to allocate fieldwork time to the participants according to their interest, skills, involvement in preparatory work and help needed. It turned out that top-down work schedules were highly appreciated by the MOSAiC School participants, as concerns of an elbow mentality arose in case a first-come-first-serve schedule would have been implemented.

Figure 11: MOSAiC School participants and organiser Josefine Lenz on the sea ice (research site L3).

The MOSAiC School participants got involved in various tasks, including unloading equipment on the ice and driving snowmachines as logistical support, watching out for polar bears on the bridge for safety and, most importantly, helping to install instruments on the ice and conducting sea ice surveys and ice coring. Given that the practical part of the MOSAiC School was hard to plan ahead and its implementation was uncertain, it can be said that it could not have been more successful. On one of the days in phase 2, 18 out of 20 students were simultaneously working on the ice. It was pointed out by many other participants including the scientific cruise leads and captain that the MOSAiC School participants were of tremendous help for getting the distributed network set-up in this limited time window.

In between, when moving from one field side to another side, additional lectures were held to cover the biological aspects in MOSAiC by newly introduced lecturers of the Biogeochemistry (Dr. Dorothea Bauch, Michael Angelopoulos) and Ecosystem Teams (Dr. Pauline Snoeijs Leijonmalm, Dr. Sebastian Rokitta), complemented by a geology lecture by Dr. Vera Schlindwein.

Figure 12: MOSAiC School participants eagerly waiting to go back on the sea ice after a lunch break, helping to install instruments, core sea ice and help with logistics.

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d. Phase 3 – Return journey

Once the set-up of the distributed network was successfully completed, RV Polarstern and RV Akademik Fedorov exchanged personnel and equipment once more for the last time. This time, exchange was performed via helicopter as the sea ice dynamics started to become challenging and pressure of an additional ship alongside RV Polarstern was too dangerous for the central MOSAiC floe. On the 17th of October, RV Akademik Fedorov started its return journey. Now transit was more time-consuming as thicker ice conditions required more ice ramming and travelling in zick-zack-mode.

The MOSAiC School lectures focussed on science communication during the return journey. Input was provided by the media journalists, teachers and educators on board. In a first part, the German teachers Friedericke Krüger and Falk Ebert, who were selected to join the expedition to produce classroom material and bring MOSAiC into schools, presented on the psychology of learning and on experiments as an example for practical learning. The latter was combined with a group exercise to develop and test experimental set-ups on MOSAiC themes. US educator Katie Gavenus, who joined MOSAiC with the PolarTREC program, presented and discussed her experience with teaching in indigenous communities. Presentations by media journalist of radio and online newspapers nicely framed the training plan on how to deal and make use of the media.

In phase 3 of the MOSAiC School, a lot of room was made available for the development of the MOSAiC Ambassador outreach concepts. In 1:1 meetings with the school organizer and a communication expert from CIRES (U Boulder), all participants discussed their Ambassador projects and identified potential linkages with other fellow participants (Figure 13).

Despite evaluating the outreach project concepts, time was used for the evaluation of the MOSAiC School experience itself. All 20 MOSAiC School participants presented their experience, personal take-home-message and planned outreach at the daily general meeting to all cruise participants.

Figure 13: Ideas for outreach events and products of the MOSAiC School participants sorted by selected audiences, summarized from submitted concept papers by school organiser Josefine Lenz.

Figure 14: After 6 weeks of intensive team building, some group exercises where now easier than ever. Experiment set-ups were tested, developed, and partly included in proposed outreach projects.

The successful participants were named “MOSAiC Ambassadors” on 27 October during a graduate celebration, and the MOSAiC School ended with the participants leaving the vessel on the 28th of October 2019. However, the education and training activities continued further on since the RV Polarstern was drifting with the ice continuing the MOSAiC Experiment, all 20 MOSAiC Ambassadors were in charge of passing their experience and (science) lessons learned to the audience of their choice.

4. Post-summer-school: MOSAiC Ambassador’s projects

The MOSAiC Ambassadors have engaged in various outreach projects. Some of them were more in the format of products to be used for science communication, others were more in the format of presentations and active exchange with the different audiences. The latter caused challenges in 2020 when the global pandemic situation did not allow for in-person events. At the same time, some of the MOSAiC Ambassadors plan to continue their outreach activities, once they are allowed again, to interact with the public. This way, the legacy of the MOSAiC School goes actually beyond the MOSAiC Expedition. In the following, the Ambassadors are summarized as outlined on the APECS Website (in alphabetical order).

Neil Aellen, Switzerland

Originally, Neil planned to give public lectures at the Museum focusTerra of the Department of Earth Sciences at the ETH Zurich, which planned to include experiments on physical phenomena. Since public museum tours were not allowed in 2020, Neil presented an alternative online tour "Eingeschlossen im arktischen Eis" (in German, published in August 2020) where he spoke about Arctic Changes and why studies like MOSAiC are important. In a second part of the online tour published in December 2020, Neil presented the different foci of the “MOSAiC Expedition”. Additionally, in cooperation with his ETH and MOSAiC Ambassadors' colleague Mauro Hermann, Neil published an Article about the expedition in the ETH students magazine Polykum and had a radio interview on radio SIRUP Zurich, about the expedition and their experience working and living on the icebreaking research vessel Akademik Fedorov.

Marylou Athanase, France

Marylou hosted a MOSAiC Ambassadors Journal (@MOSAiC_embassy) on Twitter in order to share all MOSAiC Ambassador’s activities with the public. Ultimately, the MOSAiC Ambassadors Journal aims to channel the rich set of outreach and educational material produced in various languages, and make it accessible to the widest audience possible. During Polar Week in March 2020, she tweeted on post per day to highlight the activities of her fellow Ambassadors. Additionally, Marylou visited several classes in a secondary school in Villemonble, France to present the goals of MOSAiC, what is an Arctic expedition like and carry out an experiment of oceanic circulation. Marylou Athanase was invited to the French radio France Inter to share her experience on MOSAiC.

Sam Cornish, United Kingdom

Sam recorded a series of interviews onboard the RV Akademik Fedorov and weaved them together into mini podcasts, with the aim of bringing the science of MOSAiC to life in audio. The mini podcasts called MOSAiC Mixdown are available on his website and various podcast outlets. Further, Sam has written articles for his department and college in Oxford, and wrote an article in the landscape photography magazine "On Landscape": Listening to the Arctic - A unique landscape is literally being lost from the face of the Earth. He has also provided the music for the MOSAiC School lecture

recordings presented on the ARICE website. Finally, Sam was also featured in a YouTube video with CIRES giving an introduction to the key dynamics of the Arctic climate system.

Lisa Craw, Australia

Lisa planned to continue her engagement to visit schools and encourage young women to study polar science. Here she makes use of interactive sessions with much of the time spent answering questions from the students and doing activities using virtual reality headsets. Further, she has been a guest on ABC radio in Hobart along with fellow MOSAiC Ambassador Natalia Ribeiro and has been working on a series of cartoons explaining Arctic climate processes in an accessible way.

Francesca Doglioni, Italy/Germany

Francesca visited schools in her homeland Italy in the hope to inspire students of age 14-18 to be curious about the Earth System. She described how challenging but at the same time how intriguing and important it is to study the physics, biology and chemistry of the Arctic and answered their questions about what it means to study Natural Sciences. In a second visit, she talked about the scientific processes behind climate change, and helped the students to experience themselves how they work by means of hands on experiments. The worksheets she developed are available in Italian, English and German. Apart from her main project, Francesca gave interviews in the newspaper “il Gazzettino” and radio (Radio Popolare).

Anika Happe, Germany

Anika developed two projects that focus on different target groups. The first project is an expedition video, more specifically a chronological collection of videos that summarize the most beautiful and important moments of the journey and gives viewers an impression of field work in the Arctic and living on a research vessel. The second project was conducted in cooperation with the "ZukunftWald" Foundation. Here, a mascot cat named Felix travelled with Anika and answered many questions from German school kids on video. These short videos created an Advent calendar, which was published on the Foundation's website during December 2019. School visits complemented Anika’s engagement with the audience. Anika’s activities raised quite some local media interest with several articles published in the Braunschweiger Zeitung.

Carolynn Harris, USA

Carrie’s main MOSAiC outreach project is developing an Arctic Scientist scout patch in collaboration with Girl Scout leaders in her home country, the United States. In April 2020, Carrie worked on highlighting women MOSAiC students among other women polar researchers across multiple social media platforms (twitter, instagram, and facebook) as part of a successful collaboration with Women Doing Science (@women.doing.science). Carrie presented her experience to the IARPC Collaborations Team in October 2019 and to the National Ocean Science Bowl, which included a marine science quiz competition for high school students, as well as a live broadcast on the "Exploring by the Seat of Your Pants"- YouTube channel.

Mauro Herrmann, Switzerland

Mauro planned to present at the EGU GIFT teachers workshop and in schools, e.g in January 2020 on a special day on “Klima and Kulturtag”. Since the EGU teachers workshop was cancelled in 2020 due to the pandemic, he and MOSAiC Educators presented instead in a special APECS-ARICE Webinar on "From icebreakers into classrooms – opportunities for educators and scientists“ in May 2020. Together

with his fellow Ambassador Aellen, he wrote an article about the expedition in the ETH students magazine and blog, and were on air for one hour (radio SIRUP, Zurich) to get some of the unique polar feelings from their trip across. Further, Mauro`s activities were covered in the Schweitzer Radio and Fernsehen (SRF), FM1 today and 20Min.

Sean Horvath, USA

Sean has conducted interviews for website articles and has been consulted on course material for an Arctic science Massive Open Online Course developed by CIRES at University of Boulder. He is in the process of producing additional educational materials for grade school students and has planned local school visits, as well as presentations at his institution as soon as the pandemic allows. Further on, Sean gave a lecture on APECS and MOSAiC for the 6th Korea Arctic Academy in Sept/Oct 2020, organized by University of the Arctic and Korea Maritime Institute.

Ewa Korejwo, Poland

Ewa gave a series of presentations at different institutions and for different audiences. In January 2020, she presented at the Polish Academy of Sciences and at the University of Gdańsk to graduate students and scientists. Ewa took part in activities organized by the Polish local science center EXPERYMENT, aimed at introducing science to the general public, especially schoolchildren. For that purpose, she recorded a short video in which she talks about the goals of the MOSAiC project and her summer school experiences. Once the pandemic situations allows, she plans to visit middle schools. In summer 2020, Ewa joined a ships cruise around Spitsbergen and gave a presentation for crew members and scientists taking part in the AREX Expedition onboard RV Oceania.

Robbie Mallett, United Kingdom

Robbie presented MOSAiC and his experience to scientists at the London Oceans Group meeting and London Global Geophysics Seminar in November 2019), as well as to a public audience at "Broadly Scientific". Further, has cooperated and advised a production company on a European Space Agency (ESA) Course entitled Earth Observations from Space.

Tatiana Matveeva, Russia

Tatiana planned MOSAiC-themed lectures in the course called “Young meteorologist" at a school for talented children, the "Intellectual" in Moscow. She already gave her first lectures and "fresh" experience in November/December 2019. Unfortunately, the global pandemic in 2020/21 had a big influence on her teaching activities. In May 2020, Tatiana gave an online interview for the Russian television 5-TV together with MOSAiC Ambassador colleagues Igor and Natalia for a special issue on the International Day of Polar Scientists. Tatiana also helped with Russian translations for a fellow Ambassador Thea's photobook project.

Alex Mavrovic, Canada

Originally, Alex planned outreach activities with the local Native community high school during his Cambridge Bay field campaign in April 2020 but due to the global pandemic, field work was unfortunately postponed. In February 2020, Alex presented his MOSAiC School experience at the Centre for Northern Studies Symposium and gave a series of three general science talks at the Université de Sherbrooke, the Université du Québec à Trois-Rivières and at the Cégep de Sherbrooke. In June 2020, Alex gave an interview on the national radio CBC, "Quebecer hops aboard ice breaker for massive polar expedition", and in November 2020, he spoke in French language in a MOSAiC coverage "Cap sur le pôle nord" in *Découverte* of the national TV Channel ICI Radio-Canada.

Rosalie McKay, Norway/Canada

Rosalie has created a 52 seconds video showcasing 1 second of each day of the MOSAiC School. Along with the video, she created a blog on the APECS website to provide background to the snapshots and unique insights into her experience of the MOSAiC School.

Ryleigh Moore, USA

Ryleigh has given several talks at the University of Utah in November/December 2019. In February 2020, she presented to young students at "Exploring by the Seat of Your Pants" about life and work on the ship and on the sea ice - Six schools joined online and asked questions live. Furthermore, Ryleigh wrote blog posts on Getting To, From, and Around the Central Arctic for *Reach the World* and on Remote Sensing and Buoy Simulations: Important Tools on MOSAiC for the University of Boulder *MOSAiC blog.* She also *gave i*nterviews for the University of Utah News Website and contributed to articles in the Science Magazine, Aftermath and E & E News Article. In addition, Ryleigh documented the deployment process and produced an explanatory video for educational and scientific audiences.

Pierre Priou, France/Canada

Pierre has conducted MOSAiC hands-on experiments and given talks at primary and secondary schools as part of the éTer(re)nelle project based in Audruicq, France. Another outreach project of Pierre was to support school kids to develop an illustrated book on Arctic research and climate change. Unfortunately, this project has been put on hold due to the pandemic. Pierre has been interviewed by the eastern Canadian newspaper "Le Gaboteur", where he talked about his experience on the RV Akademik Fedorov. Further on, Pierre has provided feedback to a Massive Open Online Course (MOOC) prepared by the Education and Outreach Team at CIRES at the University of Boulder.

Natalia Ribeiro Santos, Argentina/Australia

Natalia planned to develop a lesson plan "Arctic and the Southern Ocean: Connected on their differences" and share her Arctic experience in interactive activities which will become available to teachers around the world. She documented her MOSAiC School and Arctic impression on a blog of the University of Tasmania, Institute of Marine and Antarctic Studies. Further, she shared her experience in female scientists-blog (in portuguese) and in radio interviews with ABC radio Hobart together with her fellow MOSAiC Ambsassador Lisa Craw. In May 2020, Natalia gave an online interview for the Russian television 5-TV together with her MOSAiC Ambassador colleagues Igor and Tania for a special issue on the International Day of Polar Scientists.

Thea Schneider

Thea's main project is a photographic documentation, namely a series of 3 photo books. On Instagram (@the.answer.is.north) she published a series of photos with short explanatory texts to give information about MOSAiC and polar research. Thea also worked together with BBC future to create a gallery for their website about Christmas at the North Pole. She posts on her personal blog about the expedition in a more personal diary style. The Year of Polar Prediction (YOPP) interviewed Thea before and after the expedition and invited her on the second episode of their podcast (The IcePod - produced in collaboration with the community radio station Radio Weser.TV) to talk about her experiences on board. In 2020, Thea started her cooperation with the German Blog NordNotes, which is also featured by Instagram stories @nordnotes.

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Igor Vasilevich, Russia

Igor presented in open lectures in formal setting at the Russian Hydrometeorological University in April 2020 but also in informal settings at the "Бакалавриат" (Bakalavriat or Bachelor`s programme) in St. Petersburg City Centre. A recording of this lecture is available in Russian. Igor has created a timelapse video of his presentation and added English subtitles. Further, Igor presented the MOSAiC School and expedition in his personal blog and gave an online interview for the Russian television 5-TV together with his MOSAiC Ambassador colleagues Tania and Natalia for a special issue on the International Day of Polar Scientists.

Julika Zinke, Germany/Sweden

Julika's MOSAiC School experience was of interest for several local media outlets, e.g. the 'Märkische Oderzeitung' published several articles before and after the expedition upon which she has been interviewed by a local radio (Antenne Brandenburg) and a TV station (RBB). Julika has presented her experience in a public talk before Christmas 2019 to a broad audience in her hometown in Germany. Further, Julika has managed the Stockholm University's Instagram account for one week in November 2019 featuring the MOSAiC School and Expedition.

5. Conclusion

The MOSAiC School was a unique opportunity – for the participating early career scientists, for the organisers, for APECS and for the Arctic Researcher Icebreaker Consortium. Interactive, hands-on trainings in intercultural exchange with fellow scientists provide a great learning experience alone. Creating a learning environment on an icebreaking research vessel in the Central Arctic was such a special chance and sometimes challenge for the participating individuals, that this once-in-a-lifetime experience will surely never leave them again.

This opportunity would not have been possible without ARICE, as well as additional support of IASC, YOPP and CliC.

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APPENDIX A

MOSAiC School 2019: Call for applications

The Multidisciplinary drifting Observatory for the Study of Arctic Climate (MOSAiC), will be the first year-around expedition exploring the coupled Arctic climate system. It has been designed by an international consortium of leading polar research institutions under the umbrella of the International Arctic Science Committee (IASC), led by the Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research (AWI), Arctic and Antarctic Research Institute (AARI) and the University of Colorado, Cooperative Institute for Research in Environmental Sciences (CIRES).

Research Vessel (RV) Polarstern will spend 350 days (September 2019 until September 2020) frozen into the drifting Arctic sea ice. 300 scientists will investigate the Arctic climate processes that couple the atmosphere, ocean, sea ice, biogeochemistry and ecosystem.

The results of MOSAiC will enhance the understanding of the regional and global consequences of Arctic climate change and sea-ice loss, and improve weather and climate predictions.

During the first leg of the expedition, the MOSAiC partners and the Association of Polar Early Career Scientists (APECS) work together to offer a the **MOSAiC School 2019 on board the support icebreaker RV Akademik Fedorov**.

Duration of the MOSAiC School 2019: **15 September – 26 October 2019** (plus / minus a few days as logistical or weather conditions may require changes of travel dates)

Port of exit and entry: **Tromsø, Norway**

The MOSAiC School 2019 will be open to **20 early career researchers** (advanced graduate students and PhD students with no to limited experience on ship-based research).

International experts that are part of the expedition will share knowledge with the students, engage in discussions and hands-on experiences in groundbreaking research, and thus help to educate future Arctic climate experts. In addition, the participants will help the MOSAiC Teams on site to set up their instruments and experiments.

The draft schedule for the MOSAiC School can be found below:

After the end of the MOSAiC school the participants will have to:

- serve as MOSAiC "ambassadors" by reporting back to their country and institutes
- Report to APECS and the MOSAiC organizers

If approved as participant, you have to:

- Have a visa for Norway and Russia (Russian visa needed for RV Akademik Fedorov) (if needed)
- pass a medical check as required by AWI
- Have flexibility in time around the MOSAiC School dates (as logistical or weather conditions may require changes of travel dates)
- Agree to accommodation in cabins of 4 people
- Be aware that the food on board will only accommodate in a very limited way to allergies or special food requirements (e.g. vegan, gluten free)
- Be aware that there will be very limited internet on board (only emails over board server but no social media ;))
- Be aware that participants will have to complete the entire journey without the possibility of leaving the ship earlier

Application Requirements:

- Background in natural sciences with a research topic relevant to the MOSAiC project / teams
- Advanced Master Student or PhD Student
- Strong interest in ship-based research
- Good knowledge in oral and written English (as this is the language of the MOSAiC School 2019)

Application deadline: 22 January 2019

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APPENDIX B

Application Form - MOSAiC School 2019

The Association of Polar Early Career Scientists invites early career researchers to apply for the MOSAiC School 2019.
For information about MOSAiC, please visit the MOSAiC website https://www.mosaic-expedition.org/. For information about the MOSAiC School 2019 including all application criteria and procedures, please visit the APECS website: https://www.apecs.is/events/upcoming-event-highlights/mosaic-school-2019.html
The application deadline is: 22 January 2019, 13:00 GMT.
Please fill in the form as completely as possible. Highlighted indicates required fields. The form can be sent to mosaic-school@apecs.is.

1. Email Address:
2. Name (First and Last Name):
3. Affiliation/Institute:
4. Street Address:
5. City:
6. State/Province:
7. Postal Code:
8. Country of Residence:
9. Country of Birth:
10. Date of Birth:
11. Phone Number:
12. Gender (female/male/prefer not to say):

Educational / Professional background

13. Current Career Status (Master Student/PhD student):
14. Name, email address and phone number of Faculty Advisor / Work Supervisor:
15. Educational Background including all degrees received, major field of study, institution, and year the degree was completed or you expect to complete it. *Example: PhD in Biology from the UiT The Arctic University of Norway, 2014*
16. Please describe your research background. *Maximum 500 words.*
17. What is the title of your current research project? *E.g. Master / PhD thesis*
18. Please write an abstract of the content of your current research project. *Maximum 500 words.*
19. Please send us your CV. *The CV should be no longer than 3 pages including publications. Please send your file as PDF and name it the following way "FirstName_LastName_MOSAiC2019".*

MOSAiC School Application

20. Statement of interest why you are interested in joining the MOSAiC School 2019, how the expedition is connected to your project and how participating might benefit your future career development. *Maximum 500 words.*
21. What experience do you have with communicating science and how would you communicate the MOSAiC project as a MOSAiC ambassador after the expedition? *Maximum 500 words.*
22. What MOSAiC Team do you feel mostly related to?
23. As you will be helping the MOSAiC teams set up their equipment on the ice, we need to know which team you would like to join.
    Atmosphere
    Sea Ice
    Ocean
    Biogeochemistry
    Ecosystem
24. What previous experience do you have doing research on a ship? *If you have none, please write "none".*
25. I confirm that I have read and understood the entire MOSAiC School announcement including the requirements for participants.

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