

# **Centre for Polar Studies**

TOWARDS  
BETTER UNDERSTANDING  
OF POLAR REGIONS



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BETTER UNDERSTANDING  
OF POLAR REGIONS

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Core writers:  
Piotr Głowacki, Dariusz Ignatiuk, Jacek Jania, Elżbieta Łepkowska

Editorial board:  
Marek Kubicki (editor-in-chief), Agata Goździk, Mariusz Grabiec, Dariusz Ignatiuk, Joanna Legeżyńska, Piotr Łepkowski, Anna Ostrowska, Wojciech Piotrowski, Joanna Potrykus, Anna Wielgopolan



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# Table of Contents

Introduction ..... 7

1. The Centre for Polar Studies ..... 8

2. The Centre in the context of Polish and international polar research ..... 12

3. Development and achievements of the Centre for Polar Studies ..... 15

    Underwater acoustic signatures od glacier calving ..... 18

    Svalbard reveals a new island ..... 20

    Freshwater in a salty fjord ..... 22

    Between genetics and palaeontology: ancient DNA in  
    palaeoceanographical research ..... 24

    Influence of glacial disturbance and food availability on organisms size  
    in Kongsfjorden and Hornsund fjords ..... 26

    Message in a stainless steel bottle thrown into deep geological time ..... 28

4. Technical facilities and infrastructure for polar research ..... 30

5. Interdisciplinary Polar Studies ..... 33

    Foundations of ISP ..... 33

    Profiles of doctoral thesis ..... 36

6. Exploration of Polar and Mountain Regions – a new speciality of MSc studies  
    at the Faculty of Earth Sciences, University of Silesia ..... 84

7. Science communication and dissemination ..... 96

8. Towards the future ..... 100



# Introduction

It seems to be apparent that researching the Earth's polar regions is extremely important for understanding the functioning of the environmental system on our planet. While the beginnings of polar research were dominated by the rivalry between national expeditions and individual researchers in conquering and exploring the Arctic and the Antarctic, they started to interact in the second half of the 20th century. The organisation of the fourth International Polar Year (IPY) in 2007-2009 led to significant intensification of research activities in both polar regions as part of wide-ranging international cooperation. This largest and globally coordinated scientific venture attracted numerous research teams from Poland. The collaboration between the scientific centres in our country became closer and included both universities and the institutes of the Polish Academy of Sciences (PAS). The spirit of this cooperation and the willingness to continue the IPY explorations have paved the way for the creation of the Centre for Polar Studies (CPS) – the entity that also administers the Interdisciplinary Polar Studies (IPS) to provide top-quality education for young researchers.

The Centre for Polar Studies, established in November 2013 by the Faculty of Earth Sciences of the University of Silesia and two Institutes: Institute of Geophysics and Institute of Oceanology, Polish Academy of Sciences (PAS), is actively supported by numerous foreign research teams, with whom the Centre has been conducting joint research for many years now. The Centre also undertakes cooperation with new partners. Good collaboration and interdisciplinary nature of the projects are characteristic features of contemporary research on polar regions – and this research is also performed by the CPS. By acquiring the status of the Leading National Research Centre (KNOW) in the contest organised by the Ministry of Science and Higher Education in 2014, the Centre is able to undertake ambitious scientific projects which are closely linked to the education of young polar explorers.

Half a decade has passed since the Centre for Polar Studies started popularising science through academic work and teaching. This entity has perfectly blended into the landscape of Polish polar sciences. It is part of the Polish Polar Consortium (established in 2012) and is currently encompassing 17 higher education institutions and scientific bodies. It works closely with the Committee on Polar Research, Polish Academy of Sciences, for instance on organisation of important international conferences or on preparation of new international research programmes. It is also expanding its presence in the global science. Currently, the first graduates of the Interdisciplinary Polar Studies are obtaining their doctoral degrees in Earth Sciences.

This publication attempts to present the Centre's profile, the specific character of its activities and sample results of its research work. However, the most important are the people who create the Centre and the greatest attention is focused on them.

The Centre keeps on developing well – however, it is facing new challenges. Difficult tasks and obstacles to overcome are nothing unusual in polar research. Therefore, I firmly believe in the long-term success and further progress of the Centre for Polar Studies.

*Jacek Jania*  
*Head of the Centre for Polar Studies*  
*Chair*  
*of the Committee on Polar Research*  
*of the Polish Academy of Sciences*



# The Centre for Polar Studies

The Centre for Polar Studies (CPS) is an organisation aimed at consolidation and reinforcement of the research and scientific and educational potential of its partners.

The Centre was established by three institutions involved in polar research, namely the Faculty of Earth Sciences of the University of Silesia (FES UoS, the leading unit), the Institute of Geophysics PAS (IG PAS) and the Institute of Oceanology PAS (IO PAS). Based on many years of fruitful educational and scientific cooperation as part of international and national research projects, as well as on the contracts concluded, these institutions signed an agreement on the establishment of the Centre for Polar Studies in 2013. On May 15, 2014, the Minister of Science and Higher Education awarded the Centre with

the status of the Leading National Research Centre (KNOW) in Earth sciences for the years 2014-2018. The financial subsidy related to this prestigious status made it possible to support research, scientific and didactic activities, as well as the mobility and development of the Centre's research staff in the fields of geography, geology, geophysics, and oceanology.

The primary goal of the CPS is to develop further the interdisciplinary research of the natural environment in the Arctic and the Antarctic region. Furthermore, to provide more effective education to its young scientific staff through expanding



>> Prof. Lena Kolarska-Bobińska, the Minister of Science and Higher Education, awarding the status of the Leading National Research Centre (KNOW) to the management of the Centre for Polar Studies during the official gala held on 15 May 2014 in the Royal Łazienki residence in Warsaw



>> The Centre for Polar Studies puts strong emphasis on education through workshops and active participation in research – the photo shows workshops for young scientists on Spitsbergen (2015)

national and international cooperation with leading scientific centres in the field of interdisciplinary and specialised polar studies (the Interdisciplinary Polar Studies and the speciality in MSc studies – Exploration of Polar and Mountain Regions – EOPG).

The mission of the Faculty of Earth Sciences of the University of Silesia encompasses three strategic goals, namely the maintenance of strong and innovative research teams undertaking priority research for Earth sciences at an international level, the provision of a high standard of education, as well as active cooperation with scientific, social and economic environments.

The Institute of Geophysics PAS is an entity involved in scientific and research activities in geophysical sciences. At the same time, it constantly monitors global geophysical fields, seismic events and selected atmosphere parameters in Poland and abroad. Moreover, the Institute extensively cooperates with higher education institutions, research institutes and scientific societies, especially in the field of research and development works, supporting education and development of scientists and specialists with specific qualifications in geophysical sciences,

including such areas as hazard forecasting, risk assessment and emergency management.

The mission of the Institute of Oceanology PAS is to conduct basic research of the marine environment and deepen the knowledge about the phenomena and processes occurring therein. The Institute conducts research on the Baltic Sea and in the European part of the Arctic.

The main body of the CPS is the Board of Directors responsible for the operational programme of the Centre, approving the assumptions of joint projects and strategic orientations.

It is composed of two representatives from each partner entity, including the Head of the CPS, whose primary tasks – besides managing the daily activities of the Centre – include representation of the CPS at the international arena, as well as reporting of and supervision over the fulfilment of the Centre's strategic goals. The activities of the Board of Directors and the Head are supported by the CPS Office located at the Faculty of Earth Sciences of the University of Silesia, acting in close cooperation with CPS coordinators in two institutes of the PAS.



## In 2013-2018, the Board of Directors of CPS was composed of:



**Prof. Jacek A. Jania**

Head of the CPS, Faculty of Earth Sciences,  
University of Silesia



**Prof. Piotr Głowacki**

Member of the CPS Board of Directors,  
Institute of Geophysics PAS



**Assoc. Prof. Tymon Zieliński**

Member of the CPS Board of Directors,  
Institute of Oceanology PAS



**Prof. Adam Idziak**

Member of the CPS Board of Directors in the years  
2013-2017, Faculty of Earth Sciences,  
University of Silesia



**Prof. Paweł Rowiński**

Member of the CPS Board of Directors in the years  
2013-2016, Institute of Geophysics PAS



**Prof. Janusz Pempkowiak**

Member of the CPS Board of Directors in the years  
2013-2018, Institute of Oceanology PAS



**Prof. Leszek Marynowski**

Member of the CPS Board of Directors since 2017,  
Faculty of Earth Sciences, University of Silesia



**Assoc. Prof. Mariusz Majdański**

Member of the CPS Board of Directors  
since 2016, Institute of Geophysics PAS



**Prof. Jan Marcin Węslawski**

Member of the CPS Board of Directors since  
2018, Institute of Oceanology PAS

Another important body is the Scientific Board of the Centre for Polar Studies, which has an advisory role towards the Board of Directors. It is composed of six eminent scientists representing various fields of Earth sciences. The Council is responsible, amongst others, for issuing opinions on the scientific strategy and the Centre's reports, counselling on the scientific and didactic plans, as well as issuing opinions on the applications of visiting professors and applications for the post-doc positions.

## Members of the CPS Scientific Board



**Prof. Jon Ove Methlie Hagen**

Department of Geosciences,  
Faculty of Mathematics and Natural  
Sciences, University of Oslo,  
Norway



**Prof. Francisco Navarro**

Professor of Applied Mathematics,  
Universidad Politécnica de Madrid,  
President of the International  
Glaciological Society, Spain



**Prof. Ursula Schauer**

Alfred Wegener Institute  
for Polar and Marine Research  
Bremerhaven, Germany



**Prof. Andy Hodson**

University Centre in Svalbard (UNIS)  
and Western Norway University  
of Applied Sciences, Norway



**Prof. Ole Jørgen Lønne**

Department of Arctic Biology,  
University Centre in Svalbard (UNIS),  
Longyearbyen, Norway



**Prof. Robert Ettema**

College of Engineering,  
Colorado State University,  
United States

### Coordinators of the Centre for Polar Studies in the units of the PAS

**Dr. Joanna Legeżyńska** at the Institute of Oceanology PAS

**Ms. Anna Ostrowska** at the Institute of Geophysics PAS since 2016

**Mr. Wojciech Piotrowski** at the Institute of Geophysics PAS till 2016

### Office of the Centre for Polar Studies

**Dr. Dariusz Ignatiuk** – Office Manager at the CPS

**Mr. Michał Ciepiły** – Promotion and school contact coordinator

**Ms. Edyta Kądziała** – Specialist for the service of the  
Interdisciplinary Polar Studies

**Dr. Łukasz Małarzewski** – IT and database specialist

**Dr. Michał Laska** – KNOW contest specialist

**Dr. Maja Lisowska** – Coordinator of the IASC Scholarship  
Programme and the support of young scientists

**Ms. Elżbieta Łepkowska** – Contact coordinator with the media  
and foreign institutions, webmaster

**Mr. Adam Ziegler** – Finance and inter-institutional cooperation  
coordinator

**Ms. Jolanta Ziółowicz** – Specialist for the service of the Explo-  
ration of Polar and Mountain Regions (EOPG) MSc speciality of  
studies, voluntary work



## Chapter 2

# The Centre in the context of Polish and international polar research

The key achievement of the Centre for Polar Studies (CPS) is the intense development of research activities, which reinforces its position as an important scientific centre acting as the leading entity in Poland, with a significant presence at the international forum.

The achievements of the CPS in the field of innovative research include effective initiatives concerning new international research programmes and projects, as well as the creation of international scientific networks. The characteristic feature of these activities is the demonstration of clear gaps in the knowledge about the polar environment and the changes occurring therein from the holistic and interdisciplinary perspectives. It is worth to mention two of the international initiatives undertaken by the CPS:

**The multidisciplinary snow cover research programme in the Arctic** was initiated during the Arctic Science Summit Week (ASSW) 2015 in Toyama (Japan). With reference to this initiative, an international interdisciplinary group of young researchers was established, which organised the workshop entitled *Taking the next step in Svalbard snow research* on 1-4 September 2015 at the University of Silesia, featuring the representatives of 15 scientific units from nine countries. A project proposal entitled *Community Coordinated Snow Study in Svalbard – C2S3* was prepared, which was granted a subsidy by the Research Council of Norway – within Svalbard Strategic Grants. Within these activities, the CPS co-organised the workshop entitled *Taking the next step in Svalbard snow research – Phase II*, which was held on 9-11 November 2016 in Gothenburg, Sweden. Simultaneously, there was a nationwide consolidation of teams researching the snow cover on Svalbard. The seminar in Sosnowiec organised on 14-15 October 2015 by the CPS and the Polish Polar Consortium (PKPol) resulted in the development of the *Polish Snow Research Programme on Svalbard*. It was presented the following year in March at the ASSW



>> Examining the snow cover on Spitsbergen

2016 in Fairbanks, Alaska, where it was incorporated in the interdisciplinary IASC programme entitled *Cutting Barriers in Snow Knowledge*. An element of broader international cooperation in the field of snow research was contribution to the report entitled *Protocols and recommendations for the measurement of snow physical properties, and sampling of snow for black carbon, water isotopes, major ions and microorganisms*, which was carried out by a team composed of Jean-Charles Gallet, Mats P. Björkman, Catherine Larose, Bartłomiej Luks, Tõnu Martma, and Christian Zdanowicz. The report was published at the beginning of 2018 by the Norwegian Polar Institute.

**The research programme concerning changes in tidewater glaciers in the Arctic scale** is intended to define the directions of their evolution and the role in raising the level of the global

>> Polish delegation at the Arctic Circle Assembly 2017 in Reykjavik



ocean. It was notified by Prof. Jacek Jania and incorporated in the activities of the IASC Network on Arctic Glaciology in January 2016. The steering group with the participation of CPS researchers prepared an international seminar entitled *The importance of calving for the mass budget of Arctic glaciers*, held on 15-17 October 2016 in Sopot under the auspices of the Centre and the IASC, featuring specialists from several leading centres from nine countries. The meeting launched the preparation of an international pan-Arctic programme. The research programme on the importance of calving (ablation in contact with sea water) for the mass budget of glaciers at the pan-Arctic level, launched by convening the above-mentioned seminar in Sopot by the CPS, was continued as part of a separate session during the *Workshop on the Dynamics and Mass Budget of Arctic Glaciers & the IASC Network on Arctic Glaciology Annual Meeting* in Bethel, Maine (the United States), which was held on 23-25 January 2017.

An institutional confirmation of the CPS's importance worldwide is the location of the secretariat section of the International Arctic Science Committee (IASC) for the support of young scientists (IASC Fellowship Program) and the secretariat of the Polish Polar Consortium in the Centre's office in Sosnowiec, as well as the participation of the CPS's representatives in international working groups and scientific decision-making bodies. For example, Assoc. Prof. Mariusz Grabiec is a representative

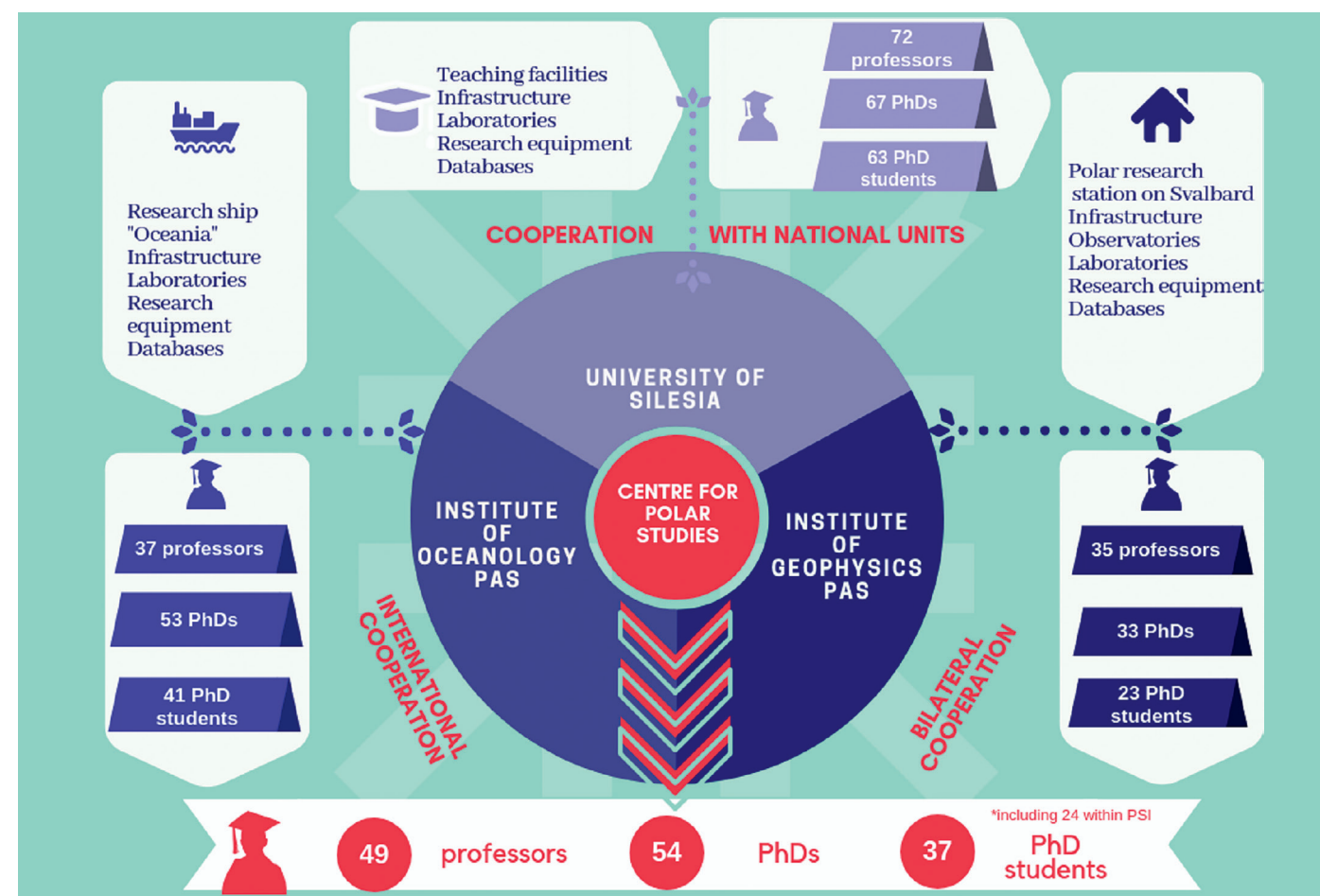
of Poland at IASC Cryosphere Working Group, Prof. Jacek Jania is a member of European Polar Board, Prof. Piotr Głowacki is a member of Svalbard Science Forum and Forum of Arctic Research Operators (FARO), while Prof. Jan Marcin Węslawski is a member of IASC Marine Working Group. Representatives of the Center also work in groups and monitoring data sharing bodies, e.g. Sustained Arctic Observing Networks Committee on Observations and Networks (SAON).

The Centre's employees offer their expertise during the preparation of opinions and documents, expert reports and consultations for the Ministry of Foreign Affairs (MSZ) regarding Poland's participation as an observer state in the works of the Arctic Council – AC. During the last meeting of the representatives of the Council's observer states with the representative of the United States Presidency in the AC, within the framework of the *Warsaw Format Meeting* organised on 8 April 2016 by the Ministry of Foreign Affairs in the Belvedere in Warsaw, the CPS researchers delivered three speeches and took active part in the discussion on the reinforcement of scientific cooperation in the Arctic. It is also the information for the Ministry of Foreign Affairs about Polish scientific activities in the Arctic and the Antarctic that is prepared by the employees of the Centre's units, for example those working in the Committee for Polar Research of the Polish Academy of Sciences. For instance, they helped the delegates from the Ministry of Science and Higher Education to prepare for their

participation in the *White House Arctic Science Ministerial* on 28 September 2016 in Washington, at the special invitation of the American side. The performance of all these activities means that the intellectual potential and the international position of the Centre have become a key element in building the image of Poland within the framework of science diplomacy.

A significant element in enhancing the good image and international reputation of the CPS was the participation in the fifth annual congress – the Arctic Circle Assembly 2017 – which took place on 13-15 October 2017 in the Harpa Conference Centre in Reykjavik, Iceland, attracting more than 2,300 participants from over 50 countries. Poland's multi-faceted participation in this event was prepared by: the CPS, the PKPol and the Com-

mittee on Polar Research of the Polish Academy of Sciences, with a significant financial support from the Ministry of Science and Higher Education. The meetings of the Arctic Circle –with a political, scientific and business profile – are prepared by a non-profit organisation having the same name, founded and managed by the former president of Iceland, Dr. Olafur Ragnar Grimsson. Thanks to the efforts of the Head of the CPS, who is a member of the Advisory Board to the Arctic Circle, and with the support of the Ministry of Science and Higher Education, Poland was for the first time entrusted with one of the prestigious plenary sessions – the so-called Country Session (15 October 2017), entitled *Poland and the Arctic*.



## Chapter 3

# Development and achievements of the Centre for Polar Studies

The Centre's strategic goals have been achieved through teaching as well as through strengthening the international cooperation and the HR potential.

In 2014-2018, the CPS achieved great success in acquiring new research grants within the EU Research and Innovation Programme "Horizon 2020", bilateral programmes, and national programmes. A special system was created to intensively support researcher's mobility, increase their qualifications and intensify international collaboration (Approximately 450 persons, including employees, PhD candidates and students benefited from the system). This contributed to significant reinforcement of the HR potential, manifested through new scientific degrees and titles, as well as acquisition of foreign employees. The projects that gained funding in open calls included scientific proposals, proposals concerning cooperation in the use of research and monitoring infrastructure, as well as some which are mainly dedicated to science communication and education.

The units forming the CPS are involved in a series of international programmes, the most important of which are:

- **INTAROS – Integrated Arctic Observations System** – the main purpose of the project is to create an effective, integrated system for Arctic observations through extending, streamlining and optimising the existing systems present in various regions across the Arctic. The project assumes optimal use of the existing platforms and measurement systems, as well as extensive databases containing the results of current observations of the atmosphere, the ocean, the cryosphere and inland areas. The participants of the project include the Institute of Oceanology PAS, the Institute of Geophysics PAS, and the University of Silesia (UoS).

- **EDU-ARCTIC (Horizon 2020, 2016-2019)** – pan-European educational programme coordinated by the Institute of Geophysics PAS, focused on using Arctic research as a vehicle to strengthen science education curricula and encourage students to pursue scientific careers. It offers, amongst other, online classes conducted by scientists, environmental monitoring and an online polar encyclopaedia available in several languages.



- **ERIS (Erasmus+, 2015-2018)** a programme coordinated by the Institute of Geophysics PAS, using the results of scientific research, including research conducted in the vicinity of the Polish Polar Station Hornsund, in order to increase students' interest in Mathematics and natural sciences and in a scientific career. It offers ready-to-use packages of educational materials that enable teachers and students to work with data collected by scientists.



- **ACTRIS-2 (Horizon 2020, 2015-2019)** – a Europe-wide infrastructure for analysing aerosols, clouds and trace gases in order to acquire better understanding of the related processes in the atmosphere. ACTRIS promotes scientists' mobility and provides them with access to measurement data and leading laboratories. One of the project's participants is the Institute of Geophysics PAS.





• **AtlantOS** – a project aiming to create a sustainable, financially effective and multidisciplinary observation system on the Atlantic Ocean. The current loosely coordinated structure offers limited possibilities of analysing observations in the particular disciplines and long-term cooperation between the disciplines. The research groups interested in using the measurement platforms in Europe may benefit from the project. One of the project's participants is the Institute of Oceanology PAS.



• **INTERACT – International Network for Terrestrial Research and Monitoring in the Arctic** (Horizon 2020, 2016-2020) – an international consortium of 47 institutions dealing with polar research in 83 research stations in the Arctic and in the high-mountain areas of Europe and Asia. It provides scientists from all over the world with the opportunity to conduct scientific research in selected bases. One of the project's participants is the Institute of Geophysics PAS.



• **SIOS – Svalbard Integrated Arctic Earth Observing System** – a programme for conducting long-term international observations of land and aquatic environments, as well as of the climate in the area of the Svalbard archipelago. Institute of Geophysics PAS participates in the programme. As an element of the SIOS, the Polish Polar Station Hornsund can be found on the Polish and European Roadmap for Research Infrastructures.



• **Assemble Plus – Association of European Marine Biological Laboratories Expanded** – a consortium combining 33 marine stations and institutes with modern research infrastructure from 14 European and associated countries. The programme is intended to provide scientists from academia and industry with access (both physical and virtual) to marine networks of biological stations in Europe and beyond. One of the project's participants is the Institute of Oceanology PAS.



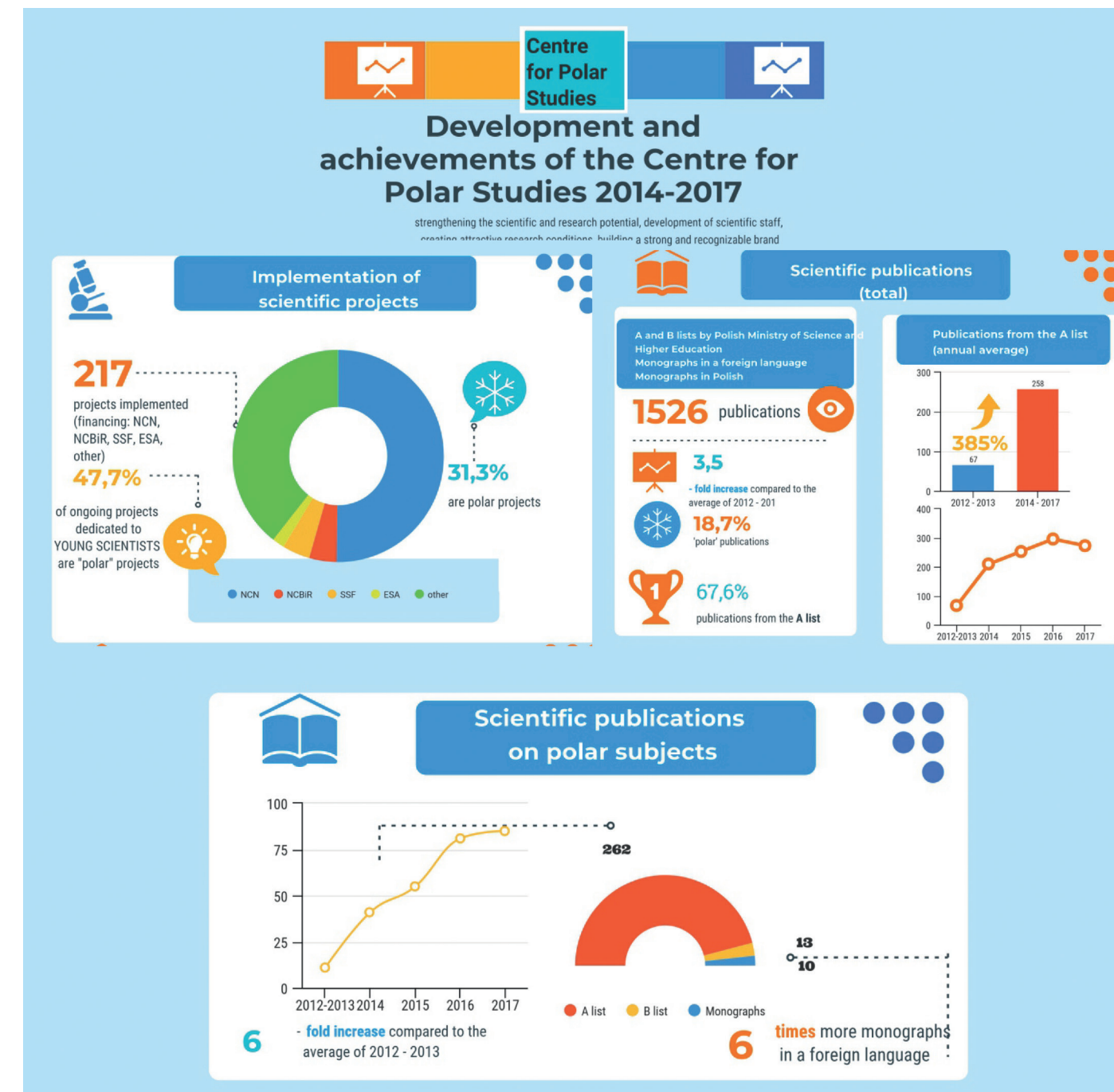
• **REACT – Growth-ring record of modern extreme weather phenomena in the Low Arctic** – a project concerning extreme climatic conditions in the low Arctic, recorded in the annual growth of woody plants in the tundra. Within the framework of the grant executed through international cooperation, dendro-climatological analyses are being conducted in such countries as Iceland and Canada. They will result in the reconstruction of the climate change occurring in the Atlantic sector of the Arctic over the past centuries. The project's leader is the University of Silesia.

• **Sea Data Cloud** – Further developing the pan-European infrastructure for marine and ocean data management – an international infrastructure for processing various oceanographic and atmospheric data collected by 56 research institutions. Its objective is to optimise the connections between data centres and integrate with other European and international networks. One of the project's participants is the Institute of Oceanology PAS.



The strength of the Centre is strongly manifested through its scientific publications that are a good measure of the quality and relevance of the research conducted by the employees from the constituent units of the CPS. In 2014-2017, the average annual number of scientific publications in the CPS institutions increased 3.5 times in relation to the average from 2012-2013. The increase in the number of publications on polar subjects is even more spectacular. The development of the scientific staff and the support for research in this area contributed to a 6-fold increase in the average number of publications compared to the years preceding the establishment of the CPS. It is worth noting that over 90% of all the publications on polar issues are included in the top-ranked journals, according to the Ministry of Science and Higher Education (so called **A list**).

The range of subjects discussed in those publications is extremely diverse. It is impossible to mention all of them here. Therefore, we have decided to choose only six of them, which are very important and illustrate the scope of the research conducted in the units of the CPS. Their brief descriptions are provided on the following pages.



# Underwater acoustic signatures of glacier calving

Geophysical Research Letters, 42(3), 804–812, 2015

Oskar Głowacki<sup>1</sup>, Grant B. Deane<sup>2</sup>, Mateusz Moskalik<sup>1</sup>, Philippe Blondel<sup>3</sup>, Jarosław Tęgowski<sup>4</sup>, Małgorzata Błaszczuk<sup>5</sup>

**Does the recording of underwater sounds during calving of glaciers allow to estimate the loss of their mass? How to study underwater calving of glaciers?**

Rapid melting of tidewater glaciers is one of the most spectacular consequences of ongoing climate changes. When losing their mass, glaciers release enormous amounts of fresh water into the world ocean, which brings about an increase in water level and poses a direct threat to people inhabiting the coasts. Decreased water salinity causes significant changes in the circulation of great ocean currents, which not only affects the living conditions of plankton, fish, birds and sea mammals, but also, for example, influences local weather conditions in regions lying thousands of kilometres away from the Arctic.

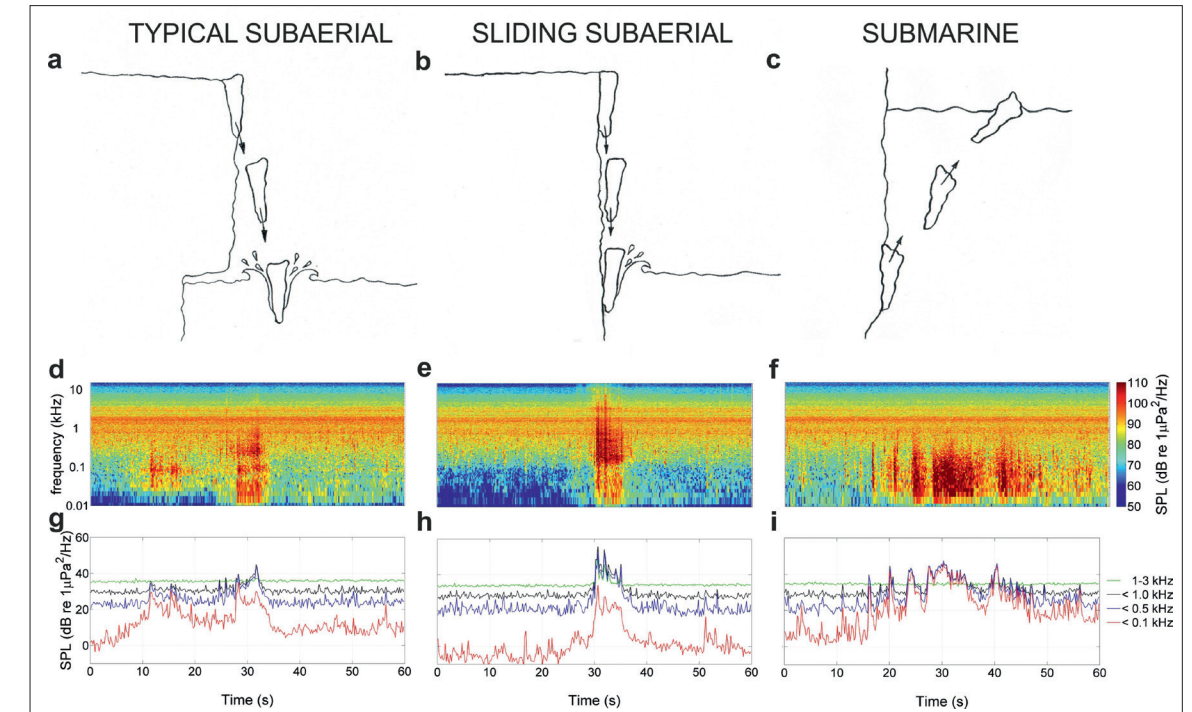
Studying the rate of glacier shrinking at the ice-ocean boundary is one of the priorities of modern environmental studies. Conditions existing in glacier bays, however, constitute a serious obstacle to taking measurements. Apart from the low air temperature, strong winds and frequently high waves, the biggest risk are the glaciers themselves. Particularly dangerous is the process of glacier calving, in which huge blocks of ice break from the glacier cliff in a totally unpredictable manner. The estimation of glacier mass loss through calving requires the use of remote sensing methods, which make it possible to stay at a safe distance from the glacier. As a result, it is a considerable challenge. Satellite methods are commonly used for the purpose, but the frequency in which photographs are taken, their spatial resolution, and fog patches frequently occurring over glacier bays make it impossible to follow the process of glacier calving with any degree of precision. Many researchers make use of seismic methods, which involve the analysis of tremors caused by glacier calving. So far, however, no correlation has been found between the size of ice blocks breaking from the glacier and the energy of the seismic signal. An alternative to seismology is passive underwater acoustics. The method in-

volves recording and analysing sounds propagating under water, after which their characteristic features are compared with the process by which the sounds were generated.

The aim of the studies conducted in the Hornsund fjord, Spitsbergen, was to correlate the calving of Hans Glacier with underwater sounds generated during the process. Time-lapse photographs taken during each of the observed calving events made it possible to estimate the size of ice blocks. The suggested model of correlation between the potential energy of a falling block of ice (closely related to the glacier mass loss) and the acoustic energy generated during a calving event explains as



>> Hans Glacier Cliff, Hornsund fjord, Spitsbergen.



>> Diagrams of three types of calving (a-c), corresponding spectrograms (d-f) and frequency-averaged sound pressure levels, calculated after applying a low-pass (black, blue, red) and bandpass (green) Butterworth filter

many as 93% of variability in real data. This means that in the future it will be possible to use acoustic methods to monitor the mass loss of tidewater glaciers on a continuous basis in a relatively cheap way and without the regular presence of observers. The analysis of underwater sounds generated within the fore-field of Hans Glacier showed that acoustic methods may also be used to study underwater calving, during which blocks of ice break from the submerged, and thus invisible, part of the glacier cliff, close to the seafloor. These processes have not been properly studied yet, even though they pose a considerable risk to ships and boats passing through areas adjacent to glacier fronts, as icebergs may unexpectedly appear on the surface of the water at any time. Moreover, the process is also responsible for releasing a considerable amount of sediment to the waters of polar fjords, which changes their physico-chemical properties. Presently, there are no reliable data available on glacier mass loss resulting from underwater calving.

The results of this research received considerable media attention and information on the topic appeared, among others, on BBC News, NPR Radio, National Geographic and Deutschlandfunk.

<https://doi.org/10.1002/2014GL062859>

<sup>1</sup>Institute of Geophysics, Polish Academy of Sciences, Warsaw, Poland

<sup>2</sup>Scripps Institution of Oceanography, UCSD, La Jolla, California, USA

<sup>3</sup>Department of Physics, University of Bath, Bath, UK

<sup>4</sup>Institute of Oceanography, University of Gdańsk, Gdynia, Poland

<sup>5</sup>Faculty of Earth Sciences, University of Silesia, Sosnowiec, Poland

Read the paper:





# Svalbard reveals a new island

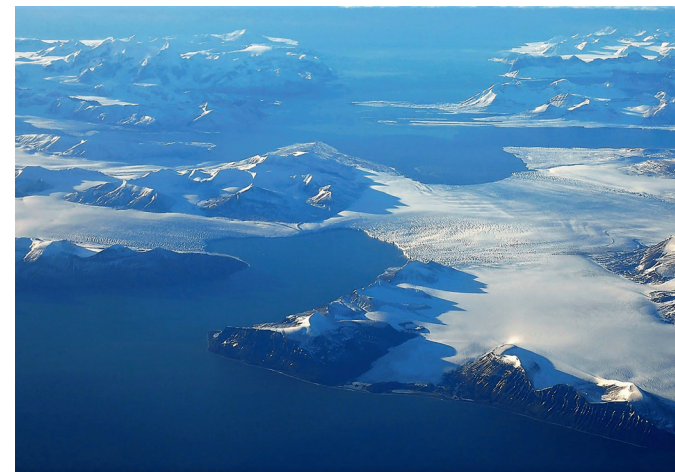
**Original title: Coast formation in an Arctic area due to glacier surge and retreat: the Hornbreen-Hambergreen case from Spitsbergen**  
**Earth Surface Processes and Landforms, 43, 387–400, 2018**

Mariusz Grabiec<sup>1</sup>, Dariusz Ignatiuk<sup>1</sup>, Jacek A. Jania<sup>1</sup>, Mateusz Moskalik<sup>2</sup>, Piotr Głowacki<sup>2</sup>, Małgorzata Błaszczyk<sup>1</sup>, Tomasz Budzik<sup>1</sup>, Waldemar Walczowski<sup>3</sup>

**Is the existence of the Hornsund fjord only temporary? Will the retreat of glaciers flowing to this fjord transform it into a strait and the area south of it will become the new island of Svalbard?**

Around mid-May 1610, a ship belonging to the Muscovy Trading Company entered the uncharted waters along south-west Spitsbergen. A group sent to the coast returned with a piece of reindeer antler and Captain Jonas Poole wrote in the ship's log: "I called this sound Horne Sound". This is how, over 400 years ago, the name "Hornsund" appeared on maps. Even though the etymology of the name is clear, many find it surprising that – in contrast to a number of other Svalbard bays formed by glaciers and called, quite simply, "fjords" (e.g. Isfjorden) – the largest form of the sort in the southern part of Spitsbergen became known as a sound. After all, the term *sound* carries a double meaning: on the one hand, it may refer to a bay (e.g. Plymouth Sound), and on the other – a strait (e.g. The Sound, separating the Scandinavian Peninsula from Denmark). In the case of Hornsund, the ambiguity inherent in the term clearly indicates the transitory character of this topographic form.

Today, Hornsund is a typical fjord, whose surface area and shoreline undergo continuous evolution as a result of changes in the extent of the fourteen glaciers that flow into it. The largest of them, Hornbreen, closes the fjord from the east. Since the end of the 19th century, i.e. the period during the Little Ice Age (LIA) when glaciers reached their maximum extent, the front of Hornbreen has retreated by about 14.2 km and, as a result of deglaciation, the surface area of the fjord has seen an average annual increase of 1.3 km<sup>2</sup>. Glacier retreat means that the



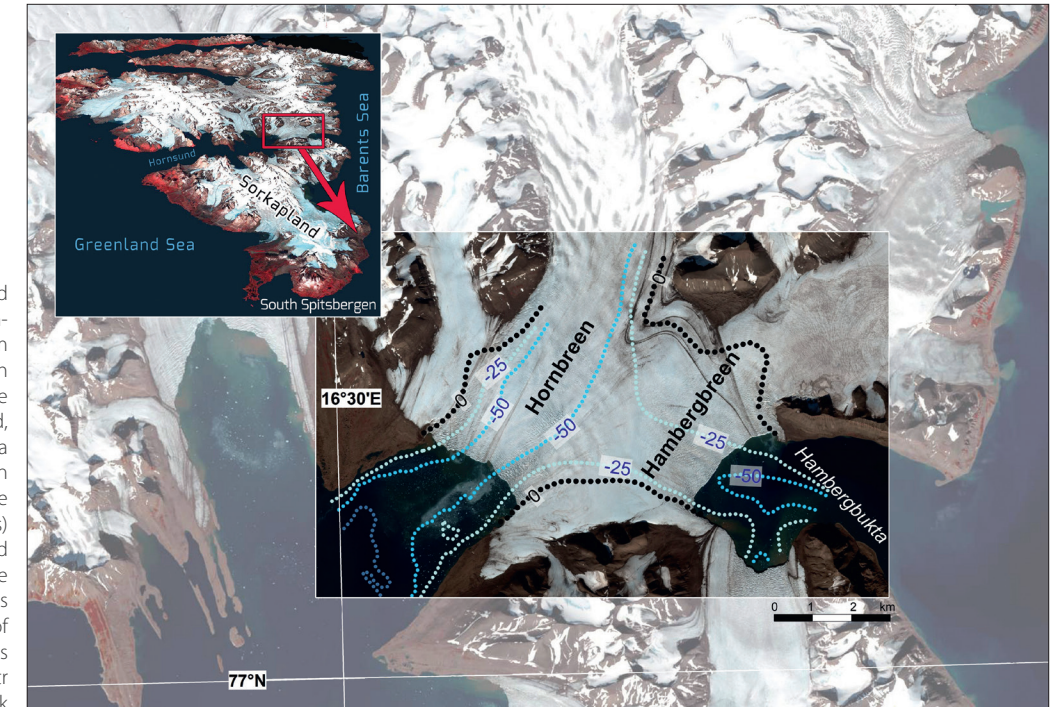
>> Airplane westbound view on the Hambergreen and Hornbreen in October 2018. In the foreground, the Barents Sea, in the background – the Hornsund fjord

distance between Hornsund and the Barents Sea is gradually decreasing. Currently, it is less than 6 km. Further deglaciation may cause bedrock to emerge from under the ice and if it forms a continuous depression below sea level, the two bodies of water will connect, separating Sørkapp Land from the rest of Spitsbergen. Measurements of glacier thickness involving the use of radar sounding, which were conducted by British, Norwegian, Finnish and Polish teams in the years 1980 and 2000, did not

Watch the animation on the island's formation:



>> Inner part of the Hornsund fjord is occupied by the Hornbreen-Hambergreen glacier system (area marked with red rectangle). If the current pace of the recession is maintained, glaciers will disappear from this area in about 40-50 years. Modern bathymetry and topography of the glacier's base (marked with dotted lines) indicate that the channel will appear, and Sørkapp Land and Spitsbergen will be separated. Satellite images come from the archive of University of Silesia, Faculty of Earth Sciences  
 Prepared by: Elżbieta Łepkowska, Piotr Łepkowski, Arkadiusz Piwowarczyk



confirm the existence of a continuous channel running below sea level under the glaciers. However, the location of bedrock close to the sea level coupled with the range of error in the obtained results meant that such possibility could not be decisively ruled out.

In 2013 and 2014, a team from the Centre for Polar Studies KNOW made new radar soundings in the area of Hornbreen-Hambergreen and on glaciers feeding into the system. Having analysed about 40 km of radar profiles, they did not find a single obstacle that would hinder the flow of water through the channel formed between the Greenland and Barents Seas once the glaciers have retreated. Under the ice bridge formed by the two glaciers lies a wide depression, lower by 30-40 m than the level of the sea. The estimated depth far exceeds the standard error of radar measurements of glacier thickness (max.  $\pm 11.9$  m). The depressions stretches along the axis of the glaciers, 15 km from the current location of Hornbreen-Hambergreen fronts, and its lowest identified point lies over 70 m below sea level.

A simulation based on the contemporary rate of glacier re-

treat indicates that the ice between Sørkapp Land and the rest of Spitsbergen may disappear between the years 2055 and 2065. As a result, the southern part of Spitsbergen will become separated and will thus form the fourth largest island in the Svalbard archipelago, with the area of about 1260 km<sup>2</sup>. Apart from geographical consequences, the event will bring about significant changes in ocean circulation and an evolution of land and marine ecosystems.

The ambiguity inherent in the word *sound* is therefore very fitting for Hornsund – a fjord which is gradually becoming a strait.

doi: 10.1002/esp.4251

<sup>1</sup>Faculty of Earth Sciences, University of Silesia in Katowice, Poland

<sup>2</sup>Institute of Geophysics, Polish Academy of Sciences, Poland

<sup>3</sup>Institute of Oceanology, Polish Academy of Sciences, Poland

Read the paper:





# Freshwater in a salty fjord

Original title: Freshwater input to the Arctic fjord Hornsund (Svalbard)  
Polar Research, in press

Małgorzata Błaszczyk<sup>1</sup>, Dariusz Ignatiuk<sup>1</sup>, Aleksander Uszczyk<sup>1</sup>, Katarzyna Cielecka-Nowak<sup>1</sup>, Mariusz Grabiec<sup>1</sup>, Jacek A. Jania<sup>1</sup>, Mateusz Moskalik<sup>2</sup>, Waldemar Walczowski<sup>3</sup>

How to analyse the quantity of freshwater input to the Arctic fjords, coming from various sources, such as calving glaciers, snowmelts or atmospheric precipitation during global warming that causes increased melting and recession of glaciers as well as increased quantities of liquid precipitation in the Arctic?

The Arctic is an area which has experienced the most rapid temperature growth over the past 100 years. Observations in the Hornsund fjord located in the south of Spitsbergen point to an increase in air temperatures by 1.03°C in each decade in the period from 1979 to 2015. This fact has a huge impact on the glaciers situated in Svalbard, which have been significantly receding since the beginning of the 20th century, thus providing increased quantities of freshwater to the environment. In water bodies where the circulation of water is hindered, such as the Arctic fjords, an increase in the supply of freshwater may alter the hydrology and hydrodynamics of the fjords, as well as affect the sedimentological processes and the ecosystem. The location of the glacier’s cliff is also important due to the fact that it constitutes the feeding zone for seabirds and other animals.

The Hornsund fjord is an ideal field laboratory, which can be used to estimate the annual input of freshwater to the fjord. The 1,200 km<sup>2</sup> catchment area of the Hornsund fjord is covered with glaciers in approx. 67%, with the 14 glaciers flowing into the sea representing 97% of the total ice cover in the catchment area. The Authors of the article attempted to estimate the quantity of freshwater input to the fjord, coming from surface melting of glaciers, ablation at the front (the calving of glaciers, i.e. detachment of icebergs from the glacier’s cliffs), solid (snow), mixed and liquid precipitation on the surface of the glaciers, the land and the fjord.

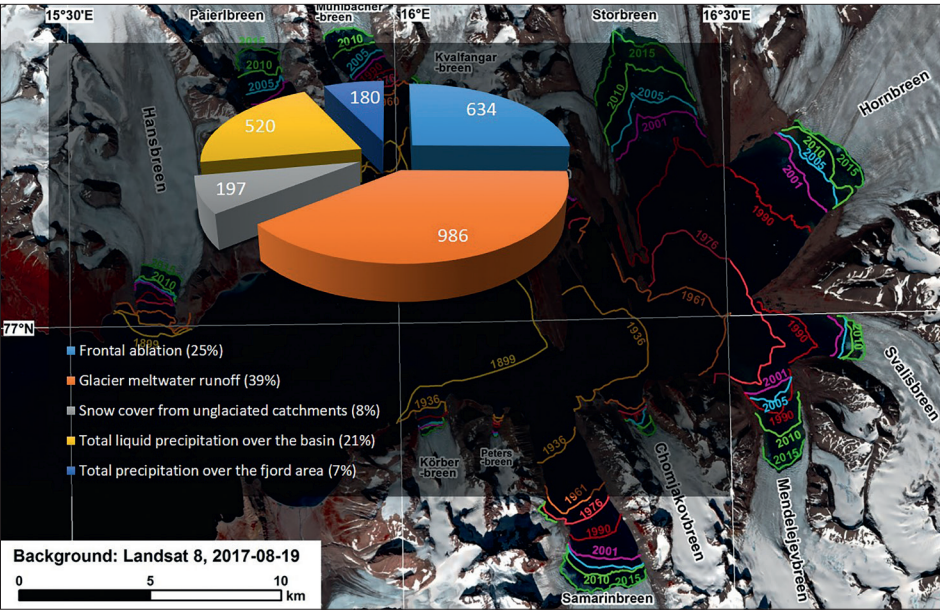
In order to determine the volume of icebergs that detach from the glacier, a wide range of data were used, encompassing remote



>> Field research by the CPS team

sensing data (satellite multispectral and radar images) and glaciological data (measurements of glacier dynamics). In situ data were mostly obtained during field works by the teams of the Centre for Polar Studies. The analysis results made it possible to determine the basic parameters necessary to estimate the size of calving, i.e. the average speed of the glacier’s movement, the glacier’s thickness on the cliff both in the under- and above-water part, as well as the glacier’s recession rate. It is worth noting that, compared to other sources of freshwater, only the calving process provides the fjord with water in a solid state.

>> The share of freshwater from different sources in the total of freshwater in the Hornsund fjord. The data in the graph refer to the amount of water [Mt/year]



Another source of freshwater, directly related to glaciers, is the water from glacier’s surface melting during the summer. Based on the data collected during the measurements on the ablation stakes mounted on the glaciers and the data derived from the World Glacier Monitoring Service (WGMS), estimation was made as to the quantity of freshwater flowing into the fjord both from the glaciers terminating on land and in the seawater.



>> The methods for estimating the quantities of freshwater supplied to the fjords were comprehensive and multi-faceted. Icebergs were also taken into account

The remaining components of the freshwater, linked to atmospheric precipitation, were calculated on the basis of spatial modelling using the data from the meteorological station in the Polish Polar Station Hornsund as well as from the field measurements of spatial distribution of snow cover.

The multi-faceted approach to the issue of freshwater input to the fjord in an interdisciplinary perspective paved the way for the first comprehensive quantitative and qualitative estimation of freshwater sources in the Hornsund fjord. The work also presents an innovative method for calculating the ablation of the front of a glacier (calving). The research pointed to a 64% share of glaciers and a 21% share of rainfall (with sporadic events of summer snow fall) in the total amount of freshwater reaching the fjord. In the age of global warming that causes increased surface melting and recession of glaciers as well as increased quantities of liquid precipitation in the Arctic, we can expect more far-reaching changes in the water balance of the hydrological basin of the Hornsund fjord.

<sup>1</sup>Faculty of Earth Sciences, University of Silesia in Katowice, Poland

<sup>2</sup>Institute of Geophysics, Polish Academy of Sciences, Poland

<sup>3</sup>Institute of Oceanology, Polish Academy of Sciences, Poland



# Between genetics and palaeontology: ancient DNA in palaeoceanographical research

Original title: Palaeoceanographic changes in Hornsund fjord (Spitsbergen, Svalbard) over the last millennium: new insights from ancient DNA

Climate of the Past, 12, 1459–1472, 2016

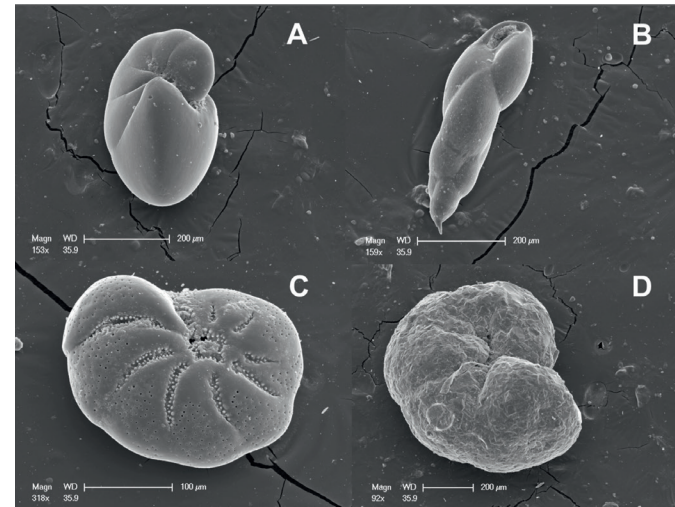
Joanna Pawłowska<sup>1</sup>, Marek Zajączkowski<sup>1</sup>, Magdalena Łącka<sup>1</sup>, Franck Lejzerowicz<sup>2</sup>, Philippe Esling<sup>2,3</sup>, Jan Pawłowski<sup>2</sup>

Can genetic research be used in palaeontology? Does the record of fossil DNA allow an indirect examination of past climate changes?

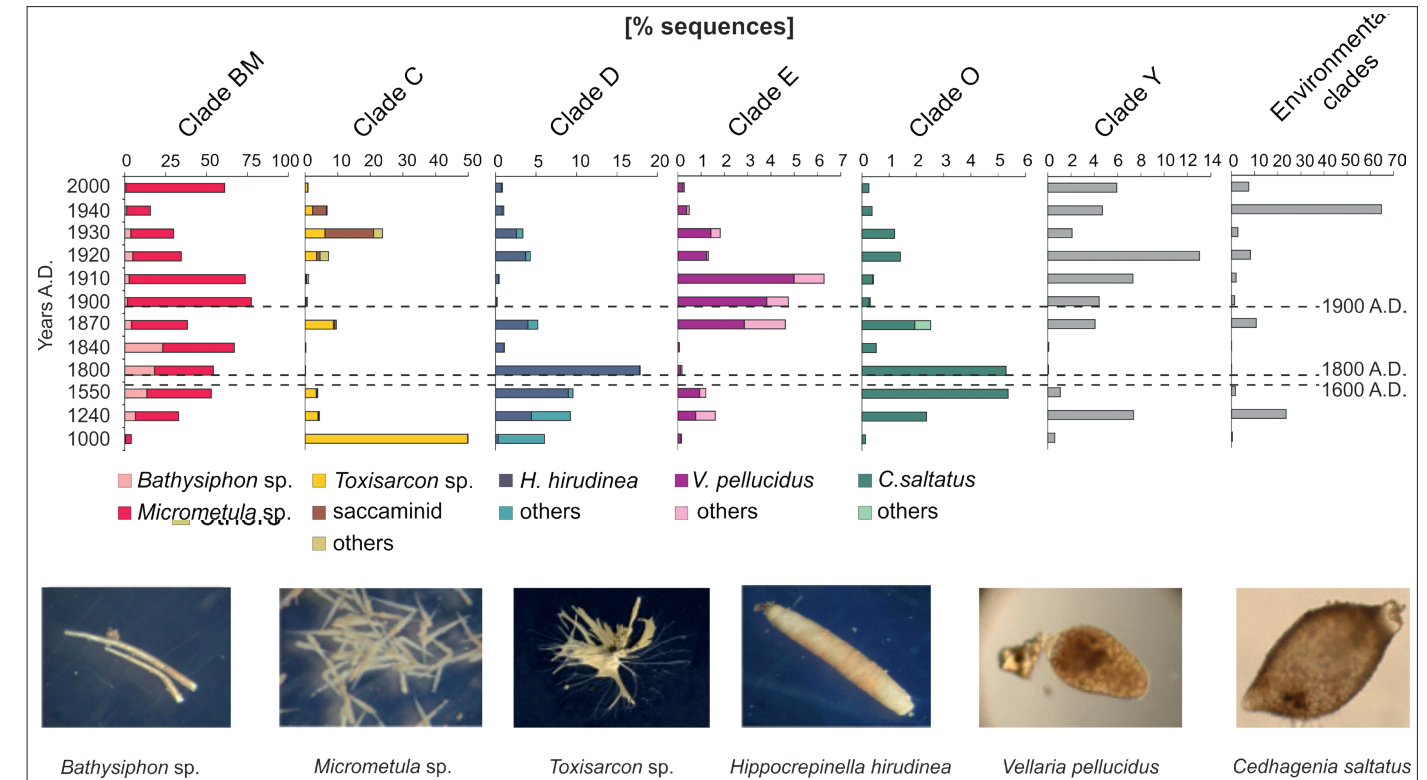
Currently, one of the greatest global challenges is to predict the direction of climate change. The Arctic is particularly important in this regard, as it constitutes one of the areas in the world that are most susceptible to climate change. However, in order to be able to effectively predict the effects of future climate and environmental changes, it is necessary to trace the history of those changes. Foraminifera are a group of single-celled eukaryotes commonly used as an indirect source of information about the paleoenvironment, i.e. the so called proxy, which is primarily due to the fact that numerous species show perfect preservation of tests in fossil records. The biodiversity of foraminiferal communities and the isotopic composition of their tests may be an indicator of such elements of the marine environment as temperature, salinity or productivity.

The paleoenvironmental research conducted to date on the basis of foraminiferal fossil records was limited to species with calcareous or agglutinated tests of a high fossilisation potential. However, in some types of marine environments, e.g. in polar regions, the foraminiferal fauna is dominated by soft-shelled species (*Monothalamea*), which are rarely encountered in fossil assemblages. The use of molecular approach allowed to provide a complete information about the foraminiferal communities, including the little known species belonging to *Monothalamea*. The analysis of fossil DNA records revealed hidden species richness of foraminiferal communities. The sequences of mon-

othalamous foraminifera represented a significant proportion (approx. 40%) of all sequences, and the presented research provided the first data on the biodiversity of this group in the past. The changes in the DNA record, especially in the area of soft-shelled foraminifera, correlated well with the environmental changes over the last millennium. This suggests that soft-shelled



>> SEM (scanning electron microscope) photos of foraminifera from the Hornsund fjord: A) *Nonionellina labradorica*, B) *Stainforthia* sp., C) *Elphidium clavatum*, D) *Cribrostomoides crassimargo*



>> The share of soft-shelled foraminifera sequences in the foraminifera population of the Hornsund fjord over the last 1,000 years (Pawłowska et al., 2016; modified). Source of the photographs: forambarcoding.unige.ch

species constitute an essential source of palaeoenvironmental information, revealing even minor changes that are not clearly indicated by the fossil record. There was a successful attempt to identify species that are potential indicators of such elements as glacier-proximal and glacier-distal zones, and high-productivity environment.

Paleogenetic methods represent a complementary source of information in the paleoenvironmental research and provide additional ecological information to that obtained with the use of classical proxy sources. Further implementation of new paleoenvironmental data in the research on climate and environmental changes may contribute to the development of molecular paleontology, encompassing not only the studies of foraminifera, but also of many other Eukaryotic groups which have no fossil records.

Read the paper:



<https://doi.org/10.5194/cp-12-1459-2016>

<sup>1</sup>Institute of Oceanology, Polish Academy of Sciences

<sup>2</sup>Department of Genetics and Evolution, University of Geneva, Geneva, CH 1211, Switzerland

<sup>3</sup>IRCAM, UMR 9912, Université Pierre et Marie Curie, Paris, France

# Influence of glacial disturbance and food availability on organisms size in Kongsfjorden and Hornsund fjords

Original title: Food and disturbance effects on Arctic benthic biomass and production size spectra  
Progress in Oceanography, 152: 50–61, 2017

Barbara Górška, Maria Włodarska-Kowalczyk

**Climate changes result in, inter alia, an increase in the inflow of freshwater and mineral material sedimentation in fjords. How does it affect the marine ecosystem, and in particular – how does it influence benthic fauna of fjords?**

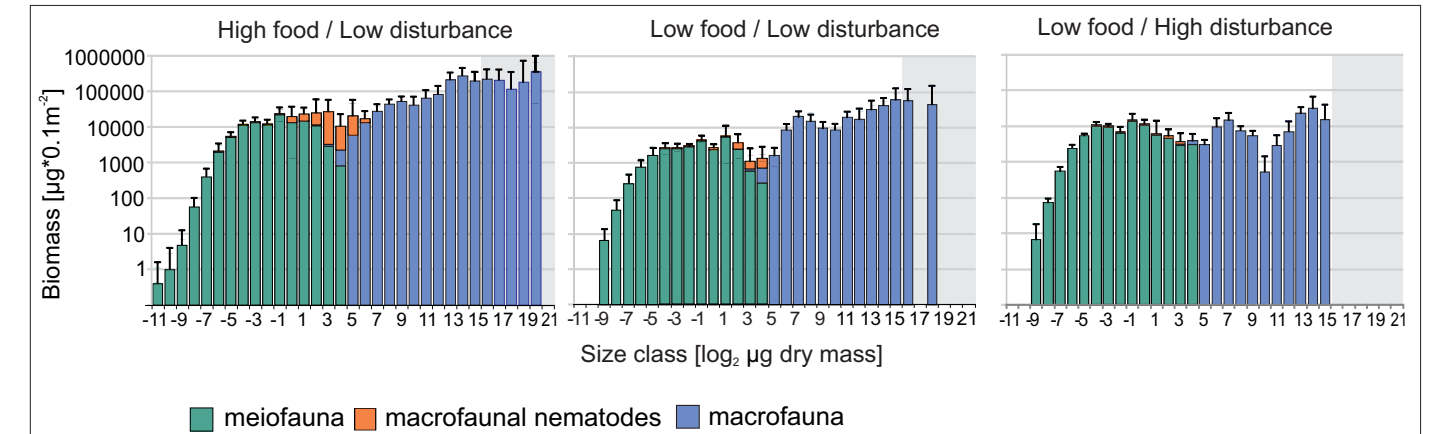
The body size constitutes one of the most significant features directly linked to the basic physiological and ecological processes at the specimen, population and community levels. The size structure of organisms' biomass is a commonly used tool for describing terrestrial and pelagic communities, useful in the assessment of productivity and energy flow. In the ecology of marine benthic communities, the biomass size structures are sparsely described due to the time-consuming laboratory analysis. Benthic communities play an important role in the carbon cycle in the global ocean. Therefore, the description of the size structures and the related secondary benthic production may significantly increase the knowledge on the flow of carbon and the functioning of marine ecosystems. This research is of particular importance in the Arctic, where the effects of global warming appeared the fastest and are expected to be more intense than at lower latitudes.

The studies were conducted in the fjords of western Spitsbergen (Kongsfjorden and Hornsund). The terrigenous run-off of glacial origin observed in the fjords leads to water turbidity, as well as increased sedimentation and sediment instability which represent the sources of natural physical disturbances for the benthic fauna. The research material was collected at six sta-

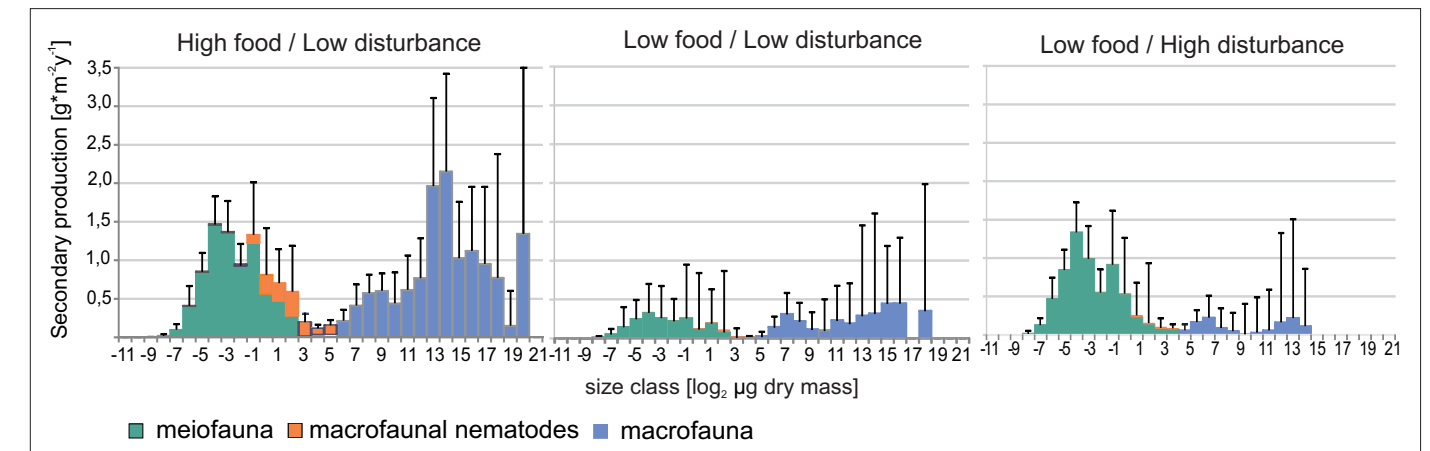
tions representing diverse environmental conditions in terms of food availability and glacial disturbances.

The majority of the stations recorded a bimodal distribution of the biomass size spectrum, similarly to other studies conducted at lower latitudes. However, in the case of macrofauna, the maximum of biomass in undisturbed sediments was shifted towards higher size classes than in the communities from lower latitudes. This suggests that organisms of larger size occur at higher latitudes. A decrease in the availability of food resulted in decreased biomass in all the size classes recorded, as well as in a lower number of classes (Fig. 1).

Glacial disturbances combined with low food availability led to further reduction in the total benthic biomass, especially in the case of macrofauna organisms. On the other hand, the meiofauna biomass in the disturbed sediments was higher than in the undisturbed ones with low content of organic matter. The disturbances had a selective impact on macrofauna organisms, eliminating species most susceptible to increased sedimentation and unconsolidated sediments (filter-feeding organisms, deep-digging organisms and organisms building habitat structures). Low availability of food and glacial disturbances also affected the secondary benthic production and its size structure



>> Fig. 1 The size structure of benthic biomass in the groups of stations defined by various availability of food and disturbance level



>> Fig. 2 The size structure of benthic secondary production in the groups of stations defined by various availability of food and disturbance level

(Fig. 2). A decrease in the availability of food led to a 74% reduction in the secondary production of meiofauna and macrofauna. On the other hand, glacial disturbances caused a three-fold decrease in the secondary production of macrofauna and a 2.5-fold increase in the secondary production of meiofauna. As a consequence, the secondary production of meiofauna represented as much as 83% of the total benthic secondary production in the disturbed sediments.

The presented research is the first to describe the impact of environmental conditions on the size structure of biomass and secondary production of benthic communities (encompassing meiofauna and macrofauna) in Arctic fjords.

Read the paper:

<https://doi.org/10.1016/j.pocean.2017.02.005>

Institute of Oceanology, Polish Academy of Sciences





# Message in a stainless steel bottle thrown into deep geological time

Gondwana Research, vol. 52, 139–141, 2017

Marek Lewandowski<sup>1</sup>, Monika A. Kusiak<sup>2</sup>, Łukasz Michalczyk<sup>3</sup>, Dariusz Szmigiel<sup>4</sup>, Ewa Śledziewska-Gójska<sup>5</sup>, Barbara Barzycka<sup>6</sup>, Tomasz Wawrzyniak<sup>1</sup>, Bartłomiej Luks<sup>1</sup>, Thor Thordarson<sup>7</sup>, Simson A. Wilde<sup>8</sup>, Armann Hoskuldsson<sup>7</sup>

**A time capsule with message from us to future civilizations was buried underground near the Polish Polar Station Hornsund. When will it resurface? What's hidden inside?**

The year 2017 saw the 60th anniversary of the Stanisław Siedlecki Polish Polar Station in Hornsund, Spitsbergen. The event was celebrated in a very unusual way. In the vicinity of the station, in a 4 m deep borehole, a time capsule was buried, containing information on our civilisation, natural environment, level of technological development, and everyday human life at the beginning of the 21st century. The idea was a brainchild of Prof. Marek Lewandowski, head of the Department of Polar and Marine Research at the Institute of Geophysics PAS.

The capsule is a 60-centimetre-long cylinder, with a diameter of 12 cm at its base, made of 4 mm thick stainless steel. It may be considered a message in a bottle, cast into the ocean of time for unknown discoverer. Due to the natural denudation processes, the capsule will make its way back to the Earth's surface in about 500,000 years. This might, however, happen earlier, if a surge of a local glacier cause severe soil erosion. Whoever finds the capsule will get information conveyed by means of carefully selected and grouped items. The so-called language of objects used to pass on the message will arguably be more comprehensible than any other known language.

The objects inside the capsule were carefully selected and divided into five thematic groups: geology, biology, natural environment, technology, and everyday human life. Objects representing each group were placed in separate stainless steel containers.

The idea has already attracted attention of scientists from other scientific centres. They want to bury their own time capsules with messages for visitors from the future.

The article about the time capsule was published by Gondwana Research, but accounts of the event were also published by Science, Nature, New York Times, and by news agencies in many countries of the world, including – of course – the Polish Press Agency and other national media.

>> Time capsule before being placed in permafrost

## Geological segment

The container holds minerals, rocks and fossils, ordered from the oldest to the most recent, representing significant stages in the Earth's evolution, e.g. a piece of Pultusk meteorite, the estimated age of which is 4.5 billion years, which is roughly the same as the Earth's; the Archaic zircon grains from different parts of the world; a piece of banded iron formation; a trilobite; an ammonite; modern-day lava from the Holuhraun volcano in Iceland. The samples were arranged in a stratigraphic order and an up-to-date stratigraphic table was attached, which – along with traces of rock dating procedures visible on the rocks' surface – will show the finders of the capsule the level of our geological expertise. The youngest rock in the capsule (lava from Iceland) will make it possible to determine the year in which the capsule was buried.



## Biological segment

The biological segment contains, among others: freeze-dried DNA of a rat, moose, potato, and a human (including baby teeth); Tardigrades, i.e. invertebrates capable of surviving in extreme conditions, including outer space; plant seeds, including e.g. green coffee beans, maize and cornflower.



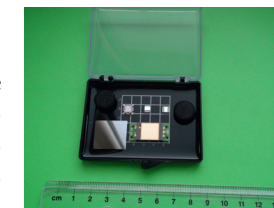
## Segment presenting the Earth's natural environment

The capsule contains data and items presenting the area of Polish Polar Station Hornsund. These include two memory cards with photographs and videos, a glass container with a sample from Hans Glacier, a piece of a reindeer antler, coal from Longyearbyen, and shells of crustaceans found in Svalbard. These objects may be subjected to an isotope analysis, which will help determine climatic conditions existing on Spitsbergen. Moreover, the container holds ceramic photographs showing Polish Polar Station in summer and winter, and the Earth and Moon as seen from space. Memory cards include photos and videos showing contemporary environments all over the Earth.



## Segment presenting the level of technological development

The container demonstrating the state of our technological advancement contains, among others: silicon crystals, a MEMS accelerometer (used in a number of modern devices, e.g. mobile phones, cars, planes), a miniature photovoltaic panel, a photodiode for detecting infrared radiation, and a glass prism. The arrangement of the items was well thought-out, e.g. quartz sand (which is the source of silicon), a silicon crystal and a piece of silicon wafer have all been put together.



## Segment presenting everyday life

The container devoted to everyday life contains, among others: matches, a syringe (as a symbol of modern medicine), coins from 25 different countries, a watch, a toy car, a bank card, a miniature book, a tiny sundial with a compass, and a penknife.



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<sup>1</sup>Institute of Geophysics, Polish Academy of Sciences, Księcia Janusza 64, 01-452 Warsaw, Poland

<sup>2</sup>Institute of Geological Sciences, Polish Academy of Sciences, Twarda 51/55, 00-818 Warsaw, Poland

<sup>3</sup>Institute of Zoology and Biomedical Research, Jagiellonian University, Gronostajowa 9, 30-387 Cracow, Poland

<sup>4</sup>Institute of Electron Technology, Al. Lotników 32/46, 02-668 Warsaw, Poland

<sup>5</sup>Institute of Biochemistry and Biophysics, Polish Academy of Sciences, Pawińskiego 5a, 02-106 Warsaw, Poland

<sup>6</sup>Faculty of Earth Sciences, University of Silesia, Będzińska 60, 41-200 Sosnowiec, Poland

<sup>7</sup>Faculty and Institute of Earth Sciences, University of Iceland, Askja Sturlugata 7, 101 Reykjavík, Iceland

<sup>8</sup>Department of Applied Geology, Curtin University, PO Box U1987, WA 6845, Perth, Australia

Find more:



Read the paper:





# Technical facilities and infrastructure for polar research

Since the beginning of its activities, the Centre for Polar Studies (CPS) has had access to two top-class research infrastructures, namely the Oceania research vessel and the Polish Polar Station Hornsund on Spitsbergen. In 2015-2017 it also acquired more than 40 devices and instruments for comprehensive research of the atmosphere, cryosphere, hydrosphere and fjords in polar regions, within the framework of the Polish Multidisciplinary Laboratory for Polar Research (PolarPOL).

## Polish Polar Station Hornsund

The Polish Polar Station Hornsund, named after Stanisław Siedlecki, is located at the Isbjørnhamna bay in the Hornsund fjord, in the southern part of Spitsbergen, the largest island of the Svalbard archipelago. The Station was established in 1957 and has been functioning as a year-round facility since 1978. It is the only Polish observatory in the Arctic which operates all year round. The Station is managed by the Institute of Geophysics PAS in Warsaw.

The Station carries out monitoring programmes aimed at improving the understanding of the functioning of Arctic nature and the changes it undergoes. The programmes cover climatology, glaciology, hydrology, oceanography, seismology, geomagnetism, physics of the atmosphere, permafrost

Watch a video about the Station:



>> Polish Polar Station Hornsund on Spitsbergen



>> R/v Oceania

and geomorphology. The research programmes implemented in the Station are mainly related to the evolution of the Arctic environment in the context of ongoing global climate change.

The Polish Polar Station Hornsund is a modern multidisciplinary research platform. Its infrastructure, comprising such elements as laboratory rooms, satellite communications, as well as social and technical facilities, so unique in polar conditions, makes it possible to accommodate 30 individuals simultaneously, including 10 persons who are participants of the year-long Polar Expeditions of the Institute of Geophysics PAS.

## R/v Oceania

R/v Oceania is the only Polish research vessel capable of conducting oceanographic research in the field of physics, chemistry, ecology and marine biology on all types of water bodies. It is equipped with state-of-the-art laboratories (chemical, spectroscopic and computer-aided), unique research equipment (probes for bottom sediments, optical and acoustic sensors, as well as devices for seawater intake) and on board systems for carrying

Find more about Oceania's specification and research facilities:





out oceanographic measurements to the depth of 5,000 metres. The equipment meets the modern global standards.

Each year r/v Oceania is at sea for 250 days, including approximately 80 days on the Nordic Seas and Spitsbergen (June-August), making several cruises across the Baltic Sea and a cruise to the European parts of the Arctic. These expeditions are related, in most cases, to own research works and the international programmes pursued by the Institute of Oceanology PAS.



>> A sea boat with a built-in cabin allows to work in polar conditions during oceanographic and geophysical research, and also guarantees safe working conditions for divers. It is equipped with such devices as a hydrographic crane, a multibeam echosounder, a side-scan sonar, ADCP and CTD probes, as well as a sediment profiler. The boat is a part of the PolarPOL's infrastructure

Watch a video about the Gavia immer boat:



Watch a video from the Polish Polar Station Hornsund, taken from a drone:



>> The CPS is equipped with two Riegl scanners for performing surveying measurements to the maximum depth of 6 km (VZ-6000) and 2 km (VZ-2000). This equipment facilitates precise surveying measurements in environmental engineering, geotechnical works, as well as in polar and high-mountain environments (including measurements of glaciers and snow cover). The equipment was purchased within the framework of the PolarPOL and the KNOW funds received by the CPS



>> In recent years, the CPS has extended its aircraft base by eight multirotors (DJI Phantom 3 and 4, Mavic, Matrice 600) and an airframe (MicroMap). A large number of researchers, PhD candidates and students have obtained a state license necessary to operate them (VLOS and BVLOS), thus being able to use their new skills in research works both in Poland and in the Arctic

## Chapter 5

# Interdisciplinary Polar Studies

The basic task of the Centre for Polar Studies (CPS), arising out of the application for the award of the Leading National Research Centre (KNOW) and the contract on its establishment, was to prepare an original, innovative curriculum of the third-degree programme of the Interdisciplinary Polar Studies (IPS).

In the academic year of 2014/2015, the Centre offered top-quality doctoral studies to young researchers from Poland and abroad, carried out mostly in English, in the fields in which the CPS units are entitled to confer the doctor and habilitation academic degree in Earth Sciences, i.e. Geophysics, Geography, Geology, and Oceanology. The Interdisciplinary Polar Studies are based on the scientific potential of the CPS and all the resources of its constituent units. A particularly important role in the educational process is played by the logistic infrastructure owned by the Centre, in the form of research platforms in the Arctic and those available in the Antarctic.

The establishment of the IPS was intended to allow the young generation of scientists to carry out scientific research at the highest level, as well as to provide them with practical training



>> During fieldwork, IPS doctoral students associate with the Arctic nature, which is dominated by polar bears

and opportunities to make their own measurements and observations in polar regions, so that the best scientific results can be achieved.

The description of programme modules and subjects along with the assumed learning plans and outcomes can be found on [www.polarknow.us.edu.pl/isp](http://www.polarknow.us.edu.pl/isp).

The unique curriculum of the IPS encompasses 2- or 3-day thematic sessions once a month, held alternately at three of the scientific units, i.e. in Sosnowiec, Warsaw or Sopot. Moreover, once per semester, there are week-long workshops, usually in the field or in the units associated with the CPS (e.g. a cruise on board of r/v Oceania, field workshops in the Beskid Mountains, classes in Geophysical Observatories in Belsk and Świdar). The subjects of the workshops include, amongst others, the abiotic



>> Within the framework of the IPS, young scientists are provided with access to the CPS equipment and infrastructure, thereby being able to conduct research at top international level



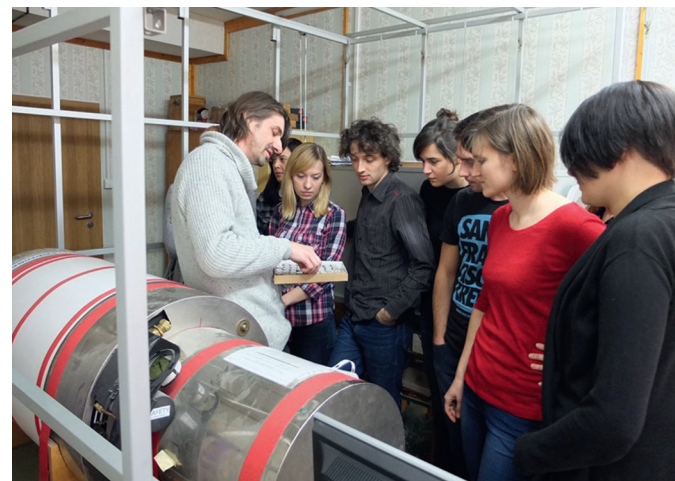
monitoring systems in the Arctic, the contemporary methods for researching marine systems, or the geophysical methods in the studies of the cryosphere. The education process is supplemented by advanced English courses, higher education didactic classes (also in the form of e-learning) and vocational training. The programme of each session includes lectures, workshops or consultations conducted by an eminent foreign scientist. In 2014-2018 there were more than 50 such visits by foreign guests in the CPS units. Thanks to the interdisciplinary curriculum of the studies and the participation of foreign lecturers, the doctoral students have a real opportunity to broaden their horizons in the context of global science. A strong emphasis was placed on innovation and the use of modern research methods.



>> Celebrating the inauguration of the 2016/17 academic year at the IPS

The Internal Educational Quality Assurance System was launched at the Faculty of Earth Sciences of the University of Silesia. Created by the Faculty Education Quality Assurance Team, it operates at the doctoral studies and the Interdisciplinary Polar Studies. This system ensures a high level of education and achievement of the assumed didactic objectives. Our reliable study programmes resulted in the positive opinion of the State Accreditation Committee, received by the Interdisciplinary Polar Studies in 2016.

The experience of the IPS demonstrates that it is capable of creating a curriculum which is better suited to the needs of students, amongst others, by extending the scope of subjects and methodological workshops at the cost of excessively specialised thematic lectures addressed to all students.



>> The IPS sessions encompass lectures, seminars, and workshops



>> Classes of the IPS doctoral students in the laboratory

International recruitment for the IPS was organised twice, in the academic years of 2014/2015 and 2015/2016. As part of the recruitment process, as many as 54 suggested topics of doctoral dissertations were announced, with a limit of 30 positions. The CPS received applications from such countries as Poland, Norway, Portugal, France, Croatia, Romania, Iraq, and Pakistan. Eventually, as many as 20 out of 39 candidates were qualified for the studies in 2014, and 6 out of 13 – in 2015. At the beginning of 2018, the number of doctoral students amounted to



>> During field workshop on Spitsbergen

24 individuals (the Faculty of Earth Sciences of the University of Silesia: six; the Institute of Geophysics, Polish Academy of Sciences: six; and the Institute of Oceanology, Polish Academy of Sciences: twelve).

The IPS implemented a system for supporting doctoral students through special scholarship grants (Polar-KNOW), which are intended to motivate young scientists to conduct high-quality research and obtain significant scientific effects, especially in the field of polar issues. The grants, for which the CPS allocated a significant proportion of the funds from the KNOW pro-quality subsidy, are awarded on the basis of an innovative system based on concrete substantive requirements. The annual assessment of each doctoral student's achievements takes into consideration the dissemination of research results through publications, presentations at international scientific conferences, the preparation of applications for research or implementation project funding and their execution, active participation in the commissions and committees of scientific conferences as well as of national and international scientific organisations.

The formula of special scholarship grants received a positive opinion of the Main Council for Science and Tertiary Education and was approved by the Ministry of Science and Higher Education. The grants were also awarded to students of doctoral studies at the constituent units of the CPS, as long as the subjects of their dissertations were in line with the strategic objectives of the CPS.



>> Geophysics workshop

At the end of each academic year, the doctoral students submit a report on the course of studies and present their work plan for the subsequent two semesters. The implementation of the assumed activities is subject to assessment by the Scholarship Committee. At the end of each academic year, the progress of doctoral students is also evaluated by the International Scientific Board of the Centre for Polar Studies.

The Interdisciplinary Polar Studies are pursued successfully – in the academic year of 2017/2018, as many as 18 out of 19 third-year students registered for a doctoral degree conferment procedure. The information from supervisors suggests there is a real prospect that most of them will submit their doctoral dissertations by the end of 2018. This would mean higher efficiency than in the case of other comparable doctoral studies in the field of Earth Sciences. The quality of the studies and the effectiveness of the scholarship system in place are best evidenced by the number of publications by the doctoral students of the IPS. By the end of 2017, they published 53 articles in journals with Impact Factor (IF), further 5 are in print, and 11 in review.

For profiles of the IPS doctoral students, please check pages 36-83.

Check out the coverage  
of the inauguration of the 2016/2017  
academic year at the  
Interdisciplinary Polar Studies:





# Paulina Aniśkiewicz

Institute of Oceanology, Polish Academy of Sciences

Studies completed: University of Gdańsk, Faculty of Oceanography and Geography, specialisation: Marine Physics

Watch a video:



## The influence of atmospheric and oceanic conditions on physical processes in two fjords: Porsanger and Hornsund

### Wpływ warunków atmosferycznych i oceanicznych na procesy fizyczne w dwóch fiordach: Porsanger oraz Hornsund

Bearing in mind the observed climate changes, it is important to make an attempt to understand the interactions between local processes and global changes.

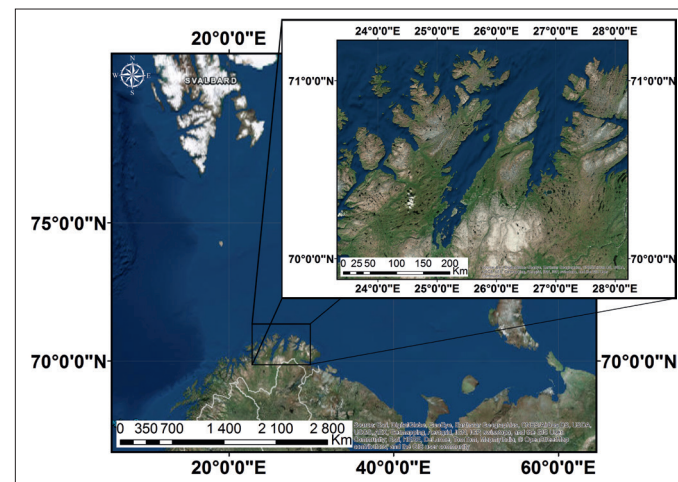
The study involves creating numerical models for the purpose of analysing atmospheric and oceanic impacts within the Porsanger and Hornsund fjords. The primary aim of the study is to determine which physical processes are currently shaping the environment of the fjords, characterise differences and similarities between the fjords, and describe the changes taking places within them. The following research tasks have been undertaken:

1. analysis of current physical and atmospheric conditions within the fjords;
2. examination of ways in which environmental conditions (the amount of solar energy and other types of energy reaching the fjords, winds, water run-off from land) influence the current state of the fjords; the aim will be achieved by means of numerical experiments, in which particular simulation conditions are modified in order to determine their impact on the modelled state of the fjords;
3. analysis of future change trends done with the help of model simulations based on scenarios provided by the Intergovern-

mental Panel on Climate Change (IPCC);

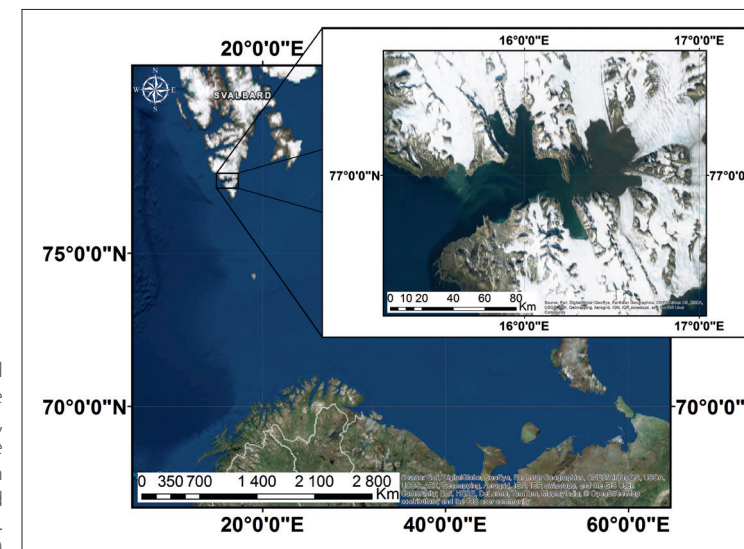
4. backward extrapolation (to the 1980s or further), which will enable a deeper understanding of these changes.

Numerical experiments make use of the hydrodynamic ROMS



>> Geographical location of the Porsanger fjord, situated in the northern part of Norway (based on: www.arcgis.com)

>> Geographical location of the Hornsund fjord, situated in the south-western part of Svalbard (based on: www.arcgis.com)



model (Regional Ocean Modelling System) and the atmospheric WRF model (Weather Research and Forecasting Model). The accuracy of the models have already been partially verified by comparing simulation results with measurement data. The variability of atmospheric conditions have been analysed on the basis of historical observational data.



## SUPERVISOR



Prof. Małgorzata Stramska  
Institute of Oceanology PAS

Research interests: her interests revolve around the application of remote sensing techniques in oceanography, marine optics, and bio-optical modelling. She was involved in NASA programmes concerning the preparations for missions and satellite data validations in the performance of sub satellite research, and the creation of new sea colour algorithms for estimating the suspended particulate organic carbon (POC). Currently, she is dealing with the use of satellite methods and bio-optical modelling in improving the understanding of the functioning of the environment of Norwegian fjords, as well as of the Baltic Sea and the Mediterranean Sea.

**Academic interests:** ocean-atmosphere interactions, ocean dynamics; the application of numerical methods in physical phenomena modelling; water exchange, interactions between waters of different density; flood risk; Geographical Information Systems; the impact of seas and oceans on cloud structure and dynamics, unusual weather phenomena, the impact of physical phenomena on human life and health.

**Other interests:** ballroom dancing, sewing.

**Motto or reflection:** "People (...) grow five thousand roses in one garden, but they can't find what they're looking for (...). Yet, they can find whatever they look for in one rose or a drop of water"

Antoine de Saint-Exupéry – *The Little Prince*



# Kaja Bałazy

Institute of Oceanology, Polish Academy of Sciences

Studies completed: University of Gdańsk, Faculty of Biology,  
field of study: Biology, specialisation: Animal Ecology

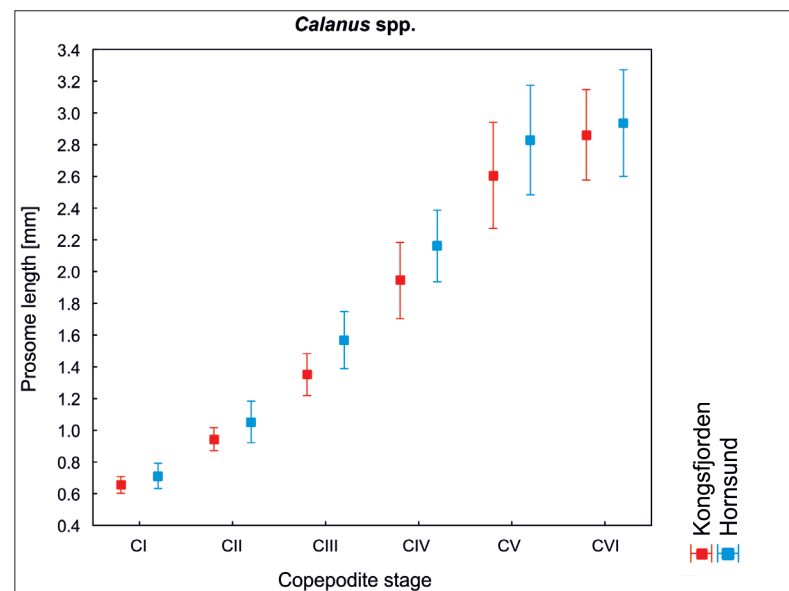
Watch a video:



## The phenology of key *Calanus* species in the context of food demand of little auk (*Alle alle*) nesting on Spitsbergen

### Fenologia kluczowych gatunków z rodzaju *Calanus* w kontekście zapotrzebowania pokarmowego alczyka (*Alle alle*) gniazdującego na Spitsbergenie

In recent years, Arctic environment has undergone considerable changes caused by climate warming. They have had an impact on the structure and functioning of Arctic marine ecosystems, and – at the same time – on the little auk (*Alle alle*), the most numerous seabird in the northern hemisphere. Little auks play crucial role in fertilization of the poor Arctic tundra, thus disruptions in their food supply may have a huge impact on the functioning of Arctic ecosystem. Little auks feed on plankton, especially on late development stages of large copepods like *Calanus*. The aim of my study is to examine the impact of ongoing climate driven changes on the phenology of *Calanus* spp. in the context of the little auk food demand. As part of the study, a match/mismatch hypothesis between the time of the highest energy requirement of planktivorous predator (little auk) and the peak of the abundance of its prey – *Calanus* spp., was tested out. The study is based on zooplankton samples collected in different periods of the summer seasons of 2015 and



>> *Calanus* spp. copepodite stages (CI-CVI) prosome length in Kongsfjorden and Hornsund. Box – mean, whiskers – standard deviation.



>> Zooplankton samples may be collected, among others, with the help of a MultiNet plankton sampler, which makes it possible to take samples from different depths in a single draught

2016 in two fjords with distinct hydrographic conditions – Kongsfjorden, affected by the inflow of Atlantic waters, and Hornsund, with a prevalence of cold Arctic waters. Study results indicate significant differences in *Calanus* phenology between the two fjords and two years. In general, the preferred food of the little auk was more available in the Hornsund fjord. The results also show that higher temperature has a negative impact on the size of individuals from the genus *Calanus*. Comprehensive analyses made it possible to come up with different variation scenarios regarding the availability of species of *Calanus* during the period of the little auk's high energy demand.

**Interests and hobbies:** Ever since I can remember, I have always been interested in animals, and I consider myself lucky to be able to combine my hobby with academic work. I spend most of my free time observing and photographing local fauna in different parts of Poland. Observing wild animals (which are often very hard to catch a glimpse of) in their natural habitat is the best way to get to know and understand their behaviour. Apart from this wildlife photography gives a wonderful opportunity to immortalise those emotional moments.

**Motto or reflection:** Conducting polar research offers the possibility to work with unique species in areas which still remain relatively unknown, and undergo significant changes at the same time, as a result of climate warming. Having the opportunity to study animals in remote locations and to look at their ecology from a new broader perspective was my main reason for choosing this topic of study. The most efficient motivation for further work is constantly discovering the richness of life forms, animal behaviours and processes, which still manage to surprise me. In the future, I would like to extend my research work to the other polar region, and expand my knowledge to include behavioural observations of seabirds.

## SUPERVISORS



Assoc. Prof. Katarzyna Błachowiak-Samołyk

Institute of Oceanology PAS

Research interests: she is interested in the broadly understood ecology of the zooplankton, and especially the exploration of its spatial distribution against the changing environmental factors, diurnal migration, seasonal differences in its composition and trophic structure. An important aspect of her interests is the application of innovative research methods (laser plankton counter) to estimate the influence of the ongoing reconstruction in the plankton size structure on the higher trophic levels that feed on it, and – indirectly – also on the functioning of short food chains in the changing Arctic.



Dr. Emilia Trudnowska

Institute of Oceanology PAS

Research interests: the main object of her research is Arctic zooplankton, in particular *Calanus* copepods, their age-size structure, distribution and ecology in the context of climate change.



# Barbara Barzycka

University of Silesia

Studies completed: AGH University of Science and Technology in Kraków, Faculty of Mining Surveying and Cartography, field of study: geodesy, surveying and cartography, specialisation: Geoinformation, Photogrammetry, Remote Sensing

Watch a video:

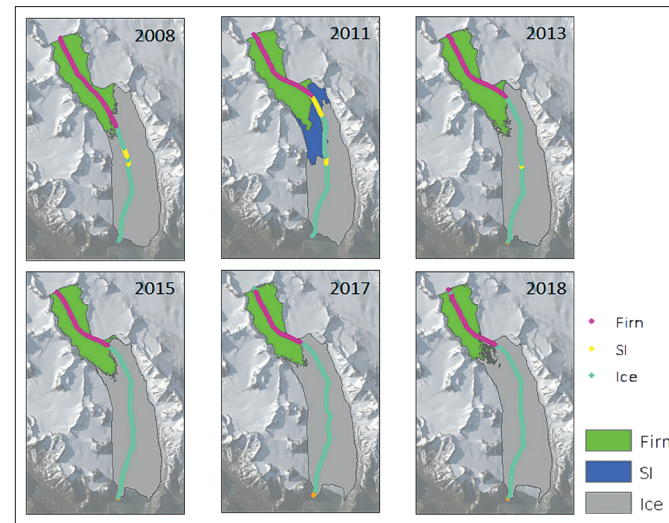


## Application of remote sensing and terrestrial measurements in distinguishing glaciers facies extents

### Zastosowanie metod teledetekcyjnych i naziemnych do wykrywania zasięgu stref glacialnych lodowców

Glaciers are good indicators of climate changes. Getting to know their evolution is easier with the use of remote sensing methods, which provide extensive data on glacier reactions to climate changes. It is crucial to distinguish glacier facies (zones), such as firn, superimposed ice and polycrystalline glacier ice. These zones occur in particular areas of glaciers and differ in terms of density, internal structure, water content and water percolation, indicating at the same time the distribution of glacier mass balance. Glacier mass balance shows how “healthy” a glacier is and serves as one of the most important indicators of climate changes. Among the most promising methods of determining glacier facies are analyses of satellite Synthetic Aperture Radar images (SAR), which make it possible to examine large, remote polar areas, regardless of the existing weather conditions. The aim of my doctoral dissertation is to improve the ways in which glacier facies are detected with the use of SAR. The results are validated by means of analyses based on terrestrial data collected during fieldwork.

The studies I carried out for the Vestfonna ice cap on Svalbard made it possible to determine that a particularly promising method of detecting glacier zones is the H- $\alpha$  classification method, which makes use of full-polarisation SAR imagery. The



>> Glacier facies of Hans Glacier (Svalbard) from 2008 to 2018. Magenta, yellow and pale blue represent respectively firn, superimposed ice (SI) and ice zones, determined on the basis of terrestrial data (ground penetrating radar measurements). Green, blue and grey represent the extents of firn, superimposed ice (SI) and ice zones, distinguished by means of remote sensing analyses. A close correspondence can be noticed between the results of terrestrial and remote sensing data analyses. The firn zone of Hans Glacier has shrunk by 8% during the analysed decade.



>> Barbara Barzycka with her dissertation supervisors: Prof. Jacek Jania and Dr. Małgorzata Błaszczuk, on Tuv Glacier (Svalbard, 2016). The picture was taken after successful flights with an unmanned aerial vehicle (UAV).

method was also used to study changes in the glacier zones of Hans Glacier (Svalbard) in the years 2008-2018. The results suggest that, due to the ongoing climate warming, in 2018 the extent of firn zone was by 8% smaller than in 2008. Moreover, the results correlated closely with the mass balance measurements obtained in the classical way. This suggests that the methodology I am working on will be applicable and that it shows considerable potential as a way of obtaining information about the extents of glacier zones within large polar glaciers and glacier caps.

**Interests and hobbies:** One of my passions is travelling, especially the spontaneous sort, when each new day brings something unexpected. When I am not travelling, I like to “visit” different countries by getting to know their cuisine (although I no longer dare to do the cooking). I spend my free time reading, mostly non-fiction, although I often find it difficult to put down a good novel. I also enjoy sports, including those that significantly raise the level of adrenaline in my blood.

**Motto or reflection:** I started PhD studies quite by chance – I sent an application hoping to find an interesting job, full of new challenges. The three years I have completed so far have not only given me a chance to experience a once-in-a-lifetime adventure, but also made me broaden my skills and knowledge, which I would not be able to do anywhere else. Doing research in polar regions helped me appreciate the beauty of raw nature, experience how it feels to be cut off from civilisation, get to know the risks inherent in fieldwork, and strike up new friendships. Polar regions are addictive, which is why I would like to go back there in the future and, through my work, be able to protect them.

## SUPERVISORS



Prof. Jacek Jania  
University of Silesia, Faculty of Earth Sciences,  
Department of Geomorphology

Research interests: evolution of glaciers and Arctic environment affected by climate change; the dynamics of tidewater glaciers; glacial geomorphology.



Dr. Małgorzata Błaszczuk  
University of Silesia, Faculty of Earth Sciences,  
Department of Geomorphology

Research interests: geodesist, glaciologist and specialist in the use of geographical information systems (GIS) and remote sensing in polar research. She carries out her main scientific activities on Spitsbergen, researching the dynamics of the fronts of glaciers calving into the sea and the interactions of glaciers with the atmosphere and the ocean.



# Mariusz Burzyński

Institute of Geophysics, Polish Academy of Sciences

Studies completed: University of Warsaw, Faculty of Geology,  
field of study: Geology, specialisation: Resource and Economic  
Geology

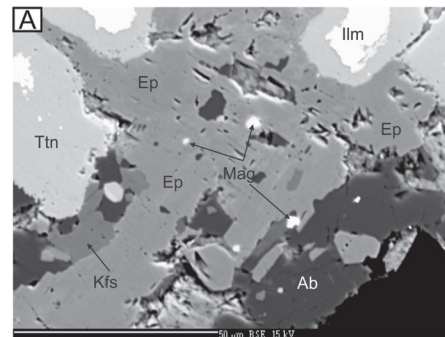
Watch a video:



## Palaeomagnetic, rock-magnetic and petrographic investigations of meta-magmatic rocks of the Western Spitsbergen

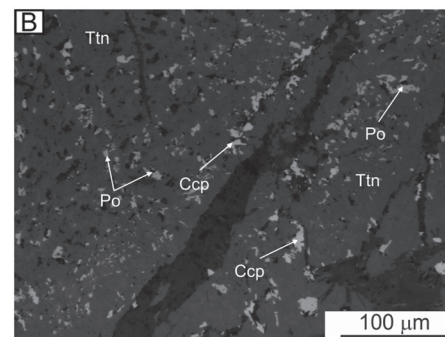
### Paleomagnetyzm, własności magnetyczne oraz petrografia skał meta-magmowych Zachodniego Spitsbergenu

The aim of my dissertation was to understand the tectonic evolution of Western Spitsbergen using palaeomagnetic methods. My first task was to identify and analyse the directions of natural remanent magnetisation (NRM) and calculate the location of paleopoles, as well as to determine the age and origin of minerals carrying the magnetic remanence. Study samples were collected from magmatic intrusions found in Western Spitsbergen, in the areas of St. Jonsfjord, Farmhamna and Trygghamna. They were used to perform the first palaeomagnetic investigation of these geological formations. The investigation involved the use of a wide range of mineralogical, rock-magnetic and palaeomagnetic methods. Apart from the NRM analysis, a thorough examination of the ferromagnetic fraction present in the mineral separates was also performed. The results made it possible to understand thermal evolution and complex geological history of crust blocks in Western Spitsbergen, rich in metamorphic events and tectonic rotations. The application of an author's method of analysing magnetic separates



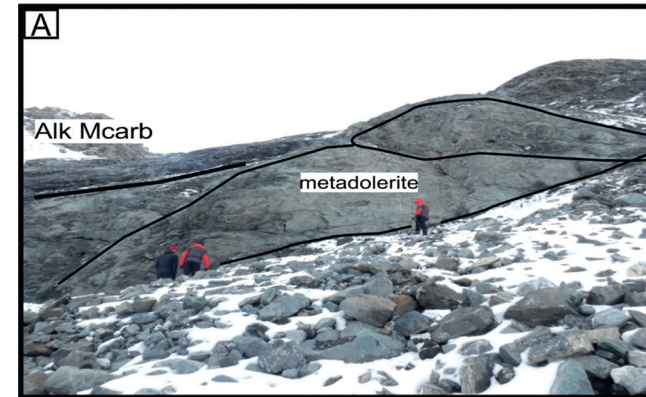
>> Fe-Ti oxides and sulphides within the examined metadolerites from Oscar II Land (Western Spitsbergen):

A) Backscattered electron (BSE) image showing small euhedral magnetite crystals within epidote. Ilmenite is surrounded by titanite as well as by small intergrowths of albite and K-feldspars

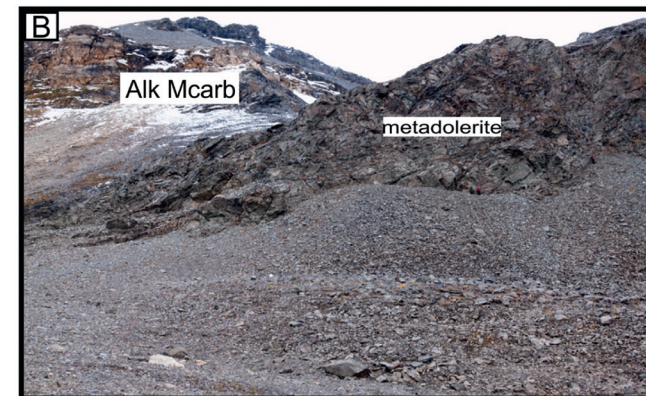


B) Titanite pseudomorph after Ti-rich magnetite. The titanite contains numerous small blebs of pyrrhotite and chalcopyrite.

Abbreviations: Ab – albite, Ccp – chalcopyrite, Ep – epidote, Ilm – ilmenite, Kfs – K-feldspar, Mag – magnetite, Po – pyrrhotite, Ttn – titanite



>> A) Field view of metadolerite sample site in Oscar II Land (Western Spitsbergen). The inside of the boudin is divided into smaller lenses (marked), cut across by fractures and small scale fault planes



>> B) Metadolerite boudin in Daudmannsdalen (Western Spitsbergen) intruding into Alkhornet metacarbonates. The boudin is cut across by several shear surfaces

enabled a deeper understanding of the origin of NRM directions. An interdisciplinary approach to the subject not only provided valuable palaeomagnetic and mineralogical data, but also led to the development of a universal methodology for conducting integrated palaeomagnetic and rock-magnetic investigations, which may in the future be used by palaeomagnetists working in other parts of the world.

**Interests and hobbies:** For me, the best way to recharge batteries has always been through contact with nature. I often spend free days in the area I come from, out of the city, where I can hone my photography skills. Sometimes I feel like staying at home, where I spend long hours playing TV games or cooking with my wife.

**Motto or reflection:** My love affair with polar regions started quite unexpectedly, not long before the beginning of my doctoral studies, when I was invited to take part in a scientific expedition to Spitsbergen as a field assistant. It took me just a few seconds to accept the offer, which turned out to be one of the most significant decisions in my life. I came back from the expedition enchanted with Spitsbergen, not only because of the beauty of its nature, but also because of the remarkable people I had met there. When I learned about enrolment for Interdisciplinary Polar Studies, I jumped at the chance. Four years down the line, I can safely say that it has been a very fruitful time, during which I have gained valuable experience both within and outside the realm of science.

## SUPERVISORS



Prof. Marek Lewandowski  
Institute of Geophysics PAS

Research interests: he specialises in palaeomagnetic research and its application in palaeogeographic and tectonic reconstructions. He conducted research in many European countries, and recently also in Africa. His favourite activities include collecting rock samples using portable drill and tasting wines, especially those from the Portuguese Douro Valley.



Dr. Krzysztof Michalski  
Institute of Geophysics PAS

Research interests: magnetic properties of rocks in the Svalbard archipelago, palaeogeography and tectonics of the Atlantic sector of the Arctic (Svalbard, Greenland) based on integrated palaeomagnetic, structural, petrological and isotopic studies.



# Marta Bystrowska

University of Silesia

Studies completed: University of Warsaw, Centre for European Regional and Local Studies EUOREG, specialisation: Spatial Management

Find out more:

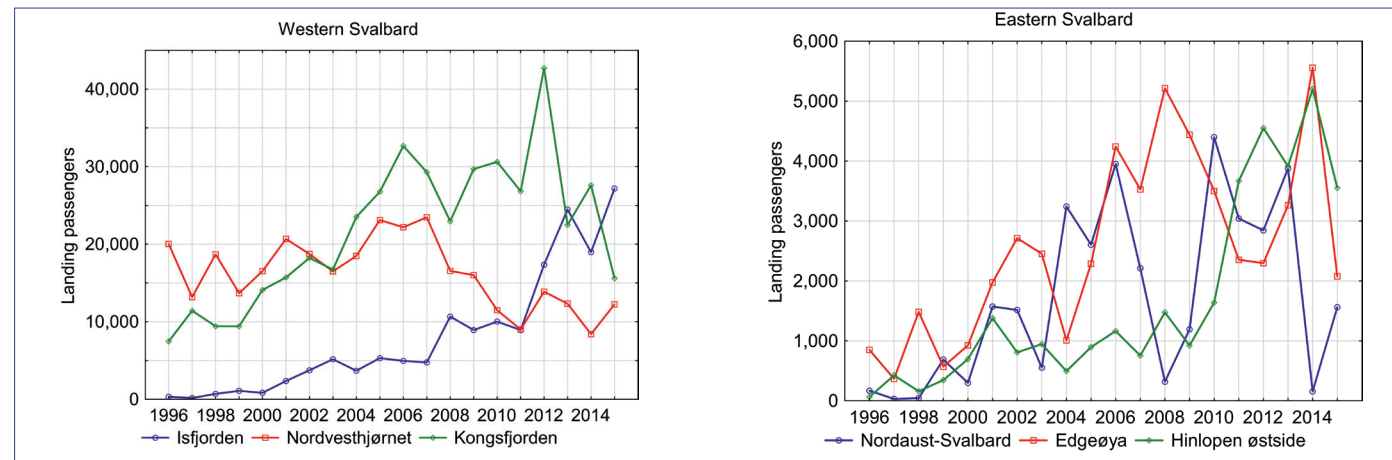


## Expedition cruise tourism in Svalbard – development determinants

### Ekspedycyjna turystyka rejsowa w rejonie Svalbardu – uwarunkowania rozwoju

In my doctoral dissertation, I am analysing the development of cruise tourism around Svalbard, paying particular attention to the role of cruise operators in shaping tourist space. Tourism is undergoing a dynamic development in the Arctic, with Svalbard being the most popular destination in the High North. The growing tourism traffic in the Arctic provides an opportunity for local economy to develop, but also poses a number of challenges.

Climate changes taking place in the Arctic have a considerable impact on its attractiveness and the accessibility of tourist places. Understanding the factors determining the development of tourism destinations in this part of the world is crucial for effective planning and organisation of tourism in the future. This is why I am focusing on what cruise operators take into account when planning and organising expedition cruises and, thus, how they



>> Changes in tourist traffic in the western and eastern Svalbard in the period 1996-2015 (number of tourists coming ashore), source: Bystrowska M., The impact of sea ice on cruise tourism on Svalbard, Arctic (in press)



>> The largest cruise ships on Svalbard can take on board more than 3000 passengers

shape tourism space (i.e. on reasons why certain areas of the Arctic are much more frequently visited than others). The analyzes show a dynamic increase in the number of cruise tourists in Svalbard in recent decades, but also variability from year to year. The spatial distribution of the intensity of tourist traffic in Svalbard generally correlates with the characteristics of the range of sea ice cover in summer seasons (see graph on page 44). The western regions are more often free of ice, while there's more ice in eastern regions. The results of the work indicate that cruise operators have a significant impact on the development of tourism in the Arctic, as they determine the route and the places visited. Climate change is paradoxically a factor negatively perceived by operators – less ice means less attractions to show. It also turns out that sea ice is not a particularly important factor for operators in route planning and does not have a large impact on the spatial diversity of the intensity of tourist traffic. Therefore, contrary to the popular belief that the melting of the Arctic sea ice facilitates the development of tourism, it turns out that is not the case. In Svalbard, the interest of cruise operators is decreasing in this area, due to the visible reduction of the ice cover, which reduces the attractiveness of the places visited.



>> Training near terminus of Hans Glacier (Svalbard)

**Interests and hobbies:** Scandinavian culture, particularly kalsarikännit; travelling, especially to northern regions; Sami folk art; Scandinavian cinema.

## SUPERVISORS



**Prof. Jacek Jania**  
University of Silesia, Faculty of Earth Sciences,  
Department of Geomorphology

Research interests: evolution of glaciers and Arctic environment affected by climate change; the dynamics of tidewater glaciers; glacial geomorphology.



**Dr. Jackie Dawson**  
University of Ottawa, Faculty of Arts  
Department of Geography

Research interests: she is an expert in the human and policy dimensions of environmental change. She is considered an international expert in Arctic shipping, Arctic oceans governance, and polar tourism.



# Katarzyna Cielecka-Nowak

University of Silesia

Studies completed: University of Silesia, Faculty of Earth Sciences,  
specialisation: Hydroclimatology

Find out more:



## Conditions and long-term variability of liquid and solid precipitation occurrence on Spitsbergen

### Uwarunkowania oraz zmienność wieloletnia występowania ciekłych oraz stałych opadów atmosferycznych na Spitsbergenie

Precipitation, depending on the distribution of air temperature between the cloud base and the ground, can be liquid (rain), solid (snow) or mixed (sleet). The frequency of snowfall and rainfall as well as their changes over time are considered to be significant indicators of contemporary climate change. Since the early 1990s, the Arctic has experienced a significant increase in air temperatures, which - as suggested by preliminary research - affects the frequency of the basic types of precipitation, especially rain. In polar regions, the form of precipitation has a significant impact on the glacier mass balance, the course of numerous environmental processes and the functioning of living organisms. The purpose of my dissertation is to quantitatively assess the factors affecting the presence of rainfall and snowfall, as well as to determine their long-term changes in spatial terms.

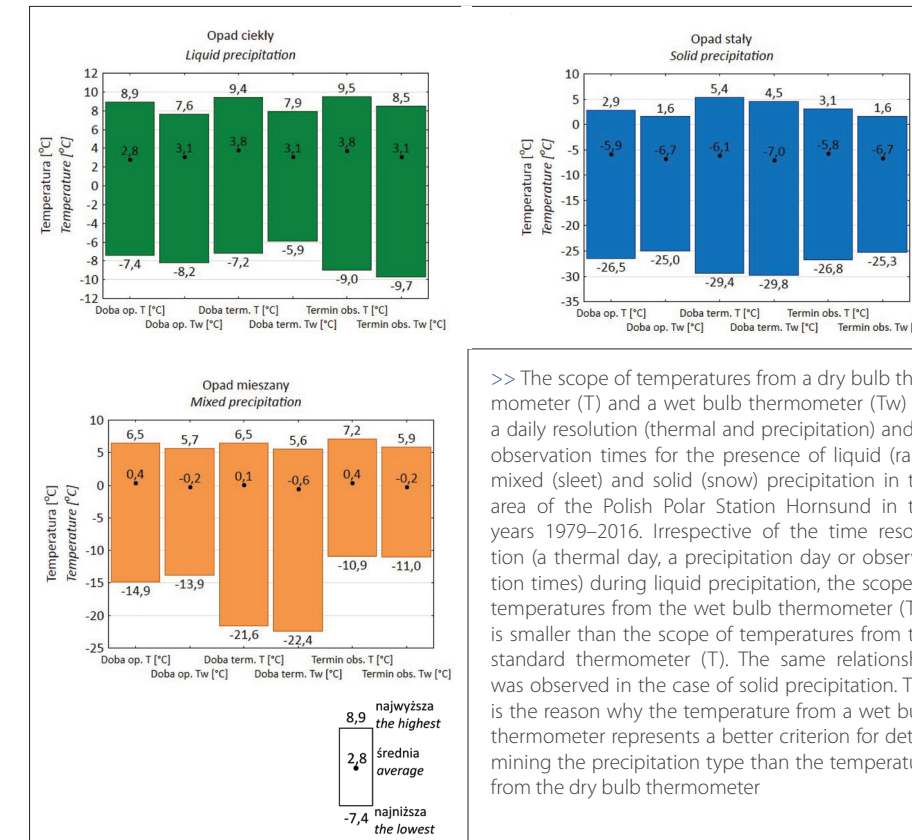
Fulfilling the objectives of my doctoral dissertation, I am involved in determining the meteorological conditions of rainfall and snowfall in the area of the Polish Polar Station Hornsund in the period from July 1978 to December 2016. In my research, I make use of the air temperature measured by both a wet and a dry bulb thermometer, the sum of precipitation and the data concerning atmospheric phenomena recorded in the current and

past weather on a daily resolution, using the thermal day (00–21 UTC) and precipitation day (06–06 UTC), as well as on an interval-based resolution (every 3 hours). The meteorological data come from the Polish Polar Station Hornsund.



>> Expedition to the automatic meteorological station (in the background) on the Hans Glacier on Spitsbergen. The goal of the expedition was to inspect the current condition of the meteorological station. Caution is advised during such passages due to the presence of glacial crevasses

The results of my research to date indicate that the temperature from a wet bulb thermometer represents a better criterion for determining rainfall than the temperature from the dry bulb thermometer. I observed the same relationship in the case of snowfall. I also analysed the cumulative frequency of rainfall and snowfall within the range of values for different thermal indicators. The frequency of rainfall exceeds 50% when the temperature on a wet bulb thermometer is higher than +2°C, while on a dry bulb thermometer - higher than +3°C. Analogous temperature limits in the case of snowfall amount to -7°C for a wet bulb thermometer and -6°C for a dry bulb thermometer.



>> The scope of temperatures from a dry bulb thermometer (T) and a wet bulb thermometer (Tw) on a daily resolution (thermal and precipitation) and in observation times for the presence of liquid (rain), mixed (sleet) and solid (snow) precipitation in the area of the Polish Polar Station Hornsund in the years 1979–2016. Irrespective of the time resolution (a thermal day, a precipitation day or observation times) during liquid precipitation, the scope of temperatures from the wet bulb thermometer (Tw) is smaller than the scope of temperatures from the standard thermometer (T). The same relationship was observed in the case of solid precipitation. This is the reason why the temperature from a wet bulb thermometer represents a better criterion for determining the precipitation type than the temperature from the dry bulb thermometer

**Interests and hobbies:** Travels, both far and near. Camping, mountain and polar trips, preferably to the Stanisław Baranowski Spitsbergen Polar Station (commonly known as "Baranówka"). Ballroom dance which I have always loved. Good concerts, obviously, and roller-skating – especially through my favourite places.

**Motto or reflection:** At a time when we believe that the Earth has no more mysteries for us and the satellites show us every nook and cranny of the planet, it turns out that there are still unique, eerie, yet fascinating places where humans are merely guests. Such places include polar areas with their enchanting landscapes, wild animals and intact natural beauty, which cannot be found anywhere else in the world.

## SUPERVISOR



Assoc. Prof. Ewa Łupikasza  
University of Silesia, Faculty of Earth Sciences,  
Department of Climatology

Research interests: synoptic climatology and climate change. She conducts research in polar regions, in Poland and in Europe, focusing on atmospheric precipitation. Recently, she has been dealing with snowfall and rainfall, as well as the determinants of their spatio-temporal changes.





# Joanna Ćwiąkała

Institute of Geophysics, Polish Academy of Sciences

Studies completed: Pedagogical University of Kraków, field of study: Geography, with a teaching specialisation (science)

Watch a video:



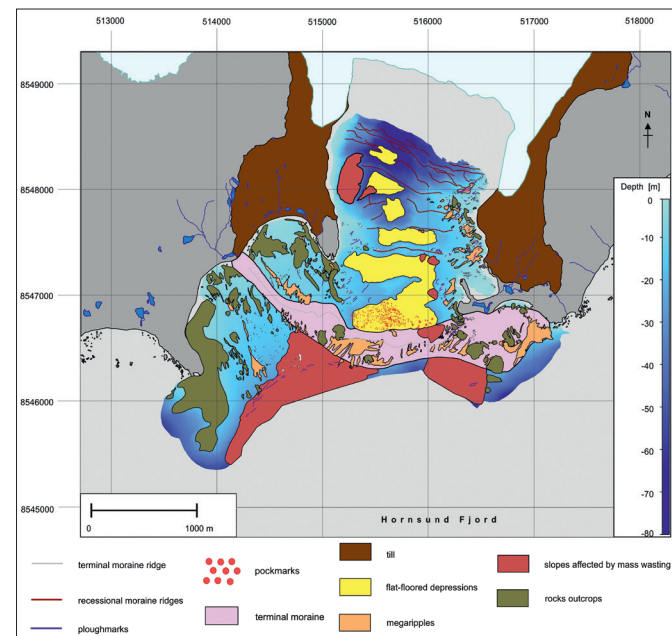
## The record of retreat of the tidewater Hans glacier in the light of geophysical, geomorphological and sedimentological research in the bays Isbjørnhamna and Hansbukta, Hornsund, southern Spitsbergen

### Zapis recesji uchodzącego do morza lodowca Hansa w świetle badań geofizycznych, geomorfologicznych i sedymentologicznych w zatokach Isbjørnhamna i Hansbukta, Hornsund, południowy Spitsbergen

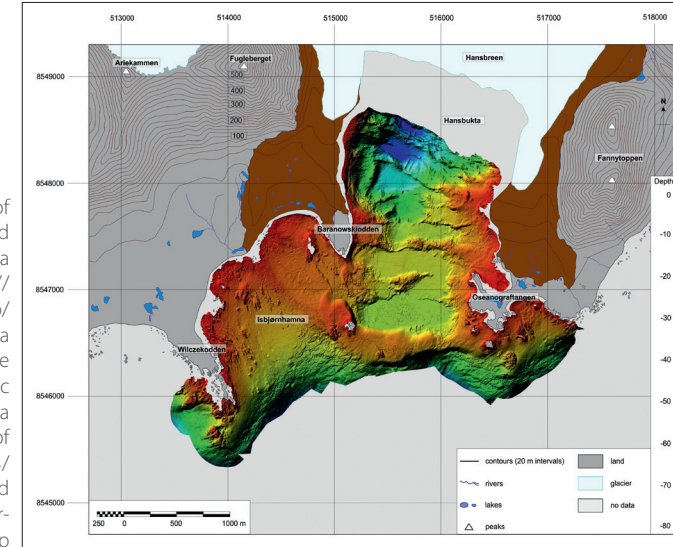
Climate change affects the Earth's natural environment. Since the turn of the 19th and 20th centuries, when the coldest period of the Holocene (the Little Ice Age, LIA) came to an end, a gradual climate warming has been observed, which has been responsible, among other things, for glacier retreat. Some glaciers surge, i.e. undergo sudden flow accelerations. Regardless of the glacier process taking place (glacier retreat or advance), the topographic relief within the forefield of a glacier undergoes changes. On the basis of topographic forms found in the area, it is possible to determine past behaviour of the glacier.

My doctoral dissertation focuses on the study of the sea floor within the forefield of Hans Glacier, which flows into the Horn-

>> Geomorphological map of the study area, created on the basis of data published on <http://geodata.npolar.no/>, bathymetric data purchased from the Norwegian Hydrographic Service (licence for data use by the Institute of Geophysics PAS, No. 13/G722), sonar data, seismoacoustic profiles, and information obtained from bottom sediment samples. Source of maps on page 48 and 49: Ćwiąkała J. et al, 2018. *Submarine geomorphology at the front of the retreating Hansbreen tidewater glacier, Hornsund fjord, southwest Spitsbergen*. *Journal of Maps* 14 (2), 123-134, Doi: 10.1080/17445647.2018.1441757



>> Bathymetric map of the study area created on the basis of data published on <http://geodata.npolar.no/> and bathymetric data purchased from the Norwegian Hydrographic Service (licence for data use by the Institute of Geophysics PAS, No. 13/G722). The map was used to create the geomorphological map



sund fjord, located in the south-western part of Spitsbergen. The study area covers two bays: Isbjørnhamna and Hansbukta. The aim of my dissertation was to determine the impact of the retreat of a non-surging glacier on sea floor topography and sediment characteristics, with the use of geophysical, sedimentological and geomorphological methods. The temporal scope of the study covered 120 years, since the end of LIA to the present. Achieving the aim was possible after becoming familiar with the topography of the glacier's forefield, as it provides direct evidence regarding past behaviour of the glacier, as well as sediments and sedimentation processes.

The topography of Hans Glacier forefield is typical of retreating glaciers. The sediments accumulated in the forefield are carried into the area by meltwater flowing out of the glacier and by icebergs. Areas of intensive sediment accumulation and erosion have been found at the bottom of both bays, in which various sedimentation processes (such as suspension sedimentation, sediment melt-out from icebergs, sediment wash-out, sediment remobilisation and resedimentation) take place.

Study results show that topographic forms found in the forefield of Hans Glacier are connected to glacier retreat and there are no forms to be found there which would be connected to glacier surges. The retreat of Hans Glacier has been taking place gradually since the end of LIA. Climate change has a significant influence on glacier retreat, as it affects glacier ablation and increases the amount of sediment-carrying water flowing out of the glacier.

Describing the course of Hans Glacier retreat within the last century and its consequences will increase the amount of knowledge available not only on this particular glacier, but also on other, similar ones.

**Interests and hobbies:** Reading, mountain hikes, diving, jogging, travelling, wildlife photography, music

## SUPERVISORS



Assoc. Prof. Witold Szczuciński  
Adam Mickiewicz University in Poznań,  
Institute of Geology

Research interests: he is a geologist. The main object of his research is sediments that act as an archive of the Earth's history. He is particularly interested in quantification of contemporary sedimentation processes and the sediment records of environmental changes, especially those related to natural disasters (tsunamis, storms, floods, meteorite impacts, and surging glaciers). He conducts research both on land and at sea, mainly in the Arctic, eastern Asia and Poland.



Dr. Mateusz Moskalik  
Institute of Geophysics PAS

Research interests: sedimentation processes and physical oceanography in fjords, the glacier-sea interaction, coastal erosion in polar regions.



# Léo Decaux

University of Silesia

Studies completed: Université Joseph-Fourier in Grenoble, Master in Earth and Environment Sciences, specialisation: Environment and Climate

Find out more:



## The water drainage in the polythermal glacial system based on radio-echo soundings and model solutions

### Drenaż wód w politermalnym systemie glacjalnym w oparciu o sondowania radarowe i modelowanie numeryczne

Water on Earth is represented at 97.5% by salty water (seas and oceans) and at 2.5% by freshwater. 68.7% of the total freshwater volume is contained by glaciers. They are the main source of freshwater on Earth which is essential for life. A glacier is an ice body flowing under its own weight and the gravity force. Here I'm using the term “flowing” because glaciers behave like a very slow river.

There are two possibilities for glaciers to lose some mass:

- melting,
- calving, i.e. creation of icebergs.

Nowadays we are in a context of global temperature warming, and those two mechanisms occur more and more. They are adding some new cold freshwater in the global water system, disturbing oceanic currents and then disturbing the climate on Earth. Moreover, by supplying the sea with additional water, they increase its level. Calving rate depends on glaciers' velocity – the higher it is, the bigger the iceberg production will be. One of the most important factors regarding glaciers' velocity is the presence of meltwater at the interface between the bottom of the glacier and the bedrock on which it is moving. The presence of meltwater at this interface will act like a lubricant and increase the glacier's speed.



>> Metallic structure allowing to fix the cable on the glacier surface on which the sensors are attached on inside the glacier mill



>> In order to follow the evolution of a cave system and to locate our sensors, we map the same cave year after year. This cave needs about 2 full days of measurement work within it to create a map

My research allows us to better understand how the water circulation on, inside and below a glacier is linked to its speed and to meteorological conditions. Our most important discovery so far is that only one week of positive air temperature during the winter can double the winter glacier's flow velocity.

**Interests and hobbies:** In order to prepare myself, as much on a physical than on a psychological level, to conduct expeditions in the harsh Arctic environment, I practiced different sports since my younger age. I spent 8 years into two clubs to train my Judoka skills (regarding polar bears) and to train my gymnastics skills (to better squeeze into small glacier cavities). I also played handball for 11 years, including 8 years at a high level (to be able to survive to the extreme intense fieldwork and to learn how to play as a team during the expeditions). I currently train my skydiving skills from a plane or in an aerodynamic tunnel (to be able to survive in any helicopter accident). I also play drums and percussion (to set the mood of the station in fire at any time with any tools!). Finally, just for fun I regularly sing karaoke and go on hiking and skiing trips!

**Motto or reflection:** During my childhood, I spent every summer holiday hiking in the Chamonix Valley (France) with my family – little did you know this would nurture my passion for high mountain environments, and especially glaciers.

Having always been intrigued by the polar regions and wanting to deepen my knowledge, I decided to study glaciology for six months at the University Centre in Svalbard (UNIS) in Longyearbyen. Having now been bitten by the polar bug, I remained on Svalbard for another year. I've always dreamed of regularly undertaking expeditions into the wilderness in order to carry out field measurements and to try to understand the mechanisms of the nature which is surrounding us.

## SUPERVISORS



Prof. Jacek Jania  
University of Silesia, Faculty of Earth Sciences,  
Department of Geomorphology

Research interests: evolution of glaciers and Arctic environment affected by climate change; the dynamics of tidewater glaciers; glacial geomorphology.



Assoc. Prof. Mariusz Grabiec  
University of Silesia, Faculty of Earth Sciences,  
Department of Geomorphology

Research interests: the functioning of glacial systems in the Arctic and high-mountain areas, as well as the interaction between glacial environment and non-glaciated areas, the atmosphere and the hydrosphere, with the application of geophysical methods (especially radar sounding).



# Kajetan Deja

Institute of Oceanology, Polish Academy of Sciences

Studies completed: University of Gdańsk, Faculty of Oceanography and Geography, major: Oceanography, specialisation: Marine Biology

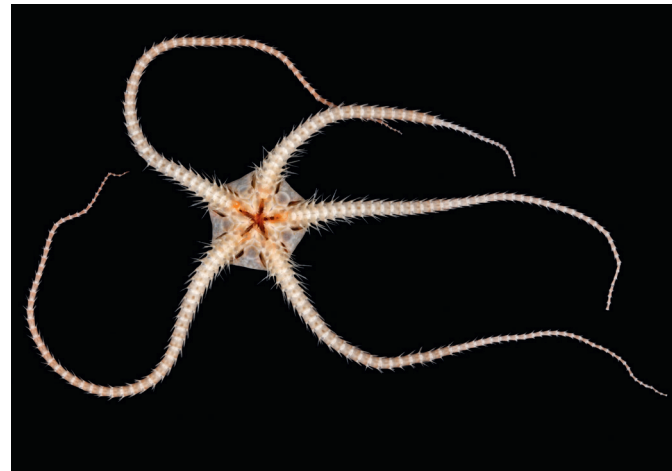
Watch a video:



## The role of benthic megafauna in Spitsbergen fjords

### Rola megafauny bentosowej we fiordach Spitsbergenu

Megabenthos is defined as a group of benthic organisms, large enough to be identified in sea-bed photographs, and collected from the seabed using towed gear. Despite its small numbers, it plays an important role in the benthic habitat, especially in deep sea polar regions, where one of the significant factors limiting the presence of benthic organisms is scarcity of food substances. The research conducted as part of my doctoral dissertation explains whether progressing environmental changes (warming, increased sedimentation and fresh water supply to fjords) may lead to changes in the role of megabenthos in those ecosystems (biomass, size, share in the food chain). The analysis of a series of multi-year data concerning echinoderms (1996-2014), compared with historical data (1900–1970) for this region, made it possible to demonstrate changes in the numbers and distribution of species. Four species were found – and they had not been recorded before 1996. On the other hand, a few species known from old records were not present in the contemporary data set. Bottom concentrations, shoals of krill in glacial regions were also observed and documented in a video. This plankton species in polar regions can be found at the bottom, affects the sediment structure, and represents a precious source of food for the benthos and sea-birds that also gather eagerly in those regions.



>> A brittle star – one of the benthic inhabitants of the cold Arctic waters

The fjords of western Spitsbergen provide a unique opportunity to encounter and study the effects of progressing climate change, as well as serve as perfect natural laboratories where we can observe the gradients of numerous key environmental factors. Small changes in the environment are capable of causing significant transformations in benthic communities.



>> R/v Oceania – the ship owned by the Institute of Oceanology PAS – in one of the Spitsbergen fjords. It was on this vessel that I spent almost every summer on Spitsbergen, conducting research from its deck



>> A moment of free time while conducting field research and an opportunity to capture the beauty of the surrounding nature in a photo. Spitsbergen, 2015

**Interests and hobbies:** I mostly enjoy exploring the world on a bike. Biking trips with panniers are, in my opinion, the best way to maximise the travel experience, with all the senses. One can feel the smells of the surrounding nature, the warmth and the cold; there is a closer contact with humans and nature. I am fascinated by Siberia, which is perhaps the most authentic place on Earth. In my rare free time, I collect and repair old tube radio sets, construct NIXIE tube clocks and tube amps. I like photographing the world around me, chopping wood and canoeing.

**Motto or reflection:** Once you experience the encounter with the north, you will probably catch the polar bug. The chance to observe calving glaciers and the sound of bursting air bubbles, both in sea foam and ice growlers, have been deeply entrenched in my memory. All of this, combined with the difficult-to-reach emptiness and the beauty of the intact nature, acts as a specific magnet that regularly attracts me to those regions of the Earth.

## SUPERVISORS



Prof. Jan Marcin Węśławski  
Institute of Oceanology PAS

Research interests: ecology of Arctic coastal waters, biodiversity change, influence of climate change on the ecosystem functioning.



Assoc. Prof. Lech Kotwicki  
Institute of Oceanology PAS

Research interests: he is a biological oceanographer, specializing in meiofauna taxonomy. He has conducted his research mainly in the Arctic Ocean and the Baltic Sea.



# Katarzyna Dudzisz

Institute of Geophysics, Polish Academy of Sciences

Studies completed: Jagiellonian University, Institute of Geological Sciences, field of study: Geology, specialisation: Mineralogy, Geochemistry, Petrology

Find out more:



## Palaeomagnetic and rock magnetic investigations of the Triassic rocks from Svalbard Archipelago

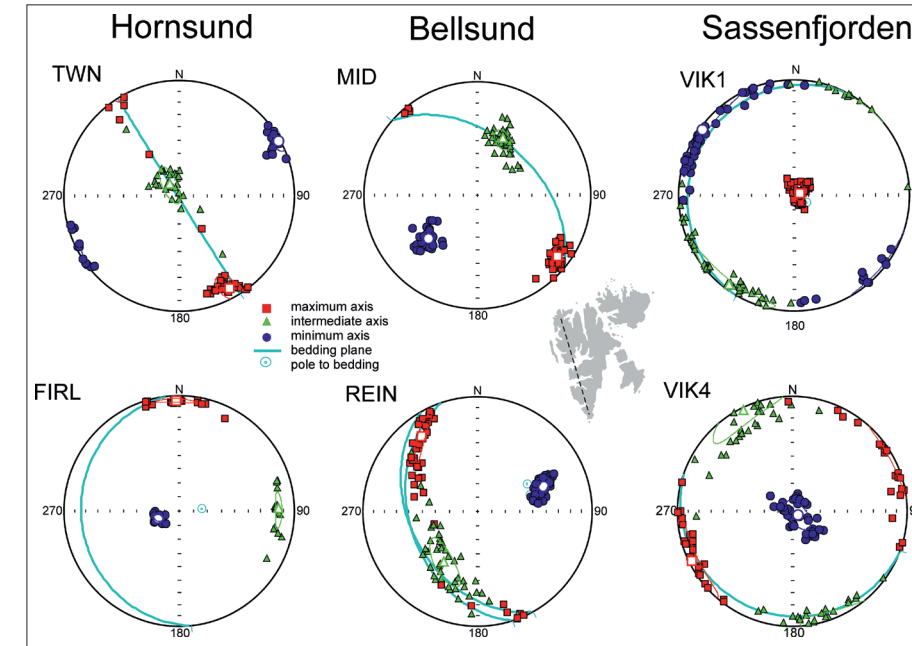
### Badania paleomagnetyczne i petromagnetyczne skał triasowych Archipelagu Svalbard

The aim of my dissertation was to determine magnetic properties of the Early Triassic sedimentary rocks from the Svalbard archipelago in order to improve the understanding of Spitsbergen's tectonic history. This refers mainly to the course and degree of tectonic deformations in the analysed rocks and their thermal history related to their burial followed by tectonic uplift or heating by magmatic intrusions. Investigations were conducted in the western part of Spitsbergen, where rocks were

folded and uplifted in the form of a mountain range, and in the centre of the island, where rock layers incline at a low angle and are not markedly deformed. The lithology and tectonic history of the analysed areas affected the rate and character of diagenetic processes, maturity of organic matter, and secondary mineralization. Investigations of magnetic susceptibility and anisotropy suggest a dominant role of paramagnetic minerals in the formation of the so-called magnetic lineation, whose



>> Triassic formations in Wedel Jarlsberg Land (tip of Nathorst Land), Bellsund, Spitsbergen



>> Projection of selected results of the anisotropy of magnetic susceptibility on a sphere. Red squares represent the orientation of maximum susceptibility axes, green triangles – intermediate axes, and blue circles – minimum susceptibility axes. Blue lines represent the bedding plane. Black dashed line indicates the orientation of main folding structures in Spitsbergen. Projection in a geographic coordinate system (modified after Dudzisz et al., 2018)

orientation corresponds with fold axes (NW–SE) within the fold belt. Anisotropy of undeformed rocks within the forefield shows a NNE–SSW orientation of magnetic lineation, which correlates with the direction of the Triassic paleocurrent. Further investigations indicate that the presence of magnetite and pyrrhotite (ferromagnetic minerals) is linked to the record of secondary magnetic remanence. Results suggest that at least some of the calculated palaeomagnetic directions are secondary, formed before the main folding phase or in its early stages. Integrated rock magnetic and mineralogical studies indicate rather chemical, than thermal, origin of the secondary magnetic remanence.

**Interests and hobbies:** I enjoy discovering what is hidden and broadening my horizons. Knowledge of foreign languages, history and architecture makes it possible for me to understand people and their traditions. On the other hand, spending time actively in the mountains fills me with excitement, helps me relax and—as a result—gives me a tremendous sense of satisfaction. Traveling allows me to collect not only minerals from all over the world, but also wonderful memories.

**Motto or reflection:** Do not try to understand everything, lest you become ignorant of everything.  
**Democritus**

## SUPERVISORS



Assoc. Prof. Rafał Szaniawski  
Institute of Geophysics PAS

Research interests: the application of palaeomagnetic methods in palaeogeographic interpretations and studies on mountain range evolution.



Dr. Krzysztof Michalski  
Institute of Geophysics PAS

Research interests: magnetic properties of rocks in the Svalbard archipelago, palaeogeography and tectonics of the Atlantic sector of the Arctic (Svalbard, Greenland) based on integrated palaeomagnetic, structural, petrological and isotopic studies.



# Magdalena Gwizdała

Institute of Geophysics, Polish Academy of Sciences

Studies completed: University of Gdańsk, Faculty of Oceanography and Geography, field of study: Oceanography, specialisation: Marine Geology

Watch a video:



## Magnetic properties of glacial-marine sediments as a tool to qualitative analysis of exaration of the Werenskiold Glacier (SW part of Wedel Jarlsberg Land, Spitsbergen)

### Zastosowanie własności magnetycznych osadów glacialno-morskich do jakościowej analizy egzaracji Lodowca Werenskiolda (SW część Ziemi Wedela Jarlsberga, Spitsbergen)

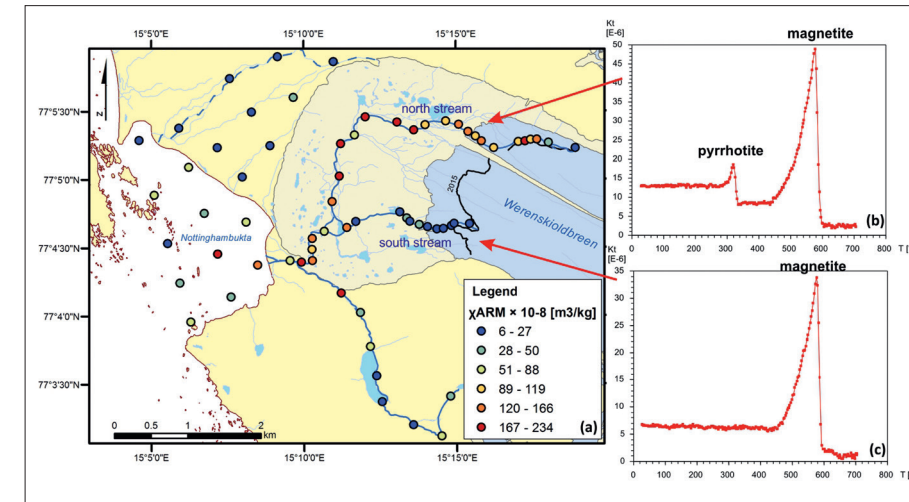
The main aim of this study was to use magnetic properties of sediments to describe the process of transport, segregation and deposition of material formed as a result of exaration or melted out from the body of a glacier during its retreat.

Rocks and surface sediments from proglacial streams were collected in the area of Werenskiold Glacier and Nottingham Bay (south-western part of Spitsbergen). Magnetic parameter measurements were used to specify magnetic properties and to identify magnetic information carriers, which made it possible to determine the origins of the sediments. Magnetic methods were complemented with granulometric and mineralogical analyses, which enabled a comprehensive description of the studied material.

Serious differences were observed between the main streams, northern and southern, flowing from Werenskiold Glacier. As it turned out, sediments from the northern stream are more varied in terms of magnetic grain size as well as content and



>> Collecting rock samples in the forefield of Werenskiold Glacier, also known as Mordor



>> Spatial distribution of anhysteretic susceptibility ( $\chi_{ARM}$ ) on the basis of maps published by the Norwegian Polar Institute (a) (<https://doi.org/10.21334/npolar.2014.645336c7>) along with sample thermomagnetic curves for the northern stream (b) and the southern stream (c) (modified after Gwizdała et al. 2018)

concentration of magnetic minerals. They also display a stronger magnetic signal than sediments from the southern stream. This is primarily a result of different lithological and geological structure of source material within the streams, and a more rapid recession rate of the northern glacial tongue. Another factor causing the variation is the changeability of hydrochemical conditions and higher flow volume in the northern stream.

The process of bedrock exaration by a moving glacier intensifies the magnetic signal emitted by the clastic material, and so does the rate of glacier retreat. Analysing the variability of magnetic properties of sediments is a useful tool for qualitative evaluation of glacier exaration.

#### Interests and hobbies:

- Books, books, books! – from mysterious detective novels, through curious fantasy, to love stories with happy ends;
- Extreme sports – there is nothing as arousing as a hefty dose of adrenaline one gets during parachute jumping, bungee jumping, diving, wakeboarding, off-roading, or a RIB ride;
- Eating, with Lady Chocolate at the top of the list – as seen from the point of view of a taster and an amateur cook;
- Love of animals – no matter if it is a guinea pig, dog, cat, dolphin or a grey seal.

**Motto or reflection:** Since I was a child, I have always been fascinated with the sea and its mysteries. Later on, this fascination became a decisive factor in the choice of oceanography as my academic path. During the course of my studies, the passion for the sea evolved rather than faded, for which the credit goes partially to Professor Łęczyński, my current supervisor. He asked why I should limit myself to the sea and if it wouldn't be worth it to understand the impact of glaciers on marine processes. Even though it has since been modified a few times, the idea caught my attention and pushed me towards doctoral studies and polar issues.

## SUPERVISORS



Prof. Maria Teisseyre-Jeleńska  
Institute of Geophysics PAS

Research interests: the palaeomagnetism of rocks from the areas of Europe and Spitsbergen; magnetic properties of rocks with a particular focus on magnetic anisotropy and magnetization reversal processes; environmental magnetism – the magnetic structure of soils, environmental pollution examined using magnetic methods.



Assoc. Prof. Leszek Łęczyński  
University of Gdańsk, Institute of Oceanography

Research interests: studies of the seabed and the coastal area of seas and oceans, including the modelling of coastal morphodynamic processes, sedimentological and geophysical methods in marine geology, polar research on the transformation of sea coasts and environmental magnetism. Implementing cooperation with archaeologists on the environmental impact of shipwrecks on the seabed and the geological reconstruction of environmental changes in the area of archaeological artefacts.



# Daniel Kępski

Institute of Geophysics, Polish Academy of Sciences

Studies completed: University of Wrocław, Faculty of Earth Sciences and Environmental Management, field of study: Geography, specialisation: Climatology and Atmosphere Protection

Watch a video:



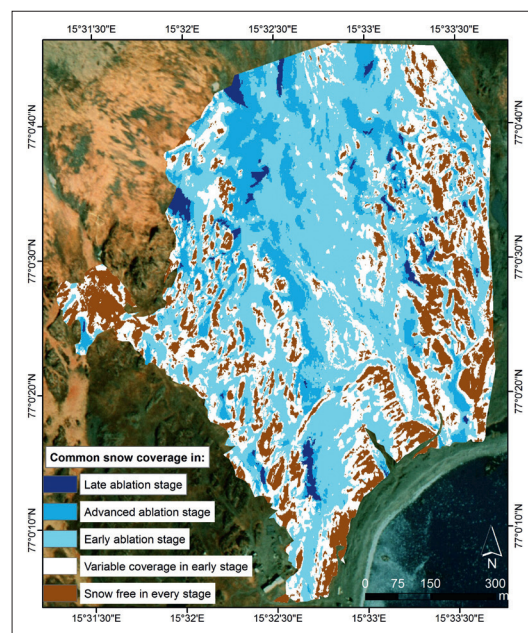
## The influence of land cover and topography on the spatial distribution and dynamics of snow cover on the tundra around Polish Polar Station in Hornsund, Spitsbergen

### Wpływ rzeźby i pokrycia terenu na rozkład przestrzenny i dynamikę zmian pokrywy śnieżnej na tundrze w okolicy Polskiej Stacji Polarnej na Spitsbergenie

The aim of the study was to determine the relationship between, on the one hand, the presence of snow cover and, on the other, the topographic relief and distribution of plant formations in Arctic tundra. The study was carried out on the coast of the Hornsund fjord (southern part of Spitsbergen), mainly in a small non-glaciated catchment of Fuglebekken stream.

An analysis of the available remote sensing and terrestrial data provided evidence of increased snow deposition and extended presence of snow cover in western parts of valleys located along the coast of the fjord. This is due to the fact that in valleys with north-south orientation snow gets transferred by the prevailing eastern winds. Moreover, it was proven that snow cover is thicker and melts later deeper in the Hornsund fjord, which is due to a gradual air temperature decrease related to growing distance from the open Greenland Sea. Snow cover was also thicker in areas covered with thick, damp plant formations (mosses), and melted faster in places where tall vascular plants, such as the polar willow, were found.

This suggests important relationships between vegetation and the presence of snow, which seems to create favourable condi-



>> The effect of combining classified and orthorectified time lapse photographs taken during the ablation seasons of 2014, 2015 and 2016. Areas marked in brown were the first to emerge from under the snow in all studied seasons; areas marked in dark blue are where the snow took the longest to melt



>> Setting up a time lapse camera close to the peak of Fugleberget. The photographs were used to determine changes in the snow cover of the non-glaciated Fuglebekken catchment during the ablation seasons of 2014, 2015 and 2016

tions for the development of hygrophilous plants (i.e. plants which grow in damp conditions) and to hinder the growth of arborescent (i.e. treelike) plants. The study makes use of SNOWPACK and Alpine 3D models, demonstrating the dynamics of snow cover formation and its spatial distribution.

The models, along with climate simulation results, were used to demonstrate snow conditions in the area of the Hornsund fjord, which – according to the models – will be observed at the end of the century. On the basis of the available data, it is possible to predict climate conditions in the future: if greenhouse gas emissions reach the highest estimated levels, average annual air temperature would rise by 6.5°C, which would shorten the period with a snow cover by almost three months. This would also diminish snow thickness despite the predicted increase in the total sum of precipitation. It would also cause more intense winter thaws, or even breaks in the period with continuous snow cover during winter seasons.

**Interests and hobbies:** Mountain hikes; books about aliens; unusual kinds of music (hardvapour, witch house, retro wave) and cinema (Korean revenge movies); production of homemade liquor; conversations about the weather. At the Polish Polar Station, I grew to like snow, the cold and the dark.

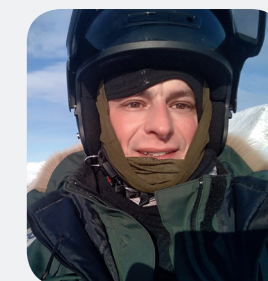
**Motto or reflection:** I have always enjoyed watching nature programmes and found places untouched by civilisation fascinating. Initially, I was particularly interested in weather phenomena, but—with time—I became interested in climate changes as well. Shortly after receiving my MA degree, I joined an all-year expedition to Polish Polar Station Hornsund, Spitsbergen, as a meteorologist. It not only gave me a chance to visit a place beyond the reach of most people, but also—and more importantly—made it possible for me to develop my academic interests, the result of which is my doctoral dissertation.

## SUPERVISORS



Prof. Krzysztof Migala  
University of Wrocław, Institute of Geography and Regional Development

Research interests: geographer-climatologist; head of the Department of Climatology and Atmosphere Protection of the Institute of Geography and Regional Development at the University of Wrocław, participant of numerous polar expeditions, including three year-round expeditions, head of XXVI PAS Polar Expedition 2003/2004 to Spitsbergen. Conducts research works related to the climatology and ecosystems of mountains and polar regions.



Dr. Bartłomiej Luks  
Institute of Geophysics PAS

Research interests: snow hydrology, spatial distribution and stratigraphy of snow cover in polar and mountainous regions, glaciology, and climatology.



# Szymon Kosecki

Institute of Oceanology, Polish Academy of Sciences

Studies completed: Gdańsk University of Technology, Faculty of Civil Engineering and the Environment, Environmental Engineering, specialisation: Hydroengineering

Watch a video:

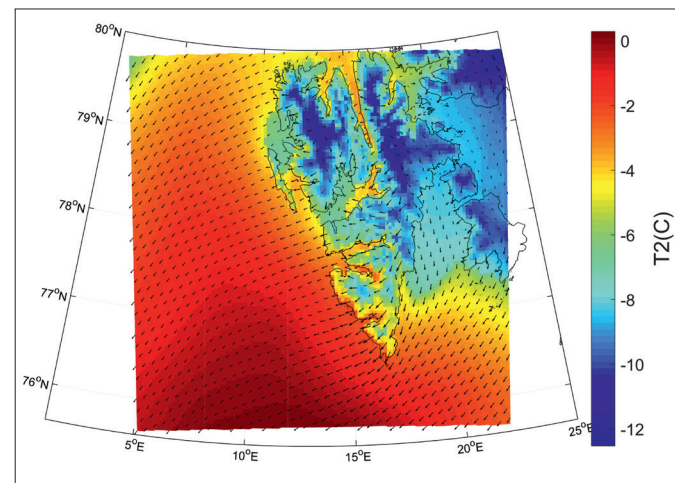


## Application of numerical modelling in investigations of changes in the hydrodynamics of chosen West Spitsbergen fjords

### Badanie zmian zachodzących w hydrodynamice wybranych fiordów zachodniego Spitsbergenu za pomocą modelowania numerycznego

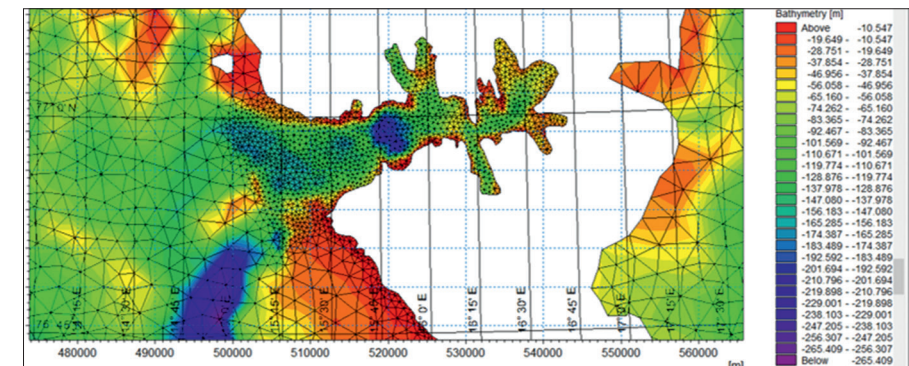
The Arctic is currently viewed as one of the main climate regulators on the global scale, and treated as an indicator of the rate and scope of climate change (IPCC 2013). The exploration of these areas is greatly facilitated by scientific curiosity and researchers' determination, which also accompany me in deepening my knowledge on the circulation of water masses in the fjords of western Spitsbergen (Hornsund and Kongsfjord).

The research problem I have undertaken is an attempt to use a computer to solve sets of equations describing the physical properties of the fluids in the above-mentioned fjords. The mathematical issues concerning fluid dynamics were formulated a long time ago, however it is still a great challenge to illustrate the dynamics of water masses in specific places, such as fjords. Numerical modelling offers huge possibilities, especially when combined with traditional methods of environmental research and remote-sensing. It allows for both spatial representation of the course of past phenomena and their prediction. In my research, numerical modelling represents a tool that helps to explore the phenomena occurring in a very dynamic period of 2010–2015 in two fjords, e.g. by determining the dependence of estuarial circulation on local winds or describing the characteristics of the At-

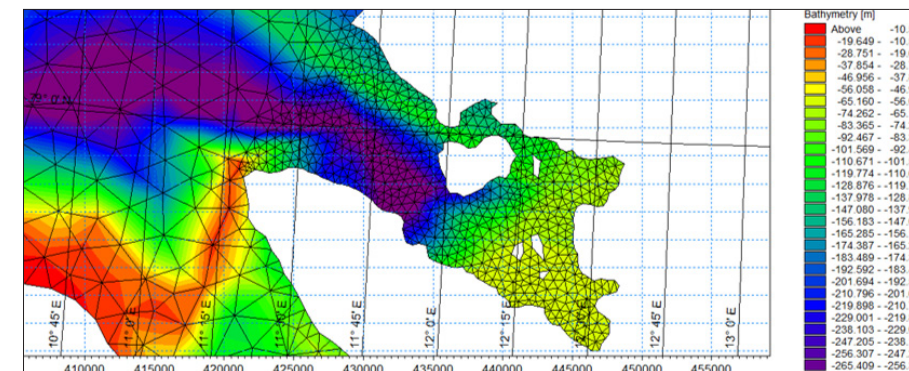


>> The average wind circulation and the average surface temperature for the Spitsbergen region. A very significant result of the work, obtained from the WRF atmospheric model. It illustrates that wind is basically dependent on the local conditions of surface temperature. At the same time, it refers to the hypothesis of my doctoral dissertation, namely: Is the surface wind in the Spitsbergen region the most important factor determining the circulation of water masses in the fjords?

lantic Water inflows to the shelf. In my dissertation, I used the WRF atmospheric model and the Mike hydrodynamic model. I took into consideration more variables than the works carried out so far. Thanks to numerous environmental research in the selected period, I have a powerful set of data which make it possible to obtain reliable results concerning the hydrographical conditions prevailing in this period. These results make it possible to use computer calculations to analyse complex systems in which various environmental factors, studied in these systems, interact with each other.



>> The computational grid of a model for the Hornsund fjord. The concentration in the fjord area is crucial to analyse the whirlpool processes of an area with a very complex coastline and bathymetry



>> Kongsfjord is deeper than the Hornsund fjord. It also has a higher water temperature, although it is located further north than the Hornsund fjord

#### Interests and hobbies:

My passions are many and varied from music, through electronics, to brewery. I can play instruments, solder and cook – I am passionate about what I create.

**Motto or reflection:** "Everybody knows that something cannot be done, and then comes the one who doesn't know it cannot be done, and he does it!" **Albert Einstein**

"Everything should be made as simple as possible, but not simpler" **Albert Einstein**

## SUPERVISOR



Assoc. Prof. Lidia Dzierzbicka-Głowacka

Institute of Oceanology PAS

Research interests: her interests are focused on issues related to studies of physical and biological processes in the marine environment using numerical methods: the modelling of hydrodynamic and biogeochemical processes (the 3D CEMBS model of the Baltic Sea ecosystem), the modelling of Spitsbergen fjords, and the Copepoda population modelling. The research she conducts is characterised by a high level of interdisciplinarity encompassing a few scientific disciplines, such as oceanology (marine dynamics, physics, biology and chemistry), mathematics and information technology (IT).



>> Landscape of Skoddebukta Bay



# Katarzyna Koziorowska

Institute of Oceanology, Polish Academy of Sciences

Studies completed: University of Gdańsk, Faculty of Oceanography and Geography; field of study: Oceanography, specialisation: Marine Geology and Geography, specialisation: Physical Geography

Find out more:



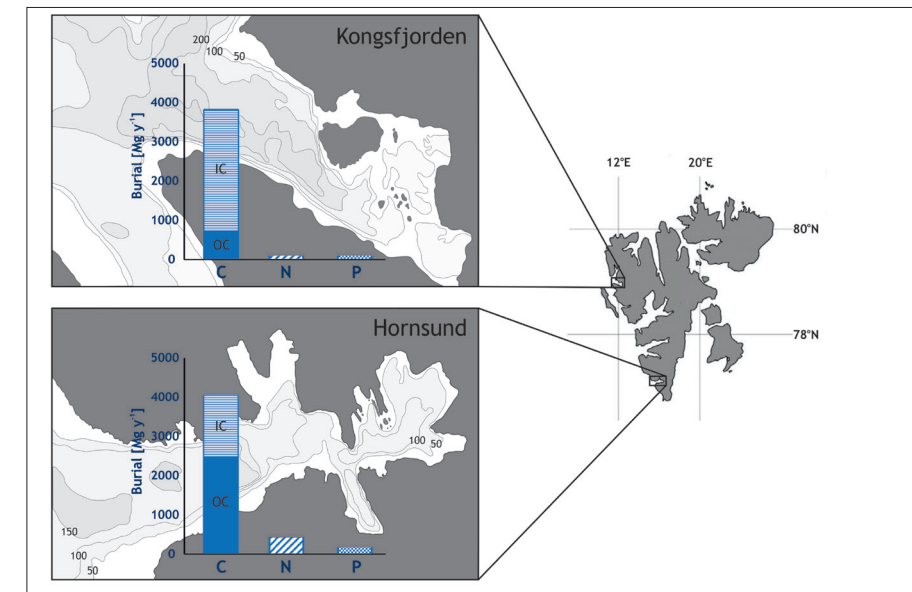
## Determination of the carbon, nitrogen and phosphorus burial rates in bottom sediments of two West Spitsbergen fjords (Hornsund and Kongsfjord)

### Ocena efektywności zagrzebywania węgla, azotu i fosforu w osadach dennych dwóch fiordów Zachodniego Spitsbergenu (Hornsund i Kongsfjord)

Carbon dioxide concentration in the atmosphere, determined by a number of processes involved in “carbon cycle”, has an influence on the climate. Biogeochemical cycles of carbon, nitrogen and phosphorus (C, N and P), which are basic biogenic macro-elements, are particularly affected by bottom sediments, which play an important role “receiving” these elements from water. The majority of them is buried in subsurface sediments and thus excluded from contemporary cycles. Burial of elements is understood as a difference between the amount of C, N and P transported to the sediments and the return flux of these elements from the sediments back to the water. Processes of biogenic element deposition in sediments and their return to water are particularly important in polar regions, especially in fjords, which are characterized by large amounts of organic matter sinking to the sediments in short periods of time. In my doctoral dissertation, I focused on the determination of C, N and P burial rates in subsurface sediments of two West Spitsbergen fjords: Hornsund and Kongsfjord. The conducted research made it possible to estimate that 7900 tons of carbon, 520 tons



>> Laboratory work at the Department of Chemistry and Marine Biochemistry. Measuring the concentration of carbon and nitrogen with the use of an elemental analyser combined with a mass spectrometer



>> The amount of carbon (C; organic fraction – OC; inorganic fraction – IC), nitrogen (N) and phosphorus (P) buried (stored) in subsurface sediments of two fjords located on the west coast of Spitsbergen (Svalbard archipelago), namely Hornsund and Kongsfjord

of nitrogen and 270 tons of phosphorus are buried annually in the sediments of these fjords, which shows that sediments constitute an important and long-term natural sink for these elements. Moreover, results suggested that sediments are also an important “source” of C, N and P to the water column, which is extremely important in studying primary production and biogenic elements cycling.

The obtained results significantly improve our knowledge of the role of sediments in carbon, nitrogen and phosphorus cycles in marine environment. They may also represent significant contribution to biogeochemical models, which often perceive sediments only as a sink for sedimentary material and do not consider them as a potential source.

#### Academic interests:

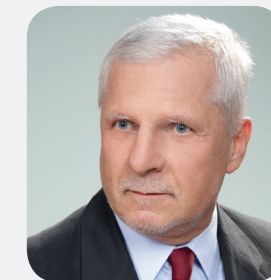
- marine biogeochemistry of polar regions,
- the impact of climate warming on the biogenic macroelements' (C, N and P) cycles,
- properties of organic matter and its role in marine environment.

#### Other interests:

- sailing (steersman licence), skiing,
- travelling, Italian and Spanish culture and cuisine.

**Motto or reflection:** What fascinates me in academic work is the opportunity to continuously develop, expand one's interests and satisfy one's curiosity. Moreover, project work makes it possible to engage in a variety of activities, such as fieldwork (often in unique places, e.g. polar regions), laboratory work (requiring thoroughness and precision), and work involving analytical skills. Through academic work, it is also possible to meet interesting people from around the world.

## SUPERVISORS



Prof. Janusz Pempkowiak  
Institute of Oceanology PAS

Research interests: a chemist by education, but a marine geochemist by experience, he is interested in the carbon cycle in shelf seas.



Dr. Karol Kuliński  
Institute of Oceanology PAS

Research interests: he specialises in the research on the carbon cycle in the marine environment. In his work, he tries to combine issues related to both the carbonate system (the abiotic part) and the role of living organisms (the biotic part), taking into account the processes occurring in the seawater column, at the water-atmosphere boundary and in bottom sediments



# Magdalena Krajewska

Institute of Oceanology, Polish Academy of Sciences

Studies completed: Gdańsk University of Technology,  
Faculty of Chemistry, field of study: Biotechnology

Find out more:



## Carotenoids in sediments as markers of changes in the marine environment

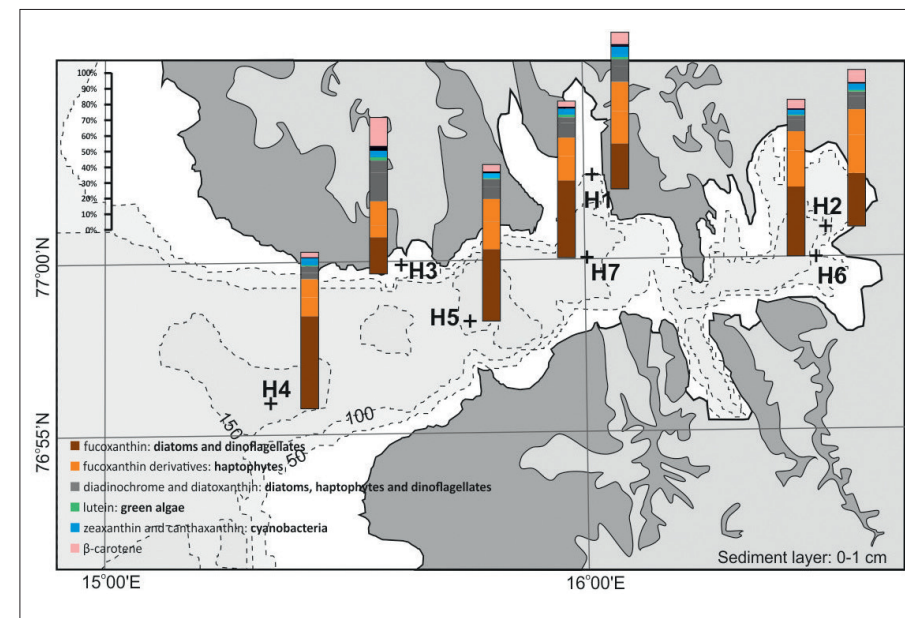
### Karotenoidy w osadach jako wskaźniki zmian zachodzących w środowisku morskim

In the marine environment, carotenoids (pigments) occur, among others, in phytoplankton, macroalgae and in sediments. The aim of my doctoral research was to compare carotenoids in recent and deep sediments found in the coastal regions of the northern hemisphere, and to mark out indicators typical of the conditions existing in the area and the dominant phytoplankton groups. My study area included aquatic basins with different climatic conditions: the Gulf of Gdańsk, Norwegian fjords, and the fjords of Spitsbergen. Pigments preserved best in sediments with a high content of organic matter and oxygen deficiencies in the near-bottom water. In marine environments with high oxygen content and extensive euphotic zone, these compounds decompose more rapidly. Pigments in the sediments of Spitsbergen fjords have not yet been described. Despite oxygen conditions and relatively small water productivity within the fjord, pigments in sediments were used as environmental markers also in this area.

Main conclusions regarding the Hornsund fjord drawn as part of this study are:

- The largest part of the phytoplankton biomass is made up of diatoms and haptophytes;

>> Collecting sediment samples in the Hornsund fjord from r/v Oceania during AREX expedition in 2015.



>> Taxonomic composition of phytoplankton in the Hornsund fjord determined on the basis of carotenoids found in sediments.

- Macroalgae are a source of organic matter for sediments in the intertidal zone;
- Zooplankton grazing is the main factor affecting the decomposition of organic matter.

Another aim of the study was to determine how climate change affects the taxonomic composition of phytoplankton and environmental conditions in other fjords of Spitsbergen.

Moreover, a significant achievement was to identify carotenoids typical of past toxic cyanobacteria blooms in sediments from the Gulf of Gdańsk. Carotenoids constitute universal markers for the study of climate change.

**Interests and hobbies:** Apart from academic interests, which include new analytical techniques and the use of organic compounds in sediments as markers of the state of environment, my main interest is reading (with the focus on Swedish detective novels). I am also interested in olfactology, which is the study of smells. I like cooking as well as Italian and Thai cuisine. Fitness classes give me a chance to be active. I particularly enjoy exercising to the rhythm of Latin American music.

**Motto or reflection:** I became passionate about academic work and deepening my knowledge about the world when I was a university student. Back then, however, I never imagined that I would be conducting scientific research in the Arctic. When I heard about the Centre for Polar Studies (CPS), I thought it would be a challenge and, thus, worth a try. Having browsed through the available materials, I realised that there is a number of publications devoted to carotenoids in sediments within different aquatic basins, but none devoted to pigments in the sediments of West Spitsbergen fjords. This is when I came up with the idea of what to focus on in my doctoral dissertation. The studies involved turned out to be so fascinating that I am already looking forward to another visit in the Arctic.

## SUPERVISORS



Prof. Grażyna Kowalewska  
Institute of Oceanology PAS

Research interests: marine chemist, in charge of the Marine Pollution Laboratory at the Institute of Oceanology PAS in Sopot, which she organised from scratch. My scientific interests concentrate on organic compounds as indicators of various processes occurring in the sea, environmental analysis, as well as new methods for monitoring the marine environment.



Dr. Eng. Małgorzata Szymczak-Żyła  
Institute of Oceanology PAS

Research interests: she is a marine chemist. She has been working in the Marine Pollution Laboratory at the Institute of Oceanology PAS in Sopot since 2001. Her scientific interests and activities revolve around issues related to the application of organic compounds (i.e. pigments, sterols) occurring in sediments as markers of primary production, eutrophication, climate change and marine environment condition.



# Anna Makarewicz

Institute of Oceanology, Polish Academy of Sciences

Studies completed: University of Gdańsk, Faculty of Oceanography and Geography, field of study: Oceanography, specialisation: Marine Physics,  
Gdańsk University of Technology, Faculty of Applied Physics and Mathematics, field of study: Applied Physics, specialisation: Technical Physics

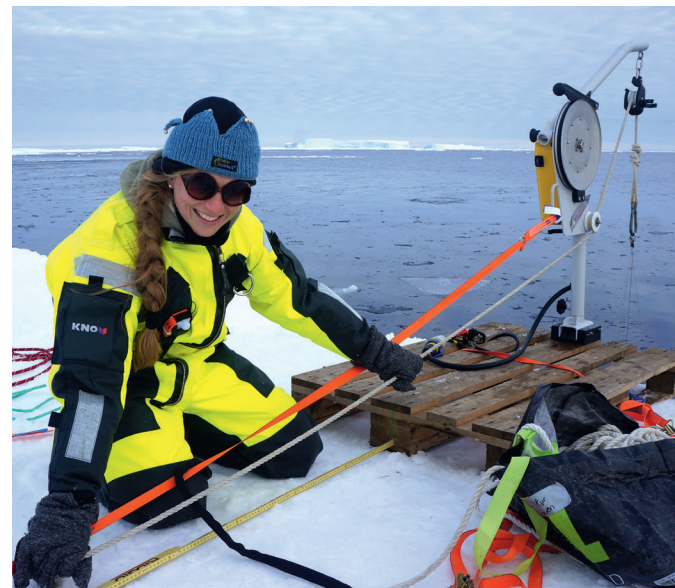
Find out more:



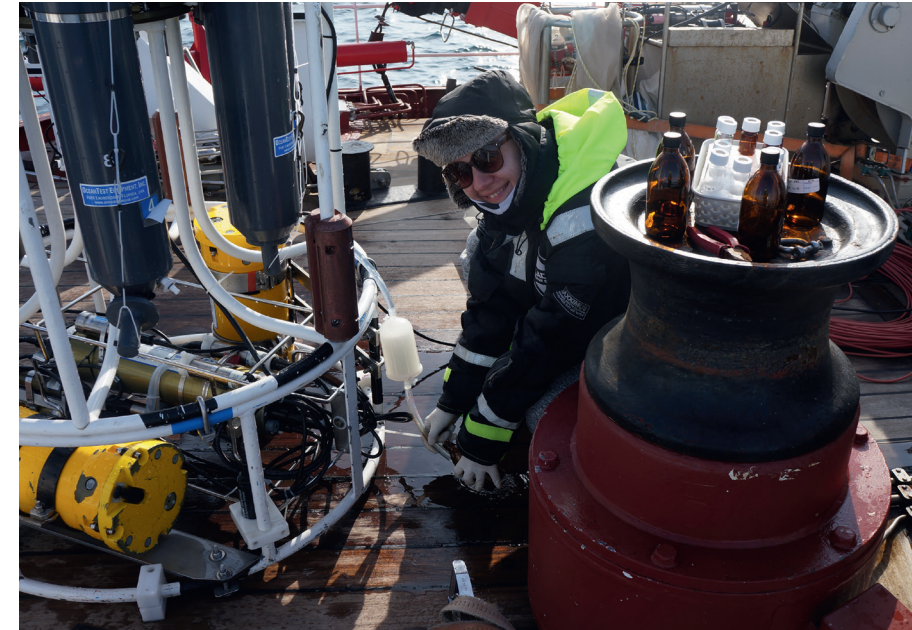
## Spectral absorption and fluorescence properties of Chromophoric Dissolved Organic Matter (CDOM) in the Nordic Seas

### Spektralne właściwości absorpcji i fluorescencji chromoforowej rozpuszczonej materii organicznej w wodach Mórz Nordyckich

A considerable amount of Arctic river is discharged into the Arctic Ocean containing high concentrations of dissolved organic matter (DOM). In the Nordic Seas (the Norwegian Sea, Barents Sea and Greenland Sea) warm waters of the Atlantic Ocean encounter and mix with the cold and low salinity waters of the Arctic Ocean. Due to a difference in DOM concentration and qualitative composition in these two contrasting water masses, dissolved organic matter undergoes a quantitative and qualitative transformation in the Nordic Seas. DOM transformation is additionally modified by the melting of sea ice. The aim of the study is to determine the spatial distribution, sources and composition of chromophoric dissolved organic matter (CDOM) on the basis of a detailed analysis of water samples, performed with the use of absorption and fluorescence spectroscopy methods. According to the dissertation's fundamental hypothesis, CDOM variability in the surface waters of the open Nordic Seas is one of the factors with the highest impact on the solar heating of the ocean's surface layer and on the amount of light available under water. As a result, it is vital for controlling both climate variability and marine ecosystem. Conducted research made it possible to determine year-to-year variability



>> Studies of the light field and the absorption and scattering of light in the water column at the edge of the fast ice of Greenland. In such difficult conditions scientific equipment must have additional security



>> Collection of sea water samples from different depths from r/v Oceania, with the use of a flow filter (with pore diameter of 0,2  $\mu\text{m}$ ), directly from a Niskin bottle to properly prepared vials. Sea water filtered in such a way contains only dissolved organic compounds and is ready for spectroscopic analyses in a lab

of light absorption by CDOM and to link the observed changes with the intensity of warm Atlantic Water inflow to the Fram Strait. Another important conclusion was that there is a close correlation between the intensity of DOM protein-like fluorescence and chlorophyll a fluorescence measured in situ, which suggests that phytoplankton biomass is a direct source of the protein-like fraction of DOM in the Nordic Seas.

#### Academic interests:

- marine optics: inherent and apparent properties of sea water,
- optical properties of chromophoric dissolved organic matter (CDOM),
- interdisciplinary studies and climate changes in polar regions,
- in-situ measurements of physical parameters of sea water.

**Other interests:** swing dance: Lindy Hop, travelling, playing the flute and the piano, classical, swing and folk music.

**Motto or reflection:** Learning is like a boundless ocean. The more of it you drink, the more thirsty you become

**Stefan Żeromski**

My fascination with marine optics started at university, during a cruise across the Atlantic, which gave me a chance to collaborate with a marine optics group from IO PAS. Doctoral studies made it possible for me to continue research in the field of marine optics. I chose the Arctic because of the limited amount of data available on these sensitive area and the unique character of fieldwork. An additional incentive was my willingness to understand climate changes in such a beautiful an remote part of the world as the Arctic.

## SUPERVISOR



Assoc. Prof. Piotr Kowalczyk

Institute of Oceanology PAS

Research interests: he conducts research in the field of marine physics and ocean optics. His main research interest and most important publications concerned absorption and fluorescence properties of dissolved organic matter in the shelf seas and Atlantic and Arctic Oceans.



>> An integrated optical-hydrological probe used to register vertical profiles of inherent optical properties of sea water (attenuation: absorption and scattering of light in the water), CDOM fluorescence and chlorophyll a fluorescence, as well as to measure conductivity, temperature and pressure, which were measured in situ at points located down to 200 m below the surface of water



# Mikołaj Mazurkiewicz

Institute of Oceanology, Polish Academy of Sciences

Studies completed: University of Gdańsk, Faculty of Oceanography and Geography, specialisation: Oceanography

Watch a video:



## Impact of environmental variability on the zoobenthos size structure in North Atlantic and Arctic coastal waters

### Wpływ zmienności warunków środowiskowych na strukturę wielkościową zoobentosu w północnoatlantyckich i arktycznych wodach przybrzeżnych

The research conducted as part of my doctoral dissertation primarily concerns the size structure of benthic communities (the share of the biomass of all the organisms in the particular size classes). The main purpose of the dissertation is to determine whether the changes of environmental conditions related to global warming will result in changes of the size structure of the zoobenthos population and communities in the coastal waters (the fjords) of the North Atlantic Ocean. The dissertation is based on the “space-to-time analogy” approach, used in researching the effects of climate change. An assumption was made that the benthic fauna living in the relatively warm waters of coastal Norway constitutes an equivalent of the future Arctic fauna in the course of the forecasted global warming. Comparing the fauna from both regions will therefore make it possible to predict the changes that are supposed to take place in arctic regions as a consequence of global warming.

The results of the research indicate that the size structure of benthic communities is not subject to high spatial variability which would depend on either the latitude or the thermal regime. However, significant differences were observed in the total biomass and numbers, which – to a great extent – resulted

from the availability and quality of food. On the other hand, the share of biomass in the particular size classes seems to be quite conservative and permanent, and – importantly – independent from the high variations of the fauna species composition in

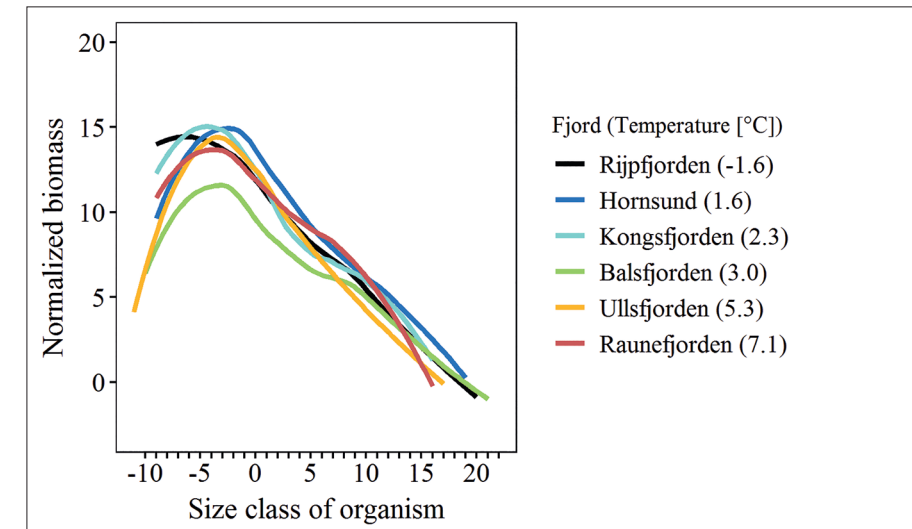


>> Field works (sifting the sediment) at the Polish Polar Station Hornsund

>> Collecting macro-zoobenthos samples during a winter Arctic cruise on board the r/v Helmer Hanssen



the fjords under analysis. Nevertheless, it is worth noting that the largest organisms are observed only in those fjords which have a relatively low temperature. This may indicate that, as the climate gets warmer, larger organisms will cease to exist or will be less represented in the communities of benthic fauna of the fjords.



>> The distribution of zoobenthos biomass in the fjords under analysis, depending on the size class. The temperature indicated refers to the temperature of bottom water during sample collection.

**Interests and hobbies:** Programming in R and Python, cooking, sport

**Motto or reflection:** I have always wanted to have a non-standard job, which would make it possible for me to travel – oceanography and polar research were the perfect choice for me.

## SUPERVISORS



Assoc. Prof. Maria Włodarska-Kowalczyk  
Institute of Oceanology PAS

Research interests: she is a marine ecologist with many years of research experience in the Arctic regions and the Baltic Sea. Her areas of interest include the interconnections of structure (taxonomic, functional and size-related biodiversity) and the functioning of benthic communities.



Dr. Joanna Legeżyńska  
Institute of Oceanology PAS

Research interests: ecology of the Arctic benthos, especially the role of crustaceans in Arctic food webs.



# Iwona Niedźwiecka

Institute of Oceanology, Polish Academy of Sciences

Studies completed: University of Gdańsk, Faculty of Oceanography and Geography, specialisation: Physical Oceanography with elements of Geoinformatics; Faculty of Biology and Earth Sciences, major: Physical Geography, specialisation: Meteorology and Climatology

Find out more:



## Analysis of mass, momentum and climate relevant gas fluxes across the sea surface in the European Arctic

Analiza strumieni masy, pędu oraz gazów istotnych dla klimatu przez powierzchnię morza w Arktyce Europejskiej

The intense changes observed on Earth – resulting from the links between geospheres, as well as the diversity and complexity of the exchange processes for mass, momentum, heat and gases that occur between those geospheres – have made it necessary to parameterise the exchange fluxes for different environments, and to determine their links to climate changes. To substantiate the parameterisation for individual fluxes, it was necessary to collect an optimal amount of data, as well as create continuous networks for monitoring climate change, which make use of different measurement techniques, such as the Eddy Covariance method. By conducting permanent measurements for the components of the air-sea fluxes, as well as by analysing the volumes of these exchanges, it is possible to determine the level of interaction between the components of the Earth's climatic system.



>> Measuring atmospheric CO<sub>2</sub> concentration levels from on board the r/v Oceania, using LI-COR 7550



>> On board the r/v Oceania in the Kongfjorden area

Polar regions are particularly susceptible to climate change due to Arctic amplification, which leads to a three-fold higher increase in air temperature in polar regions compared with the global average. This is caused by the difference in the annual supply of radiant energy to the ground and the specific ocean circulation. As a result, heat resources from lower latitudes are transported to the areas of high latitudes. Observation and description of the changes occurring in polar regions is crucial in determining global climate changes.

**Interests and hobbies:** First of all, culinary tourism. I enjoy exploring new places by exploring new tastes. My second area of interest is art, especially Expressionism – my two favourite painters are Edward Dwurnik and Egon Schiele. I spend my free time sewing on a sewing machine, reading, and cultivating plants.

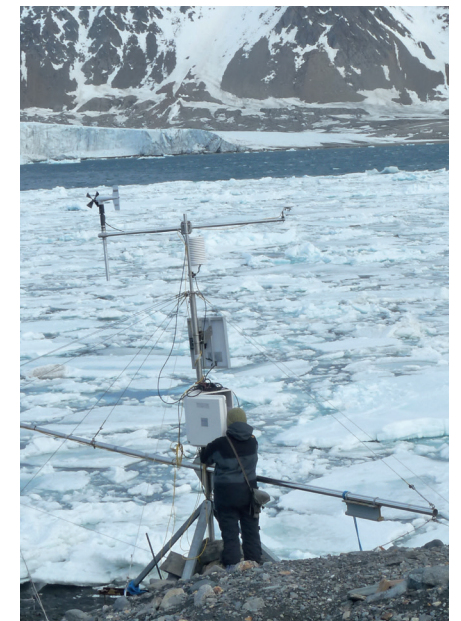
**Motto or reflection:** Don't let the fear of striking out keep you from playing the game. I took up polar research somewhat by chance. During my master studies, I was fascinated by lightning, which is a highly intriguing phenomenon. I started to search for contact points between oceanography and meteorology. This led me to Prof. Piskozub, who encouraged me to explore the physical aspects of climate change in polar regions, where I began to examine CO<sub>2</sub> levels. Environmental changes in the Arctic have been a long standing cause of concern for researchers, who find it extremely challenging to explore the problems affecting these areas. The research work in these regions and the commitment to protect polar regions quickly transform into passion. This was also the case with me and I am extremely happy about it.

## SUPERVISOR



Prof. Jacek Piskozub  
Institute of Oceanology PAS

Research interests: he deals with ocean-atmosphere exchange on all scales, the radiation processes in the ocean and the atmosphere, as well as the influence of the ocean on the Earth's climate.



>> Automatic weather station located on Baranowski Cape near the Hornsund fjord. It provides information on selected meteorological parameters (temperature and humidity, wind speed and radiation, solar radiation).



# Anna Pouch

Institute of Oceanology, Polish Academy of Sciences

Studies completed: University of Gdańsk, Faculty of Oceanography and Geography, chemical and analytical specialisation

Find out more:



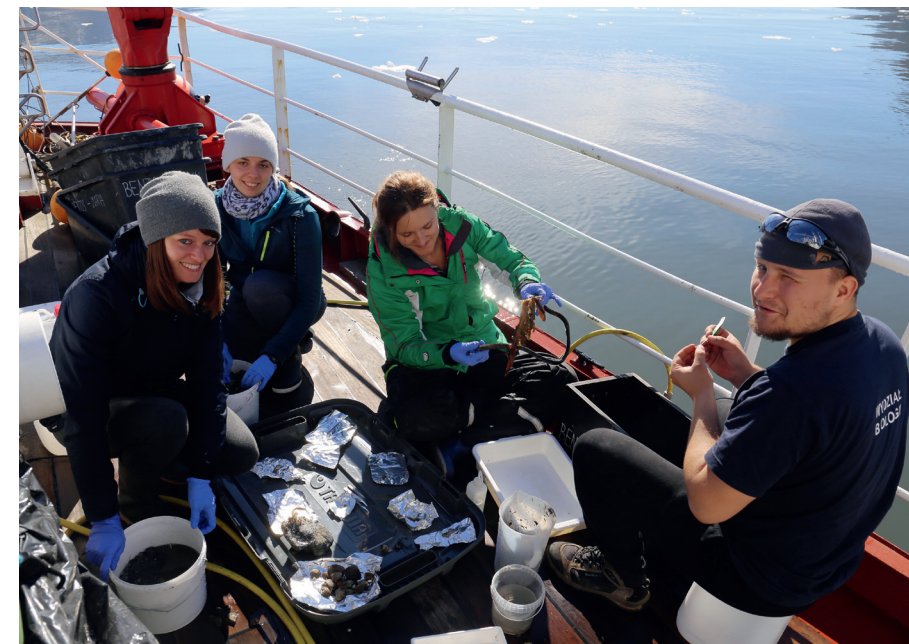
## Assessment of exposure of organisms to persistent organic pollutants (POPs) in West Spitsbergen fjords benthic habitats

Ocena narażenia organizmów na zanieczyszczenia z grupy trwałych zanieczyszczeń organicznych (TZO) w siedliskach bentosowych fiordów zachodniego Spitsbergenu

For a long time, the Arctic had been viewed as a pristine region. However, it is not free from pollutants that are transmitted along with air masses, sea currents or sea ice. Persistent organic pollutants (POPs) are chemical compounds characterised by persistence, volatility, hydrophobicity, and ability to bioaccumulate and biomagnify. Many of the organic pollutants identified in the Arctic are harmful to the fauna due to their toxicity. These compounds not only negatively affect the nervous and reproductive systems, but they are also carcinogenic.

The purpose of my doctoral dissertation is to examine the distribution of concentrations for selected organic pollutants in biotic and abiotic components of the ecosystems in western Spitsbergen fjords (Hornsund, Adventfjorden, and Kongsfjorden). The results obtained made it possible to assess the exposure of the organisms living in those fjords to the effects of compounds belonging to polychlorinated biphenyls and polycyclic aromatic hydrocarbons. The analyses of organic pollutants in cores of bottom sediments revealed that, in recent years, higher concentration levels of pollutants occur primarily in the vicinity of intensively melting glaciers, which points to the supply of pollutants in the waters of the melting glaciers (the results

>> The research material collected during the AREX 2017 expedition (shrimps collected to determine the concentrations of persistent organic pollutants)



>> Working on board of the r/v Oceania - benthos sampling (AREX 2017 - Hornsund)

were published in *Environmental Monitoring and Assessment*). The results obtained as part of my doctoral dissertation expand the knowledge on the circulation of persistent organic pollutants in the arctic fjord environment and contribute to the understanding of the consequences of intense environmental changes occurring in recent years in the regions explored.



**Interests and hobbies:** cycle tourism, literature, environmental chemistry.

**Motto or reflection:** I became interested in environmental protection during my master studies. During my internship at the Institute of Oceanology, I came across environmental research carried out in the Arctic. I was intrigued by the issue of persistent organic pollutants in polar regions, and especially by how intense climate change can modify the distribution and harmfulness of toxic chemicals in the Arctic environment.

## SUPERVISORS



Assoc. Prof. Ksenia Pazdro  
Institute of Oceanology PAS

Research interests: the circulation of persistent organic pollutants and of new emerging pollutants (e.g. pharmaceutical residues) in marine ecosystems (the Baltic Sea and the Svalbard fjords). Assessing the impact of persistent organic pollutants and pharmaceutical residues on marine organisms.



Assoc. Prof. Agata Zaborska  
Institute of Oceanology PAS

Research interests: she is a marine geochemist, but her greatest interest is the contamination in the Arctic.



# Agnieszka Promińska

Institute of Oceanology, Polish Academy of Sciences

Studies completed: University of Gdańsk, Faculty of Oceanography and Geography, field of study: Physical Oceanography

Find out more:



## Dynamics of interannual and seasonal variability in temperature, salinity and currents in Hornsund Fjord, Spitsbergen

### Dynamika międzyletnich i sezonowych zmian temperatury, zasolenia oraz prądów morskich w fiordzie Hornsund, Spitsbergen

Arctic fjords play an important role in climate changes, as they constitute a link between land and open sea. Fjords situated along the west coast of Spitsbergen deserve particular attention because of the West Spitsbergen Current, which carries warm, salty Atlantic Water northwards into the Arctic Ocean. On the way, Atlantic Water mixes with the waters of coastal current and increases their temperature. As a result, it serves as an important source of heat for waters in fjords lying in this part of Spitsbergen.

The main aim of my doctoral research is to investigate temporal and spatial variability in temperature, salinity and currents in the Hornsund fjord, situated in the south-west of Spitsbergen. In comparison with other fjords located along the west coast of Spitsbergen, Hornsund is least affected by Atlantic Water, mainly because of the cold Sørkapp Current (transporting fresher water), whose impact is clearly visible in the Hornsund area. Compared to Kongsfjorden, located in the north-western part of Spitsbergen, Hornsund fjord has, on average, lower water temperature (by 1°C) and lower salinity, but its fresh water



>> Successful removal of an anchored measurement system (mooring) at the mouth of the Hornsund fjord. Moorings make it possible to record data every 5-10 minutes for up to 2 years. They are usually equipped with an acoustic current meter (attached to the frame), which records data on the speed and direction of currents in the water column, and CTD sensors attached to a rope at specified depths



>> CTD probe (Conductivity, Temperature, Depth) in a frame that allows to make continuous measurements, i.e. the device measures sea water parameters from the surface to the bottom, while the ship is moving along the designated transects, which enables obtaining high-resolution horizontal cross-sections for temperature and salinity (up to several hundred meters)

content is twice what it is in Kongsfjorden, mainly due to melting and calving of tide-water glaciers located nearby.

Still, hydrographic data collected every July since 2001 show an increase in the temperature and salinity of waters in the Hornsund fjord, which stems from the fact that waters of the Atlantic origin is becoming more abundant than local waters formed in the fjord. This reflects the fjord's sensitivity to the observed changes in environmental conditions in the Svalbard region (warmer winters, gradual decrease of sea ice, increased temperature and salinity of the West Spitsbergen Current, and increase in occurrence of conditions facilitating the inflow of Atlantic Water into fjords).

**Interests and hobbies:** Because my work involves long hours in front of a computer screen, I enjoy spending free time actively. I love swimming and hiking. To take advantage of the fact that I live in the Tricity, I combine business with pleasure and explore Tricity Landscape Park armed with Nordic walking poles. And when the weather makes it hard to enjoy the outdoors, I go to interesting live concerts with friends or cook for them, using recipes typical of countries I have managed to visit.

**Motto or reflection:** When I was a child I was terrified of... water. I could swim, but only reluctantly, until I watched a documentary on marine rescue services and suddenly decided to join them. Health issues thwarted my plans, but I became convinced that water was my element. I graduated from Oceanography and, after going to Spitsbergen on a research ship for the first time, I understood that heat was not my thing. I love working at sea, despite a potential lack of creature comforts, with people I can learn a lot from.

## SUPERVISORS



Assoc. Prof. Waldemar Walczowski  
Institute of Oceanology PAS

Research interests: he is a physical oceanographer. He is mainly interested in ocean circulation and its impact on the Earth's climate. This is the reason why the Arctic, a region with such an extremely important influence on the climate, is the main area of his research. In recent years, he has been working on the mutual interaction processes between the ocean - the atmosphere and cryosphere in Arctic fjords.



Dr. Agnieszka Beszczyńska-Möller  
Institute of Oceanology PAS

Research interests: she is a physical oceanographer with over 25 years of experience in polar research and the main interest in oceanic exchanges and ocean-sea ice-atmosphere interactions in the Nordic Seas and Arctic Ocean. Participated in 30+ Arctic expeditions on Polish, German and Norwegian research vessels and icebreakers, leader in several international projects including ASOF, DAMOCLES, ACOBAR, PAVE, and H2020 INTAROS.



# Krzysztof Senderak

University of Silesia

Studies completed: University of Wrocław, Faculty of Earth Sciences and Environmental Management, Institute of Geological Sciences, field of study: Geology, specialisation: Exploration Geology

Watch a video:



## Reflection of environmental conditions in the internal structure of talus slopes on Southern Spitsbergen

### Zapis warunków środowiskowych w strukturze wewnętrznej stoków usypiskowych południowego Spitsbergenu

Talus slopes are formed at the bottom of rock outcroppings, in places particularly predisposed to the accumulation of loose, thick and irregular rock debris. The origin of these formations is closely related to the process of deglaciation. Exposure of an area from under the glacial ice masses leads to an unstable tectonic situation in the rock mass and activates processes that destroy the rocky slopes, thus providing the material for the formation of tali. This phenomenon is slowed down or accelerated by climate change. The glaciers on the northern hemisphere began to disappear several thousand years ago and this phenomenon has been occurring with varying intensity. Since then, contemporary talus slopes have been subject to continuous evolution, which depends, amongst others, on the rate of deglaciation and the size of the rock massifs over the tali (the alimentation area). Reconstructing the evolution of talus slopes on Spitsbergen is one of the most important objectives of my doctoral dissertation. The research methods include electrical resistivity tomography (ERT) and a georadar (GPR). The research to date has made it possible to develop a model of early slope evolution, which is mostly affected by the interaction with the glacier. Due to the fact that the accumulation of rock debris



>> The size and shape of talus slopes depend partially on the alimentation area (the place of origin of the rock debris) and the geological structure. The photograph shows the extremely steep and loose slopes of the Fannytoppen massif (390 m a.s.l.), which is primarily made of phyllite shales. Geophysical surveys in such conditions call for good organisation and sometimes also climbing skills of the entire surveying team



>> The system of eight talus slopes (cones) in the quartzite Gullichsenfjellet massif (583 m a.s.l.) in the Brattegg valley. The disappearance of the Brattegg Glacier occurred at least 3,500 years ago (similarly as in the neighbouring Rev valley). Despite the passage of time, the development of these slopes is still very dynamic. The photograph clearly presents the debris flow routes that deeply intersect the surface of the tali

occurs faster than the melting of glacial ice, the marginal zones of the glacier are covered by loose slope sediments. The ice thus buried becomes part of the internal structure of the slopes and determines their dynamic development. Another concept that was developed is the three-stage evolution of talus slopes divided into three periods, namely paraglacial, periglacial and alluvial. Comparing the slopes on Spitsbergen with those in the Tatra Mountains made it possible to trace their development over a longer time-scale covering more than ten thousand years.

**Interests and hobbies:** My interests have always revolved around sports. I have been cycling semi-professionally for over 10 years, which is my strongest discipline. I completed my first cycling marathon in secondary school in 2006. Since then, I have had a successful track record of over 75 MTB competitions both in Poland and abroad. Cycling teaches you how to be persistent in pursuing your goal (the finishing line), which made it easier for me to decide whether to take up my doctoral dissertation. Besides sports, I am enthusiastic about Polish jazz and travelling across distant continents with hand luggage only.

**Motto or reflection:** I ended up doing polar research by accident. When I was studying geology at the University of Wrocław and asked Dr. Anna Kowalska if she would be the supervisor of my master thesis, she responded: "OK, but the only subject I can suggest is related to Spitsbergen". Then, she offered me a 2-month trip to the Stanisław Baranowski Spitsbergen Polar Station, but I had only a few hours to make up my mind. I agreed. My curiosity about polar subjects and fascination with the Arctic stayed with me throughout my master studies and made it possible for me to continue the research on talus slopes as part of my doctoral dissertation.

## SUPERVISORS



Assoc. Prof. Bogdan Gądek  
University of Silesia, Faculty of Earth Sciences,  
Department of Geomorphology

Research interests: the functioning of and changes in the cryosphere of high mountains in the Pleistocene and Holocene, contemporary changes in the natural environments of high-mountain and polar regions, snow cover: physical processes, parametrisation and modelling.



Dr. Marta Kondracka  
University of Silesia, Faculty of Earth Sciences,  
Department of Applied Geology

Research interests: she specialises in the application of geophysical methods in an interdisciplinary approach to geological, geomorphological and environmental research, with a particular consideration of soil contamination with heavy metals, and the use of geophysical research in describing the spatial diversity of permafrost in the coastal area of the Arctic.



# Zofia Teresa Smoła

Institute of Oceanology, Polish Academy of Sciences

Studies completed: University of Gdańsk, Faculty of Oceanography and Geography, field of study: Oceanography

Find out more:



## Impact of environmental changes on the development of marine protist communities and their quantitative and qualitative structure in the fjords of western Spitsbergen

### Wpływ zmieniających się warunków środowiskowych na rozwój oraz skład jakościowy i ilościowy zbiorowisk morskich pierwotniaków we fiordach zachodniego Spitsbergenu

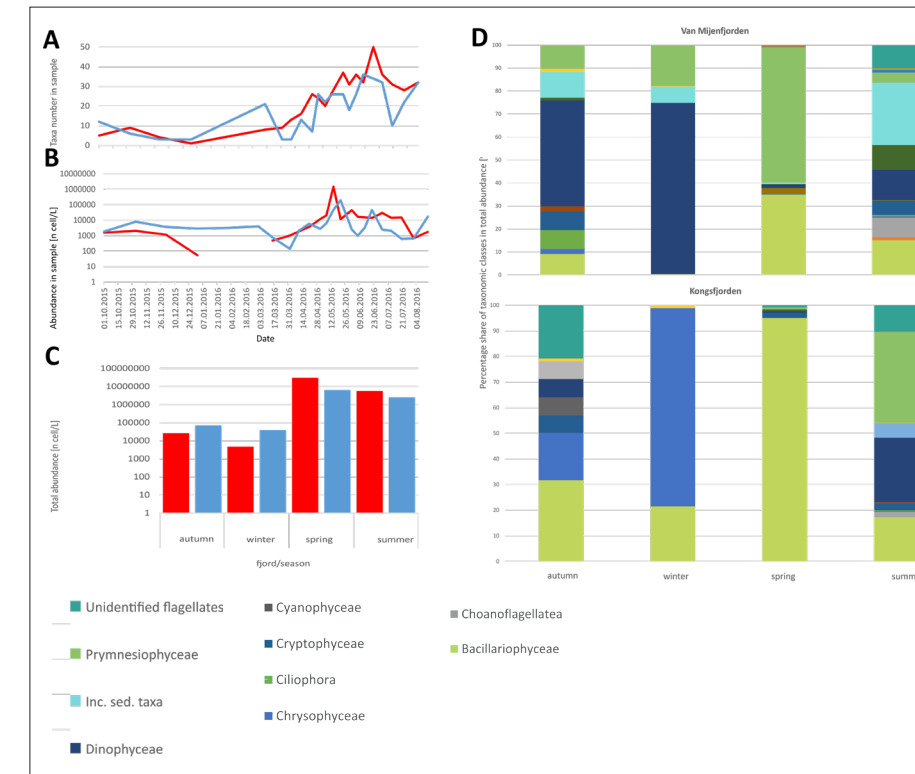
My doctoral dissertation focuses on Arctic marine and sea ice protists and, above all, on analysing the impact of current environmental changes on the (taxonomic, quantitative and trophic, etc.) structure of arctic marine protist communities and their development. The dissertation also attempts to define the mechanism of Arctic spring blooms and their scenario in the future as well as the potential consequences of the ongoing changes for the functioning of Arctic sea ecosystems. An essential, yet at this time fairly unexplored problem is to explain the impact on the year-round development of protist communities, loss of one of their component, at the earliest stage of growing season, the so-called sympagic protist community (protist related to the sea ice). The different environmental conditions of the selected fjords (Kongsfjorden and Van Mijenfjorden) make it possible to track the ongoing changes in the environmental parameters essential for the development of the organisms under analysis (e.g. hydrological and light conditions), as well as the impact of such changing parameters on the structure of Arctic sea protist communities and their growth.

The research and work on the doctoral project are closely related to the fulfilment of the international project entitled FAAbulous (*Future Arctic Algae Blooms and their role in the context of climate change*).



>> On duty – ensuring that no polar bear takes us by surprise during sample collection in the coastal zone of Isfjorden, Spitsbergen

Currently, I am finalising the analysis of all-year data (Fig. 1) acquired using autonomous devices registering environmental conditions and collecting samples of protist communities. I have also collected a wide variety of environmental data and samples of the protist communities from the past three years, which will be analysed statistically and then published.

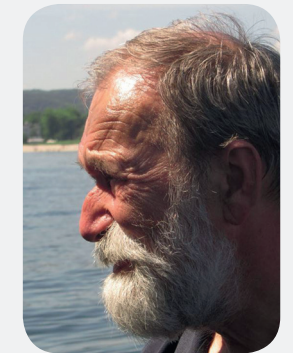


>> Figure 1. The annual variation in the number of taxa (A) and the average cell count (B) in Kongsfjorden and Van Mijenfjorden, the seasonal variation in the total cell count (C) and the seasonal variation in the percentage share of taxonomic classes in the total protist cell count in Kongsfjorden and Van Mijenfjorden

**Interests and hobbies:** I love wool, all kinds of wool and everything made of wool, especially things that can be worn. I would prefer to spend the long autumn and winter evenings knitting, with a mug of hot, aromatic black tea. My new favourite pastime is to travel by bike with a bicycle trailer with two little adventurous kids inside.

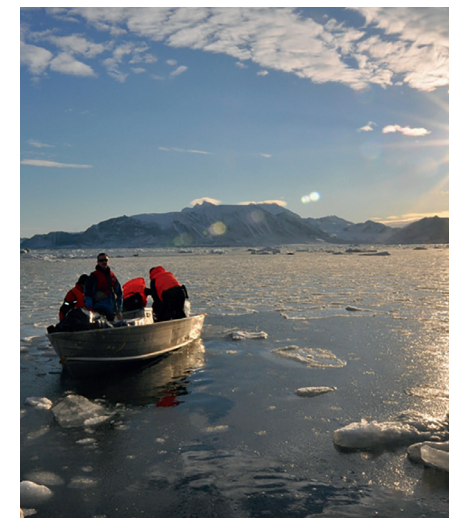
**Motto or reflection:** As a child, I devoured 'A Practical Guide for the Amateur Naturalist' by Gerald and Lee Durrell, discovering the world of plants and animals. My childlike curiosity has stayed with me until today and transformed into the willingness to explore issues related with the functioning of the natural environment. I am happy that the pursuit of my interests has taken me to the proverbial 'end of the world' – the Arctic. The work I perform is challenging in many respects. However, overcoming difficulties gives me a lot of satisfaction and motivation to tackle new challenges. The experience gained and the time spent in the Arctic are absolutely memorable and invaluable.

## SUPERVISOR



Assoc. Prof. Józef Wiktor  
Institute of Oceanology PAS

Research interests: a biologist who graduated from the Adam Mickiewicz University (specialisation: botany). He has been dealing with marine Protista – planktonic, ice-associated, and benthic (macroalgae), their taxonomy and ecology. The research areas are the regions of the Canadian Arctic, Svalbard, north-eastern Greenland, and the Chukchi Sea.



>> During field research



# Joanna Sziło

Institute of Geophysics, Polish Academy of Sciences

Studies completed: Jagiellonian University, Institute of Geography and Spatial Management, specialisation: Physical Geography

Watch a video:



## The impact of the recession of glaciers on the relief and hydrological conditions on the western shore of Admiralty Bay (King George Island)

### Wpływ recesji lodowców na rzeźbę obszaru i warunki hydrologiczne zachodniego wybrzeża Zatoki Admiralicji (Wyspa Króla Jerzego)

Climate changes observable around the world are particularly visible in polar regions. They are manifested mainly in the increase of air temperature, which contributes to glacier melting or accelerates the process. Glaciers located on the western coast of Admiralty Bay, on King George Island (West Antarctica), are especially susceptible to climatic fluctuations, as a result of which they may be treated as indicators of these changes. Their melting is determined by factors such as subglacial topography (which serves a stabilising or destabilising function), air temperature, and surface temperature of the sea they flow into. Glacier melting uncovers new areas, where meltwater gradually forms stream beds. As a result, stream beds found in front of a retreating glacier demonstrate different stages of development, with younger stream beds being more susceptible to transformations caused by erosion processes than the older ones. Study results indicate that, on the basis of grain size distribution of material transported by the streams, it is possible to determine the degree of development of proglacial stream beds.



>> Hydrological measurements in Fosa Creek in the forefield of Baranowski Glacier



>> Measurements of Suszczewski Cove bathymetry in front of Ecology Glacier



>> On the way to work. Seen in the background is the southern tongue of Baranowski Glacier.

**Interests and hobbies:** music, trekking, snowboarding

**Motto or reflection:** The difference between those who pursue their dreams and the rest of the world does not lie in the contents of one's wallet. It's all about the fact that some people spend their lives reading about far-away lands and dreaming about adventures, while others raise their eyes from the book, get up from the armchair and set off to meet their dreams.

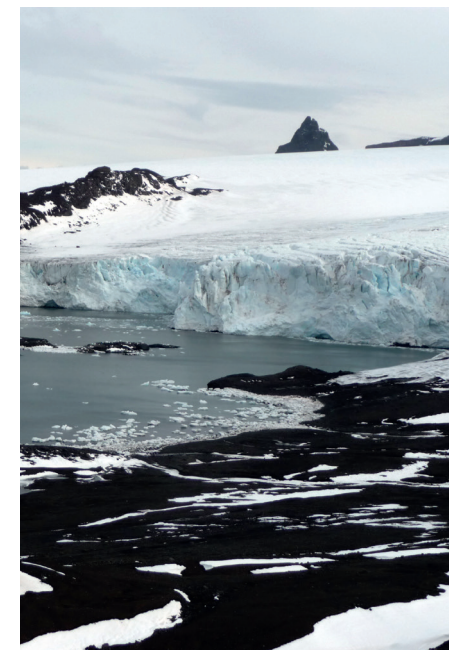
**Wojciech Cejrowski**

## SUPERVISOR



**Assoc. Prof. Robert J. Bialik**  
Institute of Biochemistry and Biophysics PAS

Research interests: Lagrangian description of bed-load sediment transport, numerical modelling of saltation, analysis of turbulence in open-channels, rivers, estuaries, and coastal areas, the flow-biota-sediment interactions, glacial hydrology, the application of remote sensing methods to physical oceanography, and hydraulic measurements in the field.



>> Ecology Glacier



# Aleksander Uszczyk

University of Silesia

Studies completed: University of Wrocław, Faculty of Earth Sciences and Environmental Management, major: Geography; Jagiellonian University, Faculty of Biology and Earth Sciences, major: Geography, specialisation: Physical Geography

Find out more:



## Condition and contemporary changes in the thermal properties of the snow cover in the Arctic

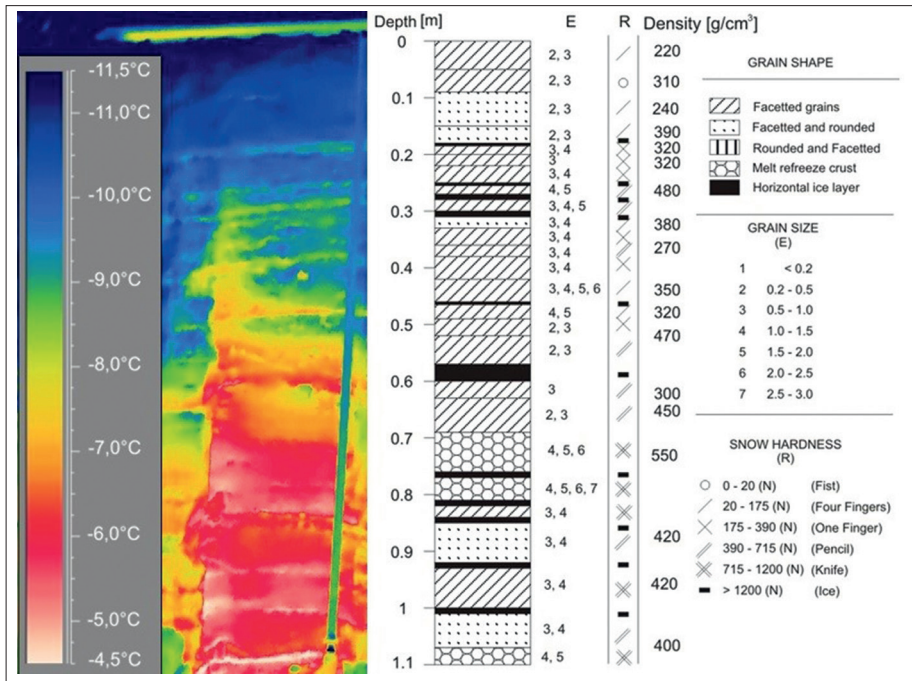
### Stan i współczesne zmiany właściwości termicznych pokrywy śnieżnej w warunkach arktycznych

Snow cover, as a part of the cryosphere, plays an important role in the functioning of polar regions. Thanks to its properties, snow acts as a regulator of thermal energy exchange between the atmosphere and the ground. Contemporary global warming has an influence not only on changes of range and duration of snow cover, but also on the physical properties of snow. Increased air temperatures in winter are manifested by frequent thaws and liquid precipitation, which translates into the formation of numerous hard layers (melt-freeze crusts) in snow cover. Studies of snow cover on different ground types in the area of southern Spitsbergen revealed lower insulation properties of both the hard layers and the entire snow column, which facilitates heat/cold penetration into the ground. On the other hand, the formation of melt-freeze crusts effectively protects the snow cover from being blown away and limits the percolation of rain and meltwater. At the same time, water is the most efficient method for transferring heat within snow cover. Both of the mechanisms (reduction of insulation properties and limitation of water percolation) are opposed to each other, accelerating or reducing the transfer of heat within snow cover. Changes of thermal properties of snow cover are reflected in the processes occurring in different environments, such as drainage



>> Measuring the thermal properties of snow cover using a thermal camera on the Werenskiöld Glacier in April 2016

and thermal structure of glaciers, geomorphological and periglacial processes, the evolution of sea and lake ice, as well as the ecology of plants and animals.



>> The internal structure of the snowpack and its thermal image from the area of the equilibrium line altitude (ELA) of the Werenskiöld Glacier (April 2016). A visible correlation of hard layers with zones of higher temperatures in the thermal image



>> Measuring spatial variability of the snow cover using laser scanning (Hornsund)

**Interests and hobbies:** My beloved family, playing guitar and djembe, trail running and snowboarding.

## SUPERVISORS



**Prof. Jacek Jania**  
University of Silesia, Faculty of Earth Sciences,  
Department of Geomorphology

Research interests: evolution of glaciers and Arctic environment affected by climate change; the dynamics of tidewater glaciers; glacial geomorphology.



**Assoc. Prof. Mariusz Grabiec**  
University of Silesia, Faculty of Earth Sciences,  
Department of Geomorphology

Research interests: the functioning of glacial systems in the Arctic and high-mountain areas, as well as the interaction between glacial environment and non-glaciated areas, the atmosphere and the hydrosphere, with the application of geophysical methods (especially radar sounding).



## Chapter 6

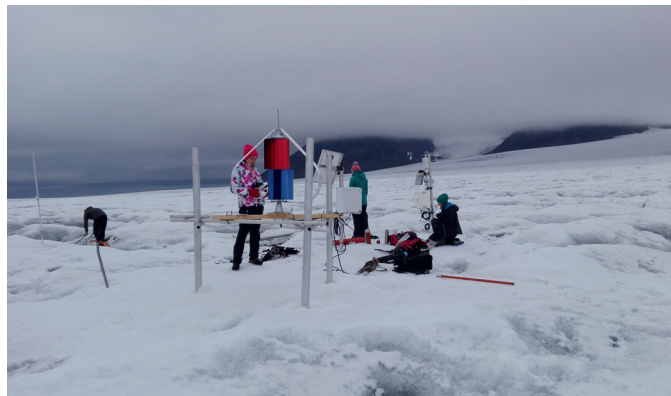
# Exploration of Polar and Mountain Regions – a new speciality of MSc studies at the Faculty of Earth Sciences, University of Silesia

The need to create a comprehensive master programme dedicated to polar and mountain regions emerged while preparing the curriculum for the doctoral Interdisciplinary Polar Studies.

As a result, a new speciality of MSc studies was launched in 2015 – the Exploration of Polar and Mountain Regions (EOPG) – at the Faculty of Earth Sciences of the University of Silesia at the major of geography. These studies are implemented under the auspices of the Centre for Polar Studies (CPS) and with the contribution of researchers employed at CPS units.

The students, under the supervision of Assoc. Prof. Bogdan Gądek from the University of Silesia, are offered a chance to participate in classes lead by top specialists, not only from the units of the Polish Academy of Sciences, the Polish Mountain Volunteer Rescue Service (GOPR), the Tatra Volunteer Rescue Service (TOPR), and the Institute of Meteorology and Water Management (IMGW), but also their counterparts from

abroad. The EOPG offers a unique and innovative curriculum, which covers classes that help to acquire knowledge on the environmental components of polar and mountain regions (including their sensitivity to climate change), the living conditions in those areas, as well as their development and impact on other regions. The workshops develop the skills of using cutting-edge methods in field research (including geodetic, geophysical and geomorphological methods) and acquiring and processing data from measurements and remote sensing observations with the use of geographical information systems (GIS). The infrastructure and laboratories of the CPS are used during field classes. Students participate in workshops on methods for analysing thermal properties of snow, ice and



>> Development and maintenance of the automatic weather station on the Hans Glacier



>> Installation of piezometers included in the hydrological monitoring network on the foreground of the Werenskiöld Glacier



>> On the way to field measurements in the area of Hyttevika



>> Didactic workshops on the use of geophysical methods in Korbiefów

water in high-mountain and polar environments, which are conducted by CPS on Spitsbergen. There are also foreign internships (for example, in the WSL Institute for Snow and Avalanche Research SLF in Davos) or exchanges under the Erasmus programme, e.g. to Norway or Great Britain.

For the profiles of selected EOPG graduates, please go to pages 86-95.

## SUPERVISORS



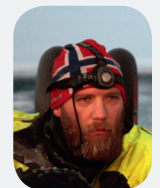
Assoc. Prof. Bogdan Gądek  
University of Silesia, Faculty of Earth Sciences,  
Department of Geomorphology

Research interests: the functioning of and changes in the cryosphere of high mountains in the Pleistocene and Holocene, contemporary changes in the natural environments of high-mountain and polar regions, snow cover: physical processes, parametrisation and modelling.



Prof. Jacek Jania  
University of Silesia, Faculty of Earth Sciences,  
Department of Geomorphology

Research interests: evolution of glaciers and Arctic environment affected by climate change; the dynamics of tidewater glaciers; glacial geomorphology.



Dr. Dariusz Ignatiuk  
University of Silesia, Faculty of Earth Sciences,  
Department of Geomorphology

Research interests: Glaciology, mass balance and energy balance of glaciers, subglacial drainage, numerical modeling, geophysical methods in the mountain and polar environment, contemporary climate change.



# Paulina Kaczmarczyk



## Variability of snow cover thickness on the Marchwiczny Żleb avalanche path in the Tatra Mountains in the light of terrestrial laser scanning and GIS analysis results

Zmienność grubości pokrywy śnieżnej w obrębie szlaku lawinowego Marchwicznego Żlebu w Tatrach w świetle wyników skaningu laserowego i analizy GIS

The thesis presents the results of monitoring of changes in the thickness of the snow cover within the Marchwiczny Gulley (Marchwiczny Żleb), which is one of the most dangerous avalanche paths in the Polish Tatra Mountains. The research was performed using the Riegl VZ-2000 laser scanner and the RiscanPro and ArcGIS software. Two terrain models were developed, presenting the monitored gulley in March (with snow cover) and in July (without snow cover). They served as the basis for creating a differential model showing the distribution of the snow cover thickness on the analysed slope. The thesis also assesses the advantages and disadvantages of using terrestrial laser scanning in snow cover analysis on high-mountain slopes.



>> Laser scanning training



>> Practical training in the Moravian Karst; the Amaterská Cave and its underground depths hide an incredible richness of karst formations

**Interests, hobbies:** extreme sports, mountain trips, the use of GIS in forensics, information security management systems, cyberterrorism, drones, photography.

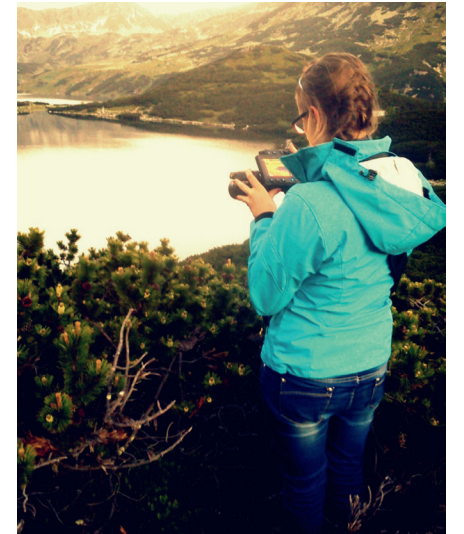
**Further career path:** further education within postgraduate studies.

# Joanna Kajdas

## Possible applications of thermovision in the research of thermal activity of high-mountain lakes on the example of the Valley of the Five Polish Lakes in the Tatra Mountains

Możliwości zastosowania termowizji w badaniach termiki jezior wysokogórskich na przykładzie Doliny Pięciu Stawów Polskich w Tatrach

The purpose of the thesis is to demonstrate the possible applications of thermovision in the research of high-mountain environments. The research was conducted using a Flir T640 thermal imaging camera. The object of the research was the high-mountain lake, namely the Front Lake in the Valley of the Five Polish Lakes (the Tatra Mts) in 2016. The thermal images were taken at different times of day and night, as well as in different meteorological conditions. Next, they were processed in the FLIR Tools software. The results indicate that the images from the thermal imaging camera may be used in a simple manner to examine the thermal activity of lakes. However, it should be borne in mind that the meteorological and topographic conditions while the images are being taken may significantly modify them.



>> A field expedition to make a series of photographs using a thermal imaging camera and collect data on the object under analysis (the Tatra Mountains, Valley of the Five Polish Lakes)



>> During the avalanche training on the operation of avalanche equipment (the Tatra Mountains, Kondratowa Valley)



>> The workshop in the Central Geophysical Observatory of the Institute of Geophysics, Polish Academy of Sciences, in Belsk near Warsaw

**Interests, hobbies:** outdoor activities, discovering new or little-known places, mountain and polar environment, striving to achieve dreams (observation of the aurora borealis from the pole, getting to the top of Mount Blanc).

**Further career path:** doctoral studies at the Faculty of Earth Sciences, University of Silesia, becoming a geography teacher in primary school.



# Katarzyna Kajdas



**An attempt to apply terrestrial laser scanning for the measurement of the mass balance of the snow-firn field Pod Bulą under the Rysy summit in the Tatra Mountains**

**Próba zastosowania naziemnego skaningu laserowego do pomiarów bilansu masy pola śnieżno-firnowego pod Bulą pod Rysami w Tatrach**

The thesis presents the possibilities of monitoring small multi-year snow firn formations in a high mountain environment by means of terrestrial laser scanning. The object of the research was the Pod Bulą Glacieret located under the Rysy summit in the Polish Tatra Mountains. The research was conducted by means of the Riegl VZ-2000 laser scanner as well as the RiScan Pro and ArcMap software. The resultant data specified the spatiotemporal changes in the thickness of the snow cover, the changes in the shape and dimensions of the Pod Bulą Glacieret, as well as the winter balance of its mass along with the determination of the snow avalanche share.



>> Analysis of thermal conditions of the Tatra lakes (the Tatra Mts, Valley of the Five Polish Lakes)



>> A measurement session performed by a laser scanner (the Tatra Mts, Morskie Oko Lake region)

**Interests, hobbies:** nature, geography, mountain environment, mountain expeditions.

**Further career:** geodesist's assistant in a private company, studies at Academy of Physical Education in Katowice.

# Mateusz Karcz



**An attempt to apply terrestrial laser scanning in the monitoring of the snow-firn patch in the Mały Kocioł Mięguszwiecki in the Polish Tatra Mountains**

**Próba zastosowania naziemnego skaningu laserowego do monitoringu rozwoju pola śnieżno-firnowego w Małym Kotle Mięguszwieckim w polskich Tatrach**

The thesis presents the results of monitoring of the snow-firn cover in the Little Mięguszwiecki Bowl (Mały Kocioł Mięguszwiecki) carried out during one season as well as the Mięguszwiecki Glacieret (Lodowczyk Mięguszwiecki) in the Polish Tatra Mountains, using the Riegl VZ-2000 laser scanner. The results of the field measurements were developed by means of the RiScan Pro and ArcMap software. The resultant data specified the spatiotemporal changes in the thickness of the snow cover and the changes in the shape and size of both objects under analysis. Moreover, the possibilities and limitations of terrestrial laser scanning were evaluated in terms of monitoring snow-covered mountain slopes.



>> A photograph taken against the background of Kazalnica while making scans for the master thesis



>> Measurements of thermal conditions of the Tatra lakes (the Valley of the Five Polish Lakes)

**Interests, hobbies:** geography, nature, astronomy, mountains, in particular the Tatras, travel, cars, mechanics, music.

**Further career path:** transport sector and further cooperation as part of scientific measurements using laser scanning.



# Mateusz Moskal



**Meteorological, snow and topographical conditions of snow avalanche accidents in the Polish Tatra Mountains in 2009–2015 period**

**Meteorologiczne, śniegowe i topograficzne uwarunkowania wypadków lawinowych w polskich Tatrach w latach 2009–2015**

The thesis demonstrates the results of research conducted on the circumstances of snow avalanche accidents in the Polish Tatra Mountains in the years 2009-2015, taking into account the meteorological, snow and topographic conditions. It reveals relationships between the number of accidents, the number of casualties, including mortality rates caused by snow avalanches, and the avalanche danger level. The results of the analyses point to the human factor as a catalyst for snow avalanche accidents. The thesis makes use of the snow and meteorological data from



>> An expedition to the Valley of the Five Polish Lakes



>> Avalanche training for TOPR rescue team members (near the Kondratowa Valley)

the Ogimet portal, the topographic data shared by the Department of Geomorphology of the University of Silesia, and the cadastre of snow avalanches developed by TOPR (Tatra Volunteer Rescue Service).

**Interests, hobbies:** catastrophic events on Earth related with endo- and exogenous processes, mountain hiking, football (watching, commenting and playing), writing poems.

**Further career path:** Airport in Pyrzowice (customs agency).

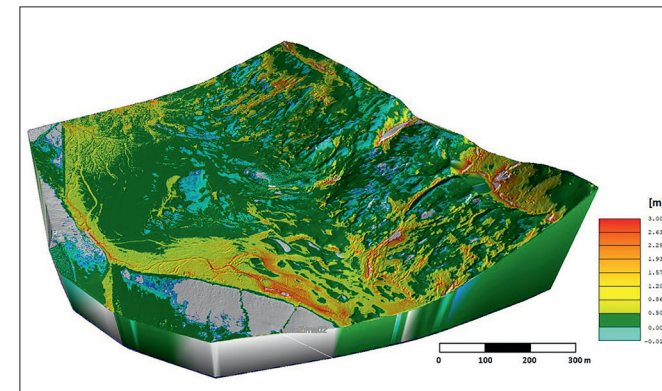
# Arkadiusz Piwowarczyk



**An attempt to determine the spatial distribution of the thickness of the snow cover in forefield of the Werenskioldbreen Glacier using terrestrial laser scanning**

**Próba określenia przestrzennego rozkładu grubości pokrywy śnieżnej na przedpolu Werenskioldbreen z wykorzystaniem naziemnego skaningu laserowego**

My dissertation attempts to determine the spatial distribution of the snow cover thickness in the forefield of the Werenskiold Glacier, using terrestrial laser scanning. The research area encompasses the north-eastern part of the forefield of the Werenskiold Glacier, covering approx. 1.8 km<sup>2</sup>. The differential model was constructed using laser scanner measurements performed in both a snowless period and a period with snow cover. The data were collected using two devices, namely Riegl VZ-6000 in the winter and Riegl VZ-2000 in the summer. The differential model confirms the possibility of using terrestrial laser scanning for determining the spatial distribution of snow cover thickness, which is an essential element of the natural environment in the Arctic.



>> A spatial distribution of the snow cover thickness on the foreground of the Werenskiold Glacier 16/04/2017 (differential model developed on the basis of data obtained by terrestrial laser scanning)



>> Field works in the Valley of the Five Polish Lakes. Here we are measuring snow depth

**Interests, hobbies:** mountain biking - participation in many cycling events, also as a representative of the University of Silesia, enthusiast of mountain bike and hiking tours, passion for the polar climate (participant of two polar expeditions)

**Further career path:** meteorologist at the Polish Polar Station Hornsund on Spitsbergen.



# Katarzyna Stachniak



## Hydrological and hydrogeological processes in the foreland of the Werenskioldbreen Glacier – groundwater flow modeling in FEFLOW software

Procesy hydrologiczne i hydrogeologiczne na przedpolu lodowca Werenskioldbreen – modelowanie odpływu gruntowego w programie FEFLOW

The results of my master thesis provide a lot of new data on meteorology, hydrology and hydrogeology for the ablation season of the Werenskiold Glacier in 2017. The data were collected during field, laboratory and detailed site-specific works as well as model-based tests.

The resultant comprehensive 3D model for the flow of groundwater in the proglacial zone of a polythermal glacier is a new approach to this issue for Svalbard. It specifies the quantitative groundwater resources of the area under investigation, including both dynamic and static resources, which make it possible to estimate the level of water retention in the active layer of the ground, the spatial diversity of the depth of the water table and the groundwater flow directions, as well as to determine the component parts of the groundwater balance.



>> A rest next to a weather station on the glacier



>> Measurements of the water flow on the surface of the Werenskiold Glacier, Spitsbergen

**Interests, hobbies:** geography (hydrology, glaciology, geomorphology), the environment of polar and high mountain areas, mountain tourism.

**Further career path:** participant of the 41st Polar Expedition of the Institute of Geophysics PAS to Spitsbergen.

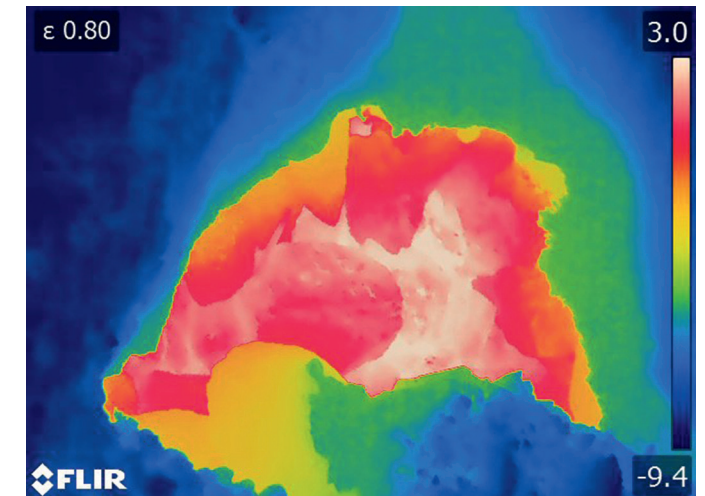
# Paulina Stec



## Application of a thermal imaging camera in the detection of high-mountain talus slopes ventilation in the Tatra Mountains and on Spitsbergen

Zastosowanie kamery termowizyjnej do detekcji procesów wentylacji wysokogórskich stoków usypiskowych w Tatrach i na Spitsbergenie

The thesis presents the results of detecting the ventilation processes of talus slopes in the Tatra Mountains and on Spitsbergen. The field research was carried out using a FLIR T640 thermal imaging camera and HOBO U 23 temperature microrecorders. The resultant thermograms were processed in the FLIR Tools software. All signs of slope ventilation were documented, including thermal anomalies, surface hoar, ventilation chimneys and snowmelt windows. The thermal imaging camera facilitated the detection of the outflows of both warm and cold air from the inside of the slopes. It also made it possible to quickly measure and document the distribution of surface temperature, as well as assess the activity of identified ventilation manifestations.



>> Digital (left) and thermal (above) images of a snowmelt window on the western slope by the Black Pond (Czarny Staw) under the Rysy summit

**Interests, hobbies:** mountain environment and tourism, polar climate (cross-country skiing, winter mountain expeditions), organisation of trips – for example kayaking; vintage objects from the 60s, plants cultivation, baking cakes.

**Further career path:** Municipal Office in Mikołów, Information Systems Development Office.



# Adelajda Widera



## Range and dynamics of snow avalanches in the Roztoka Valley in the Tatra Mountains in the light of numerical modeling results using ArcGIS and RAMMS

Zasięg i dynamika lawin śnieżnych w Dolinie Roztoki w Tatrach w świetle wyników numerycznego modelowania z wykorzystaniem programów ArcGIS i RAMMS

The dissertation presents the results of determining potential release areas (PRA) for snow avalanches in the Roztoka Valley in the Tatra Mountains as well as modelling their dynamics and range. Use was made of the methods developed in the WSL Institute for Snow and Avalanche Research SLF in Davos. The PRA units were determined by means of the ArcGIS software, while the two-dimensional simulation of the snow mass movement was performed using the RAMMS (Rapid Mass Movement Simulation) software. 196 potential release areas were identified, the total area of which amounts to 2.17 km<sup>2</sup>, thus representing 16% of the area under analysis. In light of the



>> A moment of rest during research and measurements in the Valley of the Five Polish Lakes in the Tatra Mts. The research included thermal activity measurements of the Tatra lakes



>> Winter tourism training course in the Gąsienicowa Valley in the Tatra Mts. Picture taken during "a walk to the azimuth"

results obtained, the maximum thickness of the activated snow may change along with the thickness of the snow cover in the release area from nearly 12 m to over 27 m. The biggest snow avalanches can reach the maximum speeds from nearly 30 m/s to over 40 m/s, while their pressure can range from approx. 365 kPa to more than 690 kPa.

**Interests, hobbies:** geography, mountaineering books, Tatra Mountains.

**Further career path:** spatial information systems inspector at the Silesian Voivodship Office, Security and Crisis Management Department.

# Karolina Ziętara



## Morphometric features of glaciokarst areas of the Polish Tatra Mountains in the light of the digital elevation model analysis

Cechy morfometryczne obszarów glaciokrasowych polskich Tatr w świetle wyników analiz numerycznego modelu terenu

My thesis undertakes the issues related to geomorphometry. The research area covers the Little Meadow Valley (Dolina Małej Łąki), the Miętusia Valley (Dolina Miętusia) and the Roztoka Valley (Dolina Roztoki). The main purpose of the thesis was to identify and quantitatively determine the morphological features typical of the high-mountain glaciokarst relief.



>> Roztoka Valley in the Tatra Mountains. Laser scanning workshop



>> Avalanche training

The analysis included the inclination, exposure, roughness and curvature of the terrain as well as the topographic position index (TPI) and the topographic wetness index (TWI). The purpose was achieved by means of a high-resolution numerical terrain model (LiDAR) and the GIS tools available in the ArcGis 10.4.1 software by ESRI.

**Interests, hobbies:** GIS, environmental hazards, sports – especially football and volleyball, cooking.

**Further career path:** further education at Environmental Risk Engineering at the Faculty of Earth Sciences at the University of Silesia.



## Chapter 7

# Science communication and dissemination

As part of its activities, the Centre for Polar Studies (CPS) is involved in a broadly conceived science dissemination by participating in numerous scientific and popular-science events, presentations, and publications in the general press. One of the most important initiatives related to the dissemination of the CPS research results was organisation of international conferences on Svalbard (2015) and in Poland (2017). These meetings offered an interdisciplinary approach of scientists from the CPS and other international participants towards polar issues.

## Interdisciplinary Polar Studies in Svalbard

### (IPSiS) Meeting

18–24 September 2015

Longyearbyen and Hornsund, Svalbard

Organisers:



The project has been co-financed within the framework of: the Svalbard Strategic Grants coordinated by the Svalbard Science Forum

Find out more:



>> The multidisciplinary workshops for young researchers, with one held in the vicinity of Longyearbyen and the other in Hornsund, were conducted by 10 specialists from different fields, under four thematic sessions:

- Atmosphere Physics and Physical Oceanography,
- Earth Sciences,
- Terrestrial Ecology and Environmental Chemistry/Pollution,
- Marine Ecology and Human Activity in the Arctic.

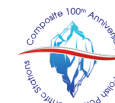


>> The IPSiS workshop attracted 69 participants from 10 countries, including 45 doctoral students and young doctors, 11 invited speakers, as well as the members of the International Scientific Board of the Centre for Polar Studies.

## Interdisciplinary Polar Studies in Poland (IPSiP) Meeting

17–19 November 2017, Staszic Palace in Warsaw

Organisers:



Honorary patronage:



Here you can find detailed information about the IPSiP meeting:

Programme:

Book of abstracts:

Photo coverage:

An anniversary video about the history of the Polish Polar Station Hornsund:



>> The conference featured a jubilee session honouring the 60th anniversary of the Polish Polar Station Hornsund in Svalbard and the 40th anniversary of the H. Arctowski Polish Antarctic Station on King George Island (South Shetland Islands). Moreover, there were three plenary and six scientific sessions, featuring 50 oral presentations and 32 posters



>> The total number of participants of the IPSiP meeting was 154 individuals from 12 countries, including Russia, the USA, Finland, Peru, Argentina, Chile, Brazil, Spain, Norway, Great Britain, Germany, and Poland. Every fourth person was a young researcher actively participating in the meeting (photo from Staszic Palace)



>> The conference was attended amongst other, by the guest speakers: Prof. Jefferson Cardia Simões (Brazil), Vice President of the Scientific Committee on Antarctic Research SCAR, Dr. Susan Barr (Norway), President of the International Arctic Science Committee – IASC, Prof. Jerónimo López-Martínez, former president of SCAR (Spain), Prof. Jon Ove Hagen, chairman of the International Scientific Council of the Centre for Polar Studies from the University of Oslo (Norway), Prof. Łukasz Szumowski, Deputy Minister of Science and Higher Education, Prof. Paweł Rowiński, Deputy President of the Polish Academy of Sciences, representatives of the Ministry of Foreign Affairs and ambassadors of states cooperating with Poland in polar research



# Dissemination activities for the general public

## Science Picnics of the Polish Radio (Polskie Radio) and the Copernicus Science Centre (Centrum Nauki Kopernik)

The Centre participated in four Science Picnics of the Polish Radio and the Copernicus Science Centre – the biggest open-air scientific event in Europe, held annually at the National Stadium in Warsaw.

During these meetings, the CPS employees and doctoral students were happy to share their experience and knowledge about polar regions. Several thousand people, including large numbers of youth and children visiting the Centre's stand, had a chance to feel like scientists exploring the far North and South.

They could become familiar with modern research equipment and devices, take part in experiments concerning glacial dynamics, and experience such phenomena as the aurora borealis. There was fun and ice for refreshment!

## Science Festivals and Science Days

The employees, doctoral students and students of the CPS participated in numerous lectures and presentations in schools, kindergartens, travellers' clubs and all kinds of festivals. The most eagerly attended events in which the Centre took part include: the Silesian Science Festivals, the Sopot Science Days, the Picnics of the Polish Academy of Sciences, the Baltic Science Festivals or the Nationwide Geophysical Workshops – Geosfera.



Check out the attractions prepared by CPS for the participants of the 20th Science Picnic in 2016.



## The Museum of the Faculty of Earth Sciences at the University of Silesia

To enhance the image of the Centre for Polar Studies, new exhibition spaces were opened in the Museum of the Faculty of Earth Sciences at the University of Silesia.

The annual number of visitors to the Museum ranges from 16 to 18 thousand, with as many as 10 thousand pupils per year taking part in lectures, museum classes and workshops for kindergartens and schools!

## Other popular science activities

The Centre also implemented other activities to promote science, for instance by organising or co-organising exhibitions and contests. One of them was the exhibition entitled: *From long tradition to modern studies of the Arctic system*, created for the purposes of the governmental/scientific panel during the Arctic Circle Assembly 2017 (for more information, please visit <http://www.pkpolar.pl/from-long-tradition-to-modern-studies-of-the-arctic-system/>).

It is also worth to mention other activities in which the CPS participated, such as the Photography Biennale of the University of Silesia entitled *Science in Focus*, the Kadry Photo Exhibition, the Sopot Youth Forum entitled *Where the World is Heading*, and the *Mysterious World of Glaciers' Interior* exhibition at the 21<sup>st</sup> Science Festival *Sapere Aude*.

Moreover, the Centre's representatives took part in numerous television and radio broadcasts, as well as delivered many popular science lectures targeted at a wide audience.

The Centre also prepared and issued several popular science publications, including the album by Magdalena Puczek and Tomasz Wawrzyniak *Polish Polar Station Hornsund on Spitsbergen* (The Institute of Geophysics PAS, Warsaw 2016) and the album commemorating the 85th birthday anniversary of Prof. K. Birkenmajer entitled *Krzysztof Birkenmajer: geologist – polar explorer* (Sosnowiec, 2014).





## Towards the future

When looking towards the future, we usually benefit from experiences in the past. Five years is not a long period in comparison to the 85 years that have passed after the first ever Polish polar expedition to Bjørnøya (Bear Island) in the Norwegian Arctic as part of the 2nd International Polar Year (1932/1933), or the 120 years since the pioneering research conducted by two Poles (Henryk Arctowski and Antoni Bolesław Dobrowolski) during the first scientific expedition wintering in the Antarctic on the ship Belgica in 1897-1899. Implementation of the tasks of the Centre for Polar Studies was based on examples of good practices from the recent past and rich history. This publication presents some of these successful activities, but we are also considering what needs to be improved in the future. Opinions of young researchers – doctoral and graduate students as well as their mentors and the International Scientific Board are important in this respect.

We certainly managed to create an integrated group of young polar researchers and their supervisors, who, thanks to cooperating on projects and participating in the international world of science, are able to look more broadly at their own research problems. Good relations between young scientists and schol-

ars from various countries result in cooperation and numerous interesting publications in international journals. Thanks to the financial support for this Leading National Research Centre (KNOW) from the Ministry of Science and Higher Education, a unique program of interdisciplinary polar studies was created, combined with a scholarship system encouraging intensive and systematic work of young scientists. The first public defence of the doctoral theses within the IPS were held in September 2018. More PhD dissertations are currently close to completion and one might hope that almost three quarters of students from the first wave of admissions will receive a doctoral degree within four to four and a half years since beginning their studies. It makes a very good result in the area of Earth sciences, especially polar sciences. Quality of theses is also high. This means that the system is working well and, after introducing certain modifications, is worth to be continued.

Several hundred employees and researchers from the Centre's partner institutions had the opportunity to take part in a wide range of training activities in the form of numerous courses dedicated to new research methods and the use of modern specialist equipment. This contributed to development of



>> Observations of the Recherche Glacier's cliff in springtime



>> R/v Oceania during the study of Hornsund fjord in a loose pack ice

their expertise, which will improve the quality of teaching and research in the future. Many of the students who have participated in the Centre's training courses will become competitive on the European labour market. The dissemination of research results should also be continued. Thanks to the coordination of activities in the Arctic, partner institutes were very effectively using the research equipment. Developing a metadata system was the first step to creating common, open access databases. This included creating a unique digital base of photogrammetric photos from nearly all Polish Arctic expeditions since 1934.

Based on a summary of successes and a critical assessment of the encountered difficulties, we are building plans for the future. We are particularly focusing on strengthening the collaboration of institutions within the Centre, while at the same time expanding national and international cooperation. It is important to have a broad, multi-faceted and interdisciplinary view of the evolution of the Arctic and Antarctic environment under the influence of climate change. The Centre will strongly support the maintenance and development of a series of long-term observations of key physical and biological parameters of the polar environment as a basis for studying and better understanding of its changes. These are invaluable scientific data, and in this respect Poland plays a significant international role. Satellite monitoring will be used much more widely, among others in glaciology and the terrestrial and marine ecology.

Significant enlargement of instrumentation and the field equipment facilities is being planned, as well as strengthening of the system for transmitting, collecting and sharing observational environmental data from polar areas. This is one of Poland's contribution to major international programs. Special attention has to be paid to better monitoring of changes in well investigated polar regions, such as the Svalbard Hornsund fjord and its surroundings. They represent unique natural "field laboratories" in the neighborhood of Polish scientific stations.

A particularly important goal is a growth and evolution of the doctoral school, basing on the experiences of the Interdisciplinary Polar Studies, taking into account a broader scope of subjects and regional context of the globe. In the former, plans are to focus on the importance of climate change for societies living in the Arctic and in mid-latitudes, taking into account multidisciplinary approach of natural sciences, together with social, medical, IT and technical sciences. The use of the IPS's methodological and organisational approach and expertise seems to be also very valuable. Looking towards the future, we must also implement and adapt the Centre's activities to the new law on science and higher education in Poland introduced in October 2018.

It should be clearly stressed that with its five years of experience, the Centre has a real chance for a leading role in the polar research and training young researchers at the national and international scale.

*Board of Directors of the Centre for Polar Studies*



>> Polish Polar Station Hornsund situated on Spitsbergen



>> Preparing new high mast poles for measuring equipment on the glacier



# CENTRE FOR POLAR

# STUDIES IN A NUTSHELL



## Plentiful syllabus

Over 70 meetings of ISP PhD students organized by UoS (Faculty of Earth Sciences), IG PAS, IO PAS.  
More than 50 foreign lecturers



## Field activities

ISP PhD students and EOPG graduate students participated in workshops and field practices (e.g. mountain rescue training)



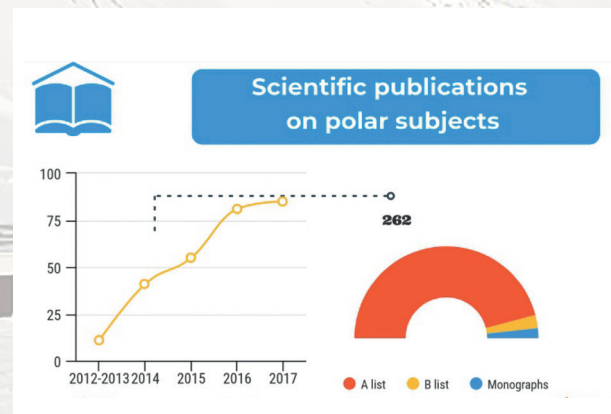
## Conference on Svalbard

69 people from 10 countries participated in international conference and field workshops (IPSiS) in 2015



## Conference in Warsaw

International conference in 2017, including jubilees: 60th anniversary of the Polish Polar Station Hornsund; 40th anniversary of the Polish Antarctic Station



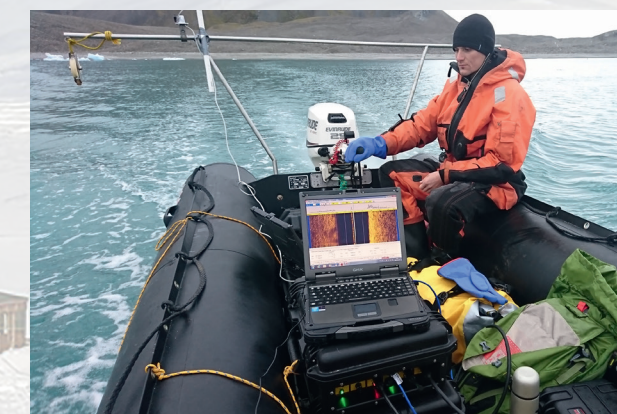
## Scientific publications

6-fold increase in the average number of „polar” publications in relation to the years preceding the creation of the Centre



## Infrastructure

Access to a unique research and training infrastructure - r/v Oceania, Polish Polar Station Hornsund



## Beneficiaries of KNOW

About 450 recipients benefited from the system of mobility support, raising qualifications and strengthening their research background



## Education and dissemination

Participation in festivals and science picnics, publications, radio and tv programs, exhibitions, lessons at the Museum of the University of Silesia (Faculty of Earth Sciences)



# Centre for Polar Studies

## **Towards better understanding of polar regions**

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