

Glaciers, Icebergs and Sea Ice Dynamics in the Arctic: The Contribution of Remote Sensing Technologies

By Line Rouyet, Norut Northern Research Institute

A good understanding of glaciers, icebergs and sea ice dynamics is essential for the management of shipping operations under arctic conditions and the interpretation of environmental processes in a context of climate change.

This requires consistent datasets and long time series that can be challenging to acquire in harsh and remote arctic areas. In this context, the development of remote sensing technologies provides new opportunities in the mapping and monitoring of the cryosphere and the Arctic Ocean.

Norut Northern Research Institute is contributing to research in this field and has been part of several projects in Ny-Ålesund for the collection and analysis of data over Kongsfjorden and Kronebreen, including activities related to CIRFA (Centre for Integrated Remote Sensing for Arctic Operations), Arctic EO (Arctic Earth Observation and Surveillance technologies), Fram Centre Flagship, the NRC-SSF funded projects “Terrestrial radar interferometry for monitoring tidewater glaciers” and “The CalvingSEIS Experiment”. The projects included national collaborations with NTNU, NPI, UiT, UiO, as well as various international partners.

These projects have different specific missions and objectives but a common vision: to develop robust remote sensing techniques suitable for

challenging arctic conditions and combine the value of satellite, airborne and ground-based datasets for the interpretation of the interactions cryosphere-hydrosphere-atmosphere.

In spring (April-May) and summer (August-September) 2015-2016, Norut performed campaigns including Unmanned Aircraft Systems (UAS, or drone) flights over the fjord and the glacier, and ground-based radar (Gamma Portable Radar Interferometer - GPRI) acquisitions from the shore. Pictures of these instruments are presented in *Fig. 1*.

The UAS missions are remote-controlled from the Norut base station at the Havnerabben airport (in blue in Fig.2), while the ground-based radar has been set up along the shore between Ny-Ålesund and Kronebreen. Between 2015 and 2016, Norut performed tens of flight missions over the fjord and the glacier. In September 2015 and August 2016, the GPRI has been installed close to the glacier front to monitor in priority its activity. In April 2016, the GPRI base camp has been set up further North-West in order to image a larger portion of the fjord (in red in Fig.2). Images are acquired every 2 minutes, during 4 days in September 2015, 5 days in April 2016 and 8 days in August 2016.

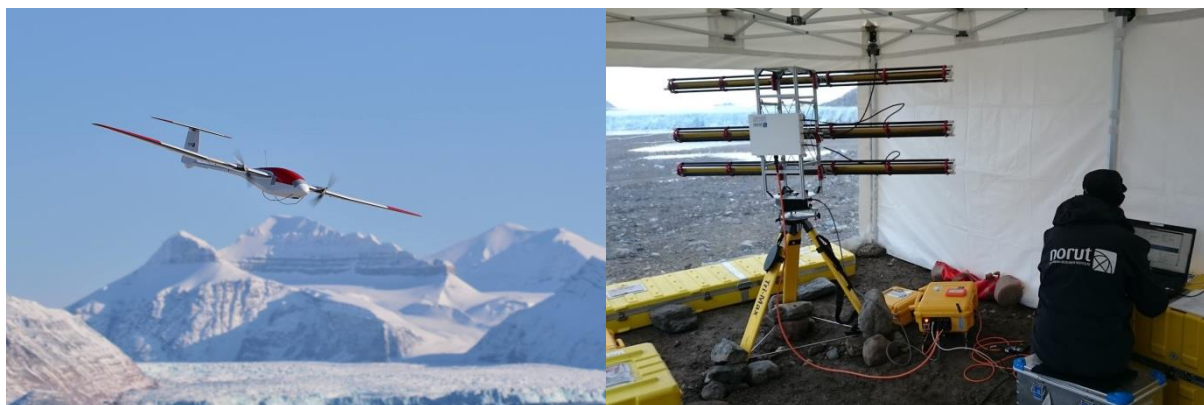


Fig. 1: Left: Norut Unmanned Aircraft Systems instrumented by camera for flight missions over Kongsfjorden and Kronebreen. Right: Gamma Portable Radar Interferometer (GPRI) owned by Norut acquiring images every 2 minutes. Photos: Pål Kvaløy, NTNU and Line Rouyet, NORUT.

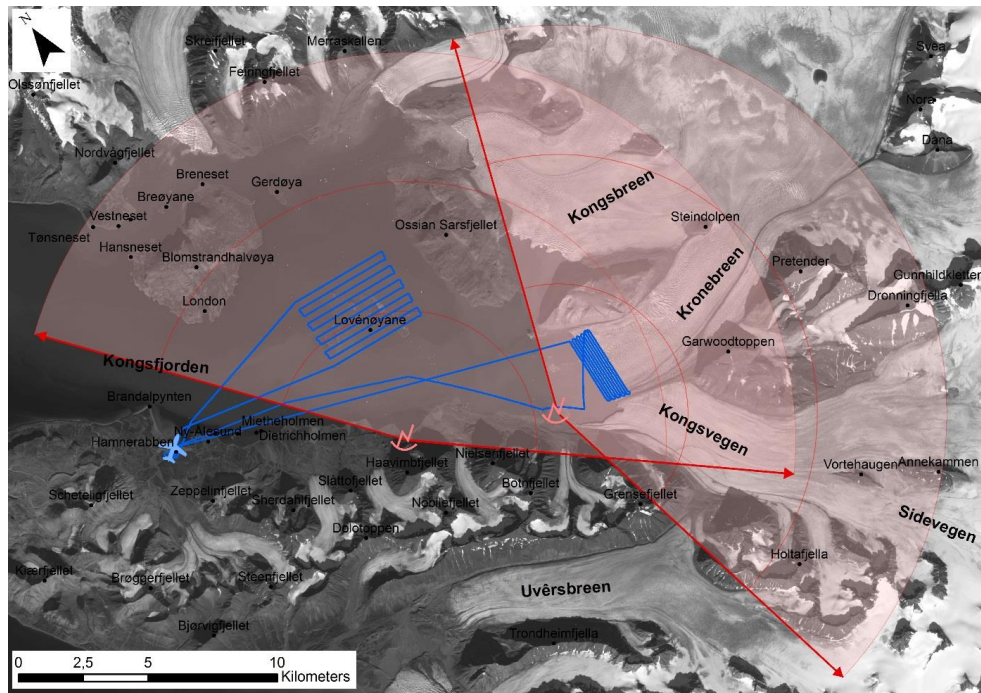


Fig.2: Location map: Landsat satellite image from August 2016, 2 examples of flight tracks over the fjord and the glacier front (in blue) and GPR base camps and view angles (in red).

UAS imaging over the fjord allows icebergs and sea ice to be detected and characterized (see Fig.3a). Thanks to the large set of images over the glacier front (see Fig.3b), high-resolution orthophoto (see Fig.3c) and digital elevation models can be generated.

The GPR images provide complementary information about the location and evolution of icebergs and sea ice on the fjord (see Fig.3c). On the glacier front, an inventory of the major calving events and velocity maps can be generated (see Fig.3d).

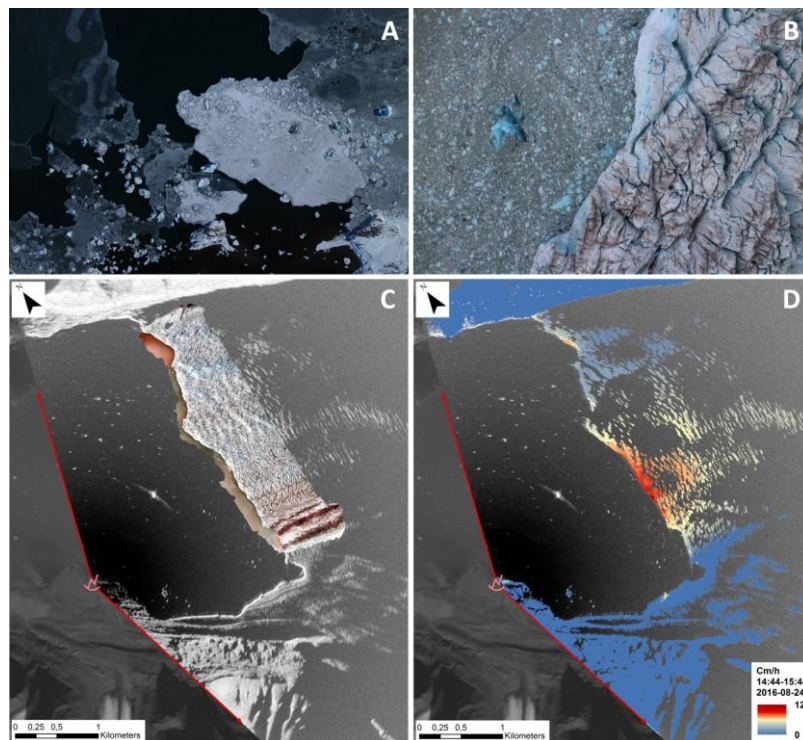


Fig.3: a) Example of UAS image over the fjord (April 2016); b) Example of UAS image of the glacier front (August 2016); c) Example of UAS orthomosaic over an intensity GPR image at the glacier front (August 2016); d) Example of GPR velocity map over the glacier (August 2016).

Thanks to partnerships with other national and international institutions, the datasets can be compared and combined with in-situ data, complementary remote sensing data, and interpreted by experts in glaciology, oceanography and sea-ice.

The results highlight the great potential of remote sensing technologies in Svalbard and the value to combine satellite, airborne and ground-based devices to provide complementary spatiotemporal coverages and resolutions, as well as integrate the different advantages of each system.

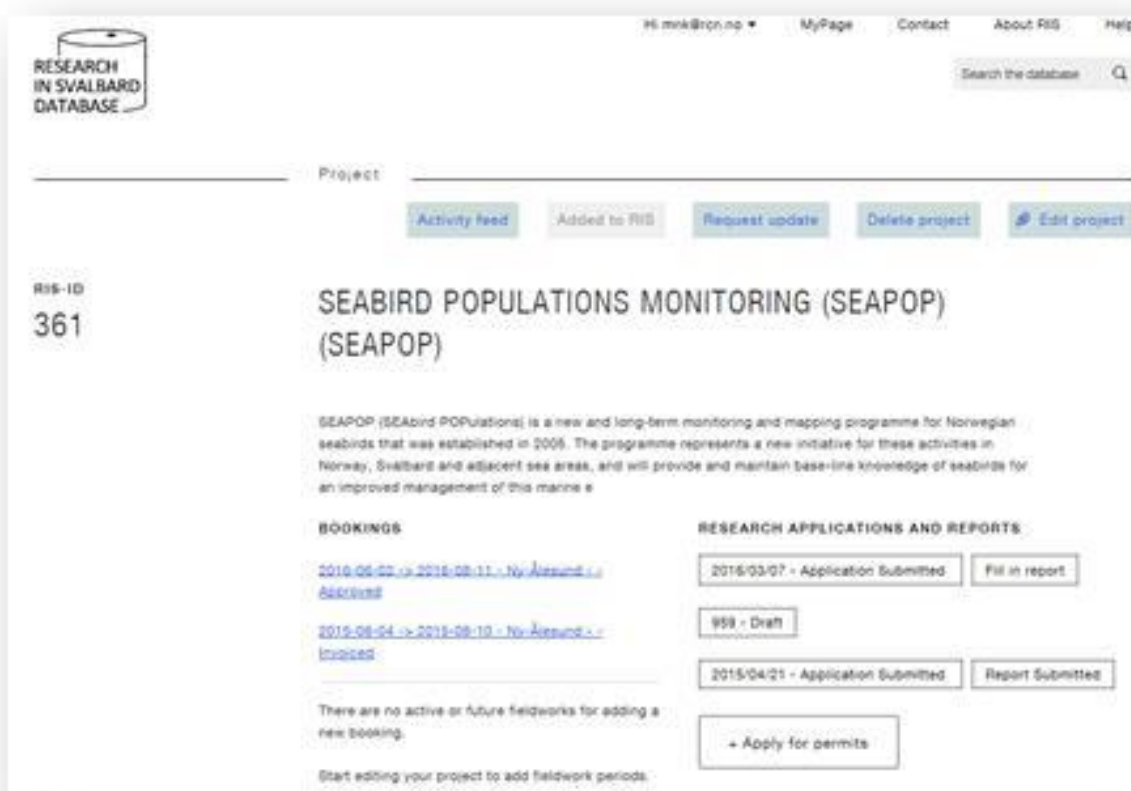
News from Svalbard Science Forum

By Margrete N.S. Kayser, SSF

RiS/ SSF News

On 25 October, RiS reached a new level. Researchers already apply for permissions to The Governor of Svalbard through the RiS portal. From end October they can also report on the permission through RiS.

On the project page there is now a section called "Research applications and reports" where the project owner has the possibility to fill in reports on the various applications that have been submitted.



Visit to Ny-Ålesund

Last week (week 45) Margrete Keyser from SSF was in Ny-Ålesund to visit and have meetings with Kings Bay and the station leaders wintering in Ny-Ålesund. The prime object of this trip was to inform about the RiS database and learn how it is working for the users in Ny-Ålesund. It is very

valuable for SSF to meet the researchers and station leaders in Ny-Ålesund as well as Kings Bay. Thanks' to Kings Bay for a nice time, and we are still waiting for the winter that has not arrived just yet..!

Memorial Workshop for the 25th Anniversary of the Japanese Arctic Research Station “RABBEN” in Ny-Ålesund, Svalbard

By Daisuke Goto, Arctic Environment Research Center/National Institute of Polar Research, Japan

The National Institute of Polar Research (NIPR) held an international workshop entitled “The 25th Anniversary Workshop on High Arctic Research in Svalbard – Towards the Next-stage International Collaboration” on September 7, 2016, in Kongsfjordhallen to commemorate the 25th anniversary of the foundation of the Japanese Research Station in Ny-Ålesund. The Station was founded in April 1991 and was the first Japanese permanent observation station in the Arctic Circle (Lat. 66.5° N), as well as the first research station of the Asian countries in Ny-Ålesund. We have conducted continuous observations of greenhouse gases and aerosols in the atmosphere, ecosystem surveys in the Arctic Circle, and other scientific research.

65 participants attended the workshop, including Dr. Nalân Koç (Research Director Norwegian Polar Institute), Mr. Ole Øiseth (Director Kings Bay AS), Mr. Shun'ichi Suzuki and Ms. Yoko Kamikawa (members of the House of Representatives in Japan, Japanese Parliamentary League of Arctic Frontier Study), Ms. Kazuko Shiraishi (Ambassador in Charge of Arctic Affairs, Japan) and Mr. Ryuichiro Shirama (Deputy Director-General, Research and Development Bureau, Ministry of Education, Culture, Sports, Science and Technology, Japan) hosted as the guests of honour. They emphasized in their speeches the role of the Ny-

Ålesund Research Station and the necessity of the continuous support by Japanese government to develop research activities in the station.

Dr. Hiroyuki Enomoto (Director, Arctic Environment Research Center, NIPR), Dr. Kim Holmén (International Director, Norwegian Polar Institute), Dr. Roland Neuber (Science Coordinator AWIPEV-Base, Alfred Wegener Polar Institute, Germany), Dr. Ole Jørgen Lønne (Interim Director, SIOS Knowledge Centre, University Centre of Svalbard) and Dr. Marzena Kaczmarek (Research Advisor, Kings Bay AS) presented their research results and the types of observations expected in the future.

Furthermore, there were discussions on the current status of international cooperation on research and observation in the Arctic. After the workshop, the icebreaker was held at the same venue, and the guests of honour had the opportunity to talk with the participants (researchers during their stay in Ny-Ålesund, etc.). We hope that the discussions at the workshop will inspire our future collaboration in Ny-Ålesund.

Acknowledgement:

We are grateful to Kings Bay AS for kind supports to hold this workshop.



Group photo at the workshop (photo: Takara Teramura)



Japanese Research Station "RABBEN" (photo: Masataka Shiobara)

Ny-Ålesund Flagship related workshops and activities this fall

By Christina A. Pedersen, Norwegian Polar Institute

The Norwegian Polar Institute have, together with partners, initiated several Ny-Ålesund Flagships related workshops this fall. First out was the Atmosphere Flagship workshop, consisting of a series of six work group meetings arranged in Kjeller the first week of October. Second was the Kongsfjorden Flagship workshop on Adaptation to Climate Change in Tromsø in mid-October. Third was the Ny-Ålesund Mass Balance workshop arranged in Oslo in early November, and last, the workshop on taking the next step in Svalbard snow research, arranged in Gothenburg in mid-November.

Common for all four was the focus on collaborative future activities, such as common publications, field-activities and future proposals. All, except from the last one, was financed through the Svalbard Strategic Grant, administrated by Svalbard Science Forum under the Research Council of Norway.

The eventful fall, started with six work group meetings among the atmospheric scientists. 55 scientists from 14 countries discussed topics spanning from clouds and aerosol, via the boundary layer down to snow. Some concrete outputs were the formation of "task-groups" for specific activities, planned on-site meetings, joint publications, collect and publish list of available

metadata, work on common data processing procedures, and work towards making available relevant homogenized open-access forcing data from Ny-Ålesund for modelling studies. This, and much more interesting information is available on the [Atmosphere Flagship webpage](#).

The Kongsfjorden System scientists, 24 in number, from 11 countries, discussed the adaptation to environmental changes in Kongsfjorden over two full days. Topics included limits of adaptation, responses in the system, and winners and losers of the changes. From the workshop, the idea to submit a proposal for the Svalbard Strategic Grant to follow up on some of the initiatives were formed. Indeed, a proposal aimed at addressing the impacts of climate change on Arctic coastal ecosystem functioning, structuring and integrating the research in the Marine Kongsfjord Flagship program along the priorities related to adaptive responses to environmental change in the Arctic, was submitted in November. More on this and other things can be found on the [Kongsfjorden System webpage](#).

The glaciologists, mainly from five international groups studying glacier mass balance in the Ny-Ålesund area, met to promote better collaboration and cooperation between the groups, and to integrate the field studies with modelling efforts

through including selected members of the Svalbard modelling community. One of the expected results is to generate a first draft of a paper, summarizing and integrating all mass balance measurements made over the common period. For next year, there is a plan to arrange a similar workshop involving the main contributors on the whole of Svalbard. This and other stuff can be found on the [Glaciology webpage](#).

Snow, the field that connects all environments and flagships in Ny-Ålesund, had a follow-up workshop: *Taking the next step to the Svalbard snow research* after their originally SSG-financed pilot-initiative Community Coordinated Svalbard Snow Sampling. The workshop's participants wrapped up results from the pilot, including discussions on the common snow sampling from seven glaciers in Svalbard, made a publication plan, as well as discussing the next steps.

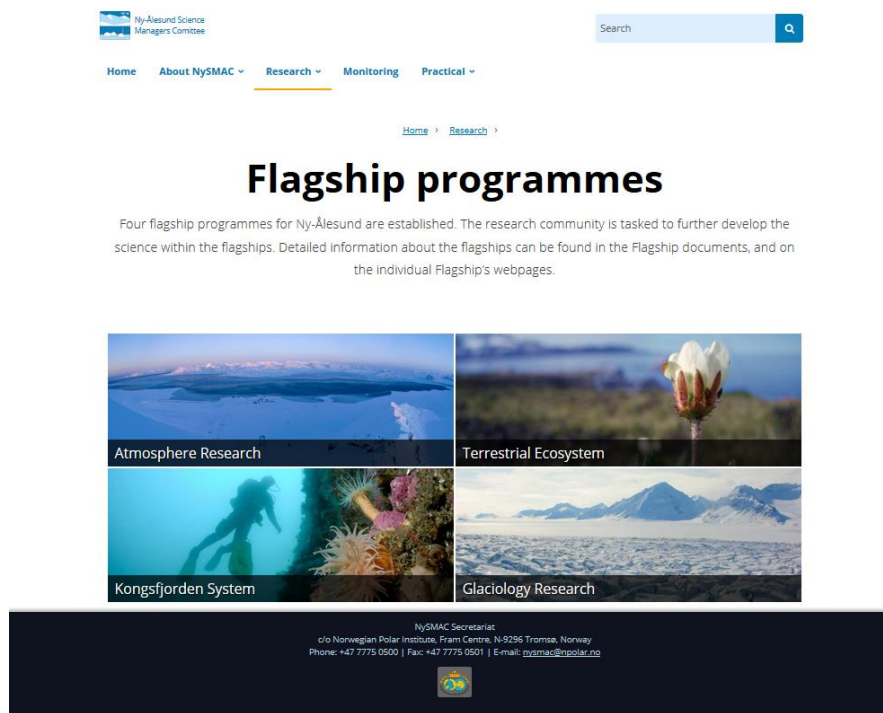


Fig. 1: This is where it happens: The webpage of NySMAC and the four Ny-Ålesund Flagships <http://nysmac.npolar.no/research/flagships/>



Participants (joined to meet the polar bear) from the Kongsfjorden Flagship workshop in Tromsø in October 2016. Photo: Elin V. Jensen, NPI.

A soil organic carbon map of Midtre Lovénbreen glacier foreland

By Ji Young Jung and Yoo Kyung Lee, Korea Polar Research Institute

With global warming, glaciers in the high Arctic have been rapidly retreating, resulting in the exposure of new land. In the proglacial environment, microorganisms and plants settle down, followed by the accumulation of soil organic carbon (SOC). Studies conducted in glacier forelands have tended to mostly focus on the chrono-sequential change of soil, plants, and microorganisms since glacier recession. However, ecosystem development over a glacier foreland is not only affected by time, but also by several environmental factors in a dynamic way, such as runoff activity of glacier streams. In the proglacial environment, SOC accumulation could represent the degree of soil/ecosystem development. SOC can also have impact on the establishment of subsequent heterotrophic microorganisms as their food source and on plants' growth through control of environmental conditions such as nutrients, moisture, etc. Hence, to understand the dynamic changes of the proglacial environment, our research team has been studying the distribution of SOC in the glacier foreland and the relationship between SOC distribution and other environmental factors.

Since the end of the Little Ice Age, Midtre Lovénbreen glacier has been retreating at an average rate of 12 meters per year. At the foreland of the Midtre Lovénbreen, our research site, several ecological studies have been conducted, such as soil development, vegetation and microbial succession.

However, all approaches were based on the line transect sampling method except one vegetation map produced in 2005 (Moreau and others). They produced a vegetation map with a consideration of microtopography, runoff activity, several other abiotic factors as well as glacier retreat period. Thus, we followed the same approach of them to look at SOC development in the whole glacier foreland.

Our results showed that SOC stock for 30 cm depth ranged from 1.5 to 15.4 Mg/ha in the foreland of Midtre Lovénbreen. The amount of SOC stock was greatly affected by the amount of gravel in soil. Among several vegetation-related parameters, the occurrence of vascular plants was closely related to SOC quantity. Moreover, the site, which has been affected by runoff at least once, showed very low content of SOC. Thus, glacier/snow meltwater would have washed out previously established vegetation and accumulated SOC. We are currently trying to produce a map of SOC stock and will continue to verify our model to estimate SOC stock in other glacier forelands. Understanding the relationship between SOC quantity and environmental parameters will allow us for a comprehensive perspective of the ecosystem development.

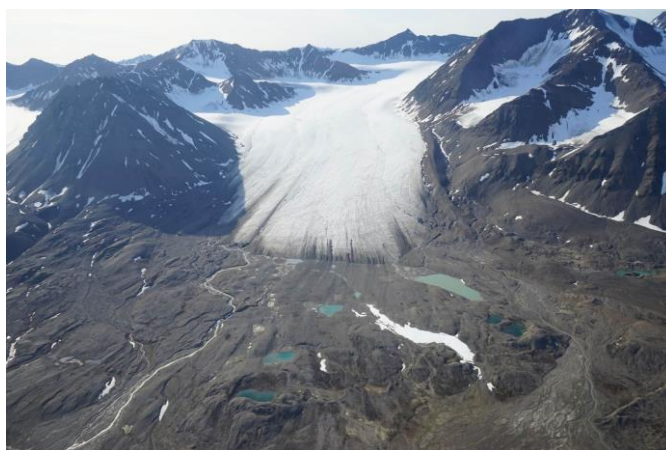


Fig. 1. Glacier foreland of Midtre Lovénbreen. Photo: Yoo Kyung Lee, KOPRI

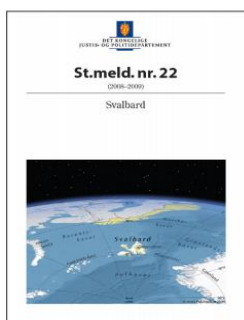


Fig. 2. Soil development since glacier retreat

News from Kings Bay AS

By Marzena Kaczmarek, Kings Bay AS

Big headlines



The Government of Norway's Svalbard White Paper was published this year. Kings Bay AS will have a new owner as of 1 Jan 2017. Climate and Environment Ministry takes us under their wing.

2016 high-profile events

The 2016 Ny-Ålesund Symposium

A few days ago, the Ny-Ålesund Symposium 2016 was concluded. From the 19th to the 21st of September, 40 to 50 people from around the globe gathered in the newly completed Kongstord hall to discuss topics related to Planet Ocean.



Every year, Ny-Ålesund is honored with high-profile visitors from the governments and highly ranked organizations in the world. In 2016 the US secretary of state – John Kerry came to Ny-Ålesund accompanied by Norway's minister of foreign affairs – Børge Brende.

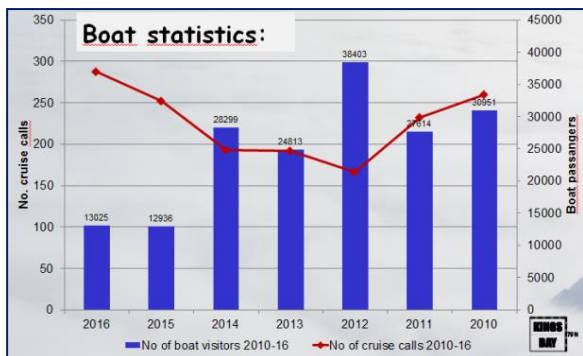


The main point for the visit was to see the climate change effects in the Arctic up close, and to meet with the climate change scientists during their fieldwork here. The Ny-Ålesund symposium, hosted by Per Sandberg, Norway's minister of fisheries, and attended by the Symposium's patron, H.R.H. Crown Prince Haakon, took place in September.



Furthermore, the Ny-Ålesund community had the pleasure to celebrate 25th anniversary of the Japanese NIPR research station and the German AWI research station in Ny-Ålesund this year.

Less cruise ships, more small boats



With the large cruise ships gone from Kongsfjorden, the number of tourists drastically dropped and remains at around 13,000 passengers per year level in both 2015 and 2016 sailing seasons.

At the same time, the number of small boats has increased to just below 300 this year.

Official opening of the museum



The residents and scientists of Ny-Ålesund attended the museum opening in October. The exhibition focuses on the history of Ny-Ålesund, both a mining town, a scientific focal point in the last 50 years and a starting point to reach the North Pole in 1920s.

The new exhibition is financed by Svalbard Environmental Fund, The Ministry of Foreign Affairs, Kings Bay, Svalbard Museum, and private contributor Per Kyrre Reymert. Stein Domaas has designed the exhibition, Per Kyrre Reymert, Svalbard Museum, and Kings Bay AS contributed with texts, pictures and practical work.

Finalized projects at Kings Bay in 2016



heavy machinery indoors during the winter months has been a long-standing necessity for Kings Bay. This is to minimize the damaging weather effect on the equipment during winter.

London 3 and 4 were upgraded with access to running water. "Gruvebadet", the clean air laboratory, was rescued from construction breakage due to melting permafrost and placed on pillars drilled into solid rock. This work caused a 2.5-month-long break in measurements period. The remaining drilling will continue in March/April 2017, and a break of 2-3 weeks at most, should be the last one for a long time in the future.



Kings Bay building plans for 2017

The renovation and building work continues in 2017. Gruvebadet needs final stabilization, and London 4 should have interior finished in the summer.

“Skutergarasjen” will be renovated to provide a few more accommodation alternatives in town. SvalRak plans to have a second rocket launch pad ready before winter 2017/2018.

Additional funds in 2017 are earmarked for the new common research facility. The work is scheduled to start in summer the coming year.

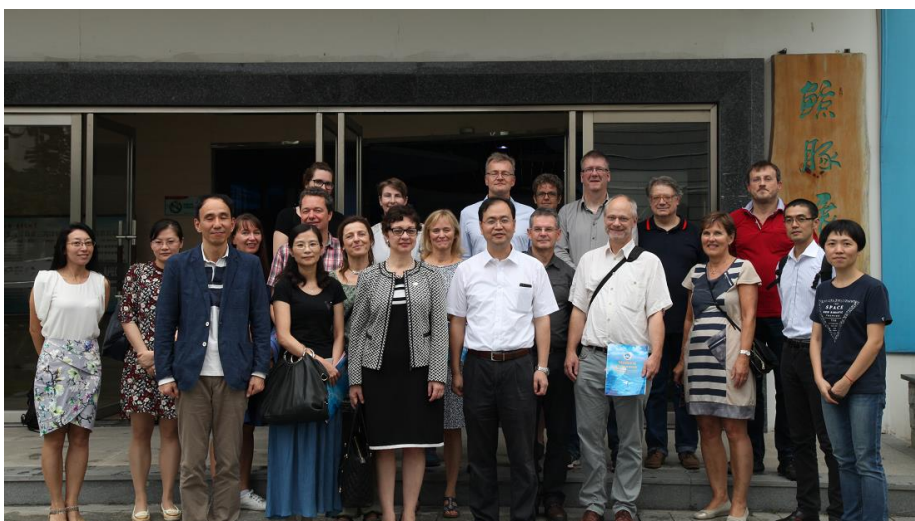


All photos in this section: Kings Bay AS.

Topics from the 45th NySMAC meeting in China

Topics from the previous NySMAC meeting held in Xiamen, China 19-21 October 2016:

- The Svalbard White Paper
- Information from Kings Bay AS
- Svalbard Science Forum work report
- Information on research permissions
- Svalbard management plan for North-West Spitsbergen
- Ny-Ålesund as a radio silent area
- SIOS update
- INTERACT II update
- Report from Ny-Ålesund flagship's activities
- Election of vice-chair



The NySMAC participants and employees from The Third Institute of Oceanology gathered outside the TIO building in Xiamen. Photo: Li Xintian, TIO.

Prior to the NySMAC meeting, the participants visited the Third Institute of Oceanology (TIO) in Xiamen with presentations and discussion about their Arctic research and the collaboration with the international scientific community. Furthermore, the TIO staff showed us their facilities including laboratories and exhibitions.

A half-day workshop on the Ny-Ålesund Flagships was arranged before the NySMAC meeting started. 30 Chinese scientists from 15 agencies attended together with the NySMAC members. The flagships were presented and followed by discussion.



NySMAC members visiting TIO



Christina A. Pedersen presenting the Ny-Ålesund flagships.

Input to Ny-Ålesund Newsletter

If you would like to contribute to future editions of this newsletter, please e-mail nysmac@npolar.no. Any ideas or suggestions for topics are also welcome. *Editor: Ingrid Halsebø Storhaug, NySMAC Secretariat. Next edition: May 2017.*

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