2018 ANNUAL REPORT

[Polar and Marine Research]

I. ABSTRACT (*max 1 page, short summary of activities of the department in 2018*)

1. Variability of snow cover parameters in polar and mountainous areas

Dust in the snowpack and firn

Aeolian dust in glaciers of Spitsbergen: an environmental messenger and a player in global change processes. Multilateral (geochemistry, mineralogy, remote sensing) approach to identification of dust components deposited in glaciers of Spitsbergen, with applications to glaciostratigraphy, glaciotectonics, and back trajectory analysis of atmospheric circulation.

Snow cover in Sudety Mountains

A preliminary study of the snow cover accumulation patterns and its impact on vegetation (and vice versa) in the chosen areas of the Karkonoski National Park. The first step was done in September 2018: terrestrial laser scanning.

Modelling of snow water equivalent in the coastal tundra of Hornsund fiord

Methodology for estimation of snow water equivalent in Hornsund coastal zone using daily snow depth observations was developed. Set of regression models was optimized and calibrated for consecutive stages of snowpack accumulation and ablation. The proposed approach for estimation of snow water equivalent gave very promising results, with the coefficient of determination higher than 0.9 for both calibration and validation therefore it's assumed that method could be extended to other Arctic sites where snow water equivalent measurements are rare.

2. Glaciated catchment components modelling

Calving ice front investigated with LiDAR scanning

Using LiDAR and video data from 2013, from Greenwich Island, South Shetland Island, it was possible to determine how does reflectivity of an ice wall changes with time elapsed since calving event. Discovered brightening of the surface was interpreted as development of layer of weathered ice. A scientific article was published with the results.

Study of mass balance of a Chilean glacier with use of digital elevation models

Four digital models of surface relief (ASTER, SRTM, TanDEM-X DEM and an aerial laser scanning based one) were used to measure change of Universidad glacier in central Chile. In addition, performance of TanDEM-X DEM in glaciological work was assessed.

3. Hydrological and hydrochemical characteristics of glaciated and unglaciated catchments (AN, TW)

Diagnosis of the hydrology of a small Arctic permafrost catchment using HBV conceptual rainfall-runoff model

The relationships between temporal changes of active layer depth and hydrological HBV model parameters, together with variation in the catchment response. The influence of model simplification, correction of precipitation, and initial conditions on the modelling results was tested.

Aluminum export from Werenskiöldbreen, Svalbard, shows association with glacier-derived nutrients (SiO_2, Fe)

The study aims to determine the relationship between the processes sourcing labile Al and glacier-derived labile nutrients (particularly Fe and Si) in glacierised basins.

Weather breakdown influence removal of invertebrates from cryoconite holes on an Arctic valley glacier (Longyearbreen, Svalbard)

The main goal of this research was to investigate any links between changes in weather conditions and short temporal changes in invertebrate densities on glaciers.

Spatial variations in air temperature and humidity over Hornsund fjord Spitsbergen)

This study deals with variations in air temperature and humidity in the region of the Hornsund fjord for the period from 1 July 2014 to 30 June 2015. Based on measurements at 11 sites, it was established that significant topoclimatic differences were dependent on height above sea level, substrate type, distance from the sea, exposition, atmospheric circulation and the ice conditions. The thermal and humidity conditions of individual sites are presented in relation to the weather conditions at the Polish Polar Station in Hornsund.

Factors controlling tidewater glacier front fluctuations in Svalbard - Hansbreen as an example

This research investigated seasonal and interannual fluctuations of the Hansbreen terminus in 23 years period. The data is mainly obtained from digitization of remote satellite imagery from a variety of sources. Then attempt to link the derived terminus fluctuations to various potential drivers (atmospheric and oceanographic) through correlation investigations. PDD+ and SST are used as proxies for surface melt (=subglacial discharge) and for fjord water temperature, respectively.

Climate changes related to SST trends in the North Atlantic, and long-term analysis of meteorological conditions in two fjords – Porsanger and Hornsund

Changes in the multiyear SAT (the air temperature 2 m above the ground), SST (sea surface temperature) and WS (wind speed) were studied on the basis of monthly Era-Interim reanalyses, as well as analyses of local differences between the two high-latitude fjords, based on data from three meteorological stations. Lakselv (L), Honningsvåg (Ho), and Hornsund (Hr).

4. Geophysical methods in marine environment studies in polar and analogue areas

- The development of methods for analyzing data from multibeam sonar and sediment profiler to determine the differences in the morphology of the bottom sediments and identification of bodies of young periglacial

- The use of passive acoustic monitoring of marine for determining the processes occurring in the icy Arctic fjords

5. Attempt to prediction of environmental change after Barents sea-Greenland sea ice-barrier breakup

We have studied changes of the coastal area in southern Svalbard with the glacier bridge between Torell Land and Sørkapp Land since the beginning of the 20th century. The results confirm the existence of a continuous subglacial depression below sea level (c. 40m deep) between Hornsund and the Barents Sea. If the retreat continues at the 2000–2015 average rate, the ice bridge between Hornsund and Hambergbukta will be broken sometime between 2055 and 2065 and the Hornsund strait will separate Sørkapp Land from the Spitsbergen Island. The work was completed and published in journal of the JCR list.

II. PERSONNEL (name and surname, position)

Lewandowski, Marek; Prof., Head of the department
Głowacki, Piotr; Prof.
Luks, Bartłomiej; Dr, adjunct
Moskalik, Mateusz; Dr, adjunct
Nawrot, Adam; Dr, adjunct
Wawrzyniak, Tomasz; Dr, adjunct
Goździk, Agata; Dr, Project Coordinator
Bożek-Andryszczak, Dagmara; educator
Giżejewski, Jerzy; Dr, educator
Podgórski, Julian; educator
Stankiewicz, Piotr; methodological adviser
Piotrowski, Wojciech; Project Coordinator

Research/Educative Projects

Surname	***Role in the project***	***Project title***	***Sources of funding***	***Host Institution***	***Period of employment in the project***
Goździk	Coordinator	EDU-ARCTIC	Horizon 2020	Institute of Geophysics PAS	1.05.2016-31.07.2019
Glowacki	Scientific Manager	EDU-ARCTIC	Horizon 2020	Institute of Geophysics PAS	1.05.2016-31.07.2019
Stankiewicz	Methodological Adviser	EDU-ARCTIC	Horizon 2020	Institute of Geophysics PAS	1.05.2016-31.01.2019
Giżejewski	educator	EDU-ARCTIC	Horizon 2020	Institute of Geophysics PAS	1.05.2016-31.01.2019
Wawrzyniak	educator	EDU-ARCTIC	Horizon 2020	Institute of Geophysics PAS	1.05.2016-31.07.2019
Bożek-Andryszczak	educator	EDU-ARCTIC	Horizon 2020	Institute of Geophysics PAS	1.05.2016-31.07.2019
Podgórski	educator	EDU-ARCTIC	Horizon 2020	Institute of Geophysics PAS	16.11.2017-30.04.2019
Goździk	Coordinator	ERIS	Erasmus +	Institute of Geophysics PAS	1.05.2016-29.04.2018
Stankiewicz	Methodological Adviser	ERIS	Erasmus +	Institute of Geophysics	1.08.2016-29.04.2018

				PAS	
Giżejewski	educator	ERIS	Erasmus +	Institute of Geophysics PAS	1.05.2016-29.04.2018
Wawrzyniak	educator	ERIS	Erasmus +	Institute of Geophysics PAS	1.05.2016-29.04.2018
Goździk	Coordinator	ODYSSEY	Erasmus +	Institute of Geophysics PAS	1.10.2018-30.04.2021
Goździk	Coordinator	BRITEC	Erasmus +	Institute of Geophysics PAS	1.10.2018-30.09.2021
Piotrowski	Coordinator	INTERACT	Horizon 2020	Institute of Geophysics PAS	4.01.2017 – 31.12.2019
Głowacki	participant	INTERACT	Horizon 2020	Institute of Geophysics PAS	4.01.2017 – 31.12.2019
Głowacki	Coordinator	SIOS (Svalbard Integrated Arctic Earth Observing System)	MNiSW (Polish in-kind contribution)	Institute of Geophysics PAS	18.04.2018-31.03.2023
Piotrowski	Participant	SIOS (Svalbard Integrated Arctic Earth Observing System)	MNiSW (Polish in-kind contribution)	Institute of Geophysics PAS	18.04.2018-31.03.2023
Głowacki	participant	EU Polarnet	Horizon 2020	Alfred Wegener Intitute, Bremerhavn, Germany	01.03.2015-28.02.2020
Głowacki	participant	INTAROS	Horizon 2020	Nansen Environmental and Remote Sensing Center, Bergen, Norway	01.12.2016-30.11.2021
Luks	Investigator	*Spatial Distributions of Black Carbon and Mineral Dust in Air and Snow Surface Layers upon Svalbard Glaciers: BC-3D*	Research Council of Norway SSF Svalbard Strategic Grant	Norwegian Polar Institute	01.03.2018-30.06.2020
Luks	Investigator	Snow Observation in Svalbard - SOS	SIOS/SIOS pilot project	Norwegian Polar Institute	01.03.2018-01.10.2018
Nawrot	participant	Hindcasting and projections of hydro-climatic conditions of Southern Spitsbergen	NCN	IG PAS	11.2018-11.2021
Nawrot	participant	*Spatial Distributions of Black Carbon and Mineral Dust in Air and Snow Surface Layers upon Svalbard Glaciers: BC-3D*	Research Council of Norway SSF Svalbard Strategic Grant	Norwegian Polar Institute	01.03.2018-30.06.2020
Nawrot	Collective investigator	*Relationship of permafrost with geomorphology, geology and cryospheric components based on geophysical research of the Hans glacier forefield and its surroundings.*	NCN	IG PAS	-

		Hornsund, Spitsbergen.			
Moskalik M.	Project Leader	*The impact of the sea ice conditions in the nearshore zone and shore ice on the wave propagation and coastal morphodynamics in polar regions on the example of south-western Spitsbergen - the analysis of processes, modeling, and prediction*	National Science Centre Poland, OPUS	IG PAS	2014.05.13-2018.12.12
Moskalik M.	Co-investigator	*Measuring the melt rate of glacier ice with underwater noise*	Wewnętrzny projekt badawczy	IG PAS	2017.11.16-2019.11.16
Głowacki O.	Project Leader	*Measuring the melt rate of glacier ice with underwater noise*	Wewnętrzny projekt badawczy	IG PAS	2017.11.16-2019.11.16
Głowacki O.	Intern	----------	Mobilność PLUS Ministerstwo Nauki I Szkolnictwa Wyższego	IG PAS / Scripps Institution of Oceanography, University of California San Diego	2018-2020
Głowacki O.	PostDoc	*Measuring the melt rate of glacier ice with underwater noise*	National Science Fundation (NSF) Early-concept Grants for Exploratory Research (EAGER)	Scripps Institution of Oceanography, University of California San Diego	2018-2020
Wawrzyniak	Co-investigator	*Hindcasting and projections of hydro-climatic conditions of Southern Spitsbergen*	NCN	IG PAS	2018.10-2021.10
Wawrzyniak	Co-investigator	*Relationship of permafrost with geomorphology, geology and cryospheric components based on geophysical research of the Hans glacier forefield and its surroundings. Hornsund, Spitsbergen.*	NCN	IG PAS	2017.02-2020.02
Wawrzyniak	Co-investigator	*Comprehensive hydrological studies of the Świder catchment with the use of modern measurement techniques*	Wewnętrzny projekt badawczy	IG PAS	2018.12-2019.12
Wojtysiak K.	Co-investigator PhD Student	*The impact of the sea ice conditions in the nearshore zone and shore ice on the wave propagation and coastal morphodynamics in polar regions on the example of south-western Spitsbergen - the analysis of processes, modeling, and prediction*	National Science Centre Poland, OPUS	IG PAS	2014.05.13-2018.12.12
Wojtysiak K.	Project Leader	*Small-scale dynamics of Arctic coastal sediments: Isbjornhamna, Svalbard*	Research Council of Norway, Svalbard Science Forum (SSF), Arctic Field Grant (AFG)	UNIS	2018,03,01-2018,12,31

PhD Students (*name and surname, country, supervisor)*

Daniel Kępski	Poland	Dr Bartłomiej Luks (supporting supervisor)
Joanna Ćwiąkała	Poland	Dr Mateusz Moskalik (supporting supervisor)
Joanna Sziło	Poland	Dr hab. Robert Bialik (IGF PAN, IBB PAN)
Kacper Wojtysiak	Poland	----------
Julian Podgórski	Poland	Prof. dr hab. Piotr Głowacki (IG PAS), dr Michał Pętlicki (CECs, supporting supervisor)

III. INSTRUMENTS and FACILITIES

Equipment

Rain gauges, Hanna multiparametric measurer, Water level, electrolitic conductivity and temperature automatic sensors; Autosampler; 2 Meteorological automatic stations Vaisala; Snow-bars; Harbortronics cameras; differential GPS; Valeport miniCTD; Niskin bootle; Sediment trapps; Muffle furnace; Transductor magnetometer GEOMAG i LEMI; Proton magnetometers; DI-fluxgate magnetometer; Induction magnetometer; Ionosonde; GPS signal scintillation monitor GSV4004; Seismometer STS-2; Logger MK-6; Atmospheric electricity sensors; 2 RBR wave sensors; Side Scan Sonar Wesmar 700; Oretech 3010 sediment profiler; CODA DA 100; 4 hydrophons with 2 Tascam registrator, RDI ADCP Sentienel 20; Air sampling station AZA-1000; Total radiation measurer and UV measurer: CMP11, CMP21, UV S-E-T;
Insolation measurer CSD3; 4-component net radiometer CNR4; Cimel photometer; Ceilometer CHM-15k; Sky camera Fuji-Campbell, dGPS station (referencial); Terrestrial Laser Scanner, DJI Phantom 4 Pro drones (3pcs), DJI Mavic Air drone .

Laboratories

The **Hornsund Polish Polar Station** (Spitsbergen) is year-round laboratory for research in the following fields:

Meteorology. Data for forecasting and climatological purposes is collected at the Station. The Hornsund weather station works as part of the Norwegian station network and is registered by the WMO (*World Meteorological Organisation*) as number 01003. Basic meteorological parameters are measured and observed here systematically, 24 hours a day, pursuant WMO standards.

Seismology. The seismology station in Hornsund belongs to the international network of seismological observatories. It is the only station constituting part of the Polish seismological network but located outside Polish territory. The main purpose of the seismology lab in Hornsund is to continuously record local earth tremors caused by plate tectonics and glaciers.

Earth magnetism. Changes in elements of the Earth's natural magnetic field are continuously recorded at the Station. Due to its geographic location, the Hornsund observatory records some of the greatest changes in the Earth's magnetic field. They are

approximately five times greater than those observed in Poland, for instance, so the results of this research are significant for scientists the world over. Since 2002, the Hornsund magnetic observatory has been part of the INTERMAGNET global research network.

Ionospheric research. The Station carries out long-term research on the structure of the ionosphere. This is aimed at determining the impact of particles and plasma originating from Solar flares on our planet.

Glaciology. The nearby Hans Glacier forms the object of glaciological research in the Hornsund region. Measurements are taken here to determine the mass balance and glacier change dynamics and, in addition, the depth of the snow cover is observed. This data is sent to the World Glacier Monitoring Service.

Atmospheric physics and optics. Observations of atmospheric phenomena include changes in the Earth's electric field, UV radiation and aerosol. This data is sent to the international AERONET network and to NASA.

Environmental research. The Station's chemical laboratory analyses the chemical composition of surface and precipitation waters. The purpose of this is to determine the biogeochemical processes occurring in them, as well as the quantities of pollutants reaching this region and depositing here, also of anthropogenic origin.

Apart from the research conducted as part of the Station's year-round research plan, in the spring and summer various groups of scientists pursuing their own scientific projects, conduct research – including in the fields of biology, geology, geodesy, geomorphology, glaciology and oceanology – in the Hornsund region. They then use the logistical and scientific facilities of the Station. The Polish Polar Station in Hornsund also participates in numerous scientific projects, both Polish and international.

Unique Polar Laboratory PolarPOL

PolarPOL was appointed by the Minister of Science and Higher Education on February 26, 2011. It functions as a National Research Center in the framework of the Polish Road Map of Research Infrastructures and, at the same time, as a separate infrastructural unit of the Institute of Geophysics PAS.

The aim of the Laboratory is to develop technical facilities, as well as to expand the organizational possibilities of conducting multilateral scientific research in the Arctic. The laboratory strengthens Polish participation in the global network of research and monitoring of land and sea polar zones. It also consolidates the current scientific potential of Polish polar explorers. PolarPOL secures Poland's participation in international polar research, which is of fundamental importance to Poland's position in the sphere of foreign policy of the state. The task of PolarPOL is to use the results of basic research for application needs, among others in the field of submarine resources of raw materials, the use of marine biological resources and new shipping opportunities that are opening up, as well as tourist activities.

IV. RESEARCH ACTIVITY and RESULTS *(max. 2 pages for each research activity/project; personnel involved in activity/project; description and 1-2 figures)*

1. Variability of snow cover parameters in polar and mountainous areas

Lewandowski, M., Nawrot, A., Luks, B. **Dust in glaciers: project objectives, methodology and first results (in preparation)**

Our knowledge on ice caps and ice sheets history, structure and physiochemical record increased significantly during the last decades due to research on ice cores, particularly in the framework of EPICA (European Project for Ice Coring in Antarctica) and GRIP (Greenland Ice Core Project) projects. However, paucity still exists about nature of solid phases impurities in snow, firn and ice. Ice caps and glaciers of Svalbard were frequently analyzed in terms of water-soluble ion chemistry record, but natural and artificial, micrometer-sized solid mineral (and amorphous) phases of aeolian origin, as well as organic particles transported by wind from distant sources, were not studied extensively so far. These particulates may be of different origin, potentially carrying important information about an impact of distant events and processes on the High Arctic environment.

The goal of this proposal is to describe an inventory of mineral (and amorphous) phases and biotic components of both natural and anthropogenic origin, residing in four glaciers of Spitsbergen. The pattern of impurities assemblages, recently deposited in snow and firn, will be traced stratigraphically, aiming at identification and correlation of coeval horizons. In general, the proposal is focused on potential usefulness of identified material for stratigraphic and environmental interpretations. Taking into account interdisciplinary research scope of this proposal, it is a first at such scale ever undertaken on Svalbard. Analysis of biogenic particulates, with the focus on cryoconite and glacial micro-fauna will also be performed in search of viable organisms of the glacial environment.

Research methodology

Selected glaciers will be cored to depths of 2-3 m (shallow) and 9-10 m (deep), yielding 16 cores of total length about 50m, providing 200 samples of c. 1,5 kG each. Each sample will be weighed, melted and filtrated using membranes with 0.45 μm pore size. Dried residuum will be packed and distributed among cooperating laboratories, in order to identify mineral or amorphous phases and biogenic components. Analytical methods cover a wide spectrum of geochemical analyses, employing scanning microscopes (ASEM), mass spectrometry including of Nd, Hf, Sr , X-ray diffractometry and tomography, and nobel gas spectrometry. Results of geochemical isotope analyses on volcanic ash particles of Nd, Hf and 87Sr/86Sr, along with the K-Ar ages, will point to dust source area. Analyses of REE are also planned. Magnetic phases will be identified using a unique Micromag AGFM 2900-02 Alternating Gradient Force Magnetometer for measurements of magnetic hysteresis of very fine samples (up to 50 μg) in room temperature.

Expected impact on the development of science

a) Dust distribution over the area under study for a last 8-10 years (for longer cores) and 2-4 years (for shorter cores) years, as well as quantitative concentration (ng/g) of water-insoluble light-absorbing particulates in the snow cover and firn will contribute to better understanding of recent albedo variation.

b) Identified assemblages of particles will be traced horizontally (for the first time on Spitsbergen), attempting to establish horizons of reference, to trace differences in a pace of the glacier seasonal firn increments, validating existing models and giving a

way to infer on internal glaciers dynamics, if compared to results similar studies in future.

c) Relative concentration of dusts from season to season may be considered a proxy in the source area environment (humid/warm vs. arid/cold).

d) A role of the black carbon particles, whatever origin, as a climate forcing agent over Svalbard will be estimated based on their concentration.

e) Concentration of anthropogenic phases will be estimated as well.

f) Back trajectory analysis of atmospheric circulation as well as isotope geochemistry methods will point to the dust components source area.

Results obtained in 2018

First results of chemical analyses are promising for this project. Detrital residuals were obtained from five cores of c. 1 m long, acquired from different glaciers, Residuals show a wide spectrum of mineral phases with a strong potential to the environmental interpretation (Fig. 1, 2). Within a frame of a pilot study, two samples were selected to recognize mineral phases of the dust present in different glaciers. Quartz and K feldspar are predominating the mineral inventory of each sample (ca. 70 % of the dust material). Phases of zircon, monazite and rutile are present in both of them. Sample SIC4 (Fig. 1) is characterized by the presence of BCP. These particles will be of the great importance to recognize historic record of anthropogenic activities in the area. Sample RIC3 (Fig. 2) from the Recherchebreen glacier contains significant amount of Fe oxide, pyrite and most probably micrometeorite.

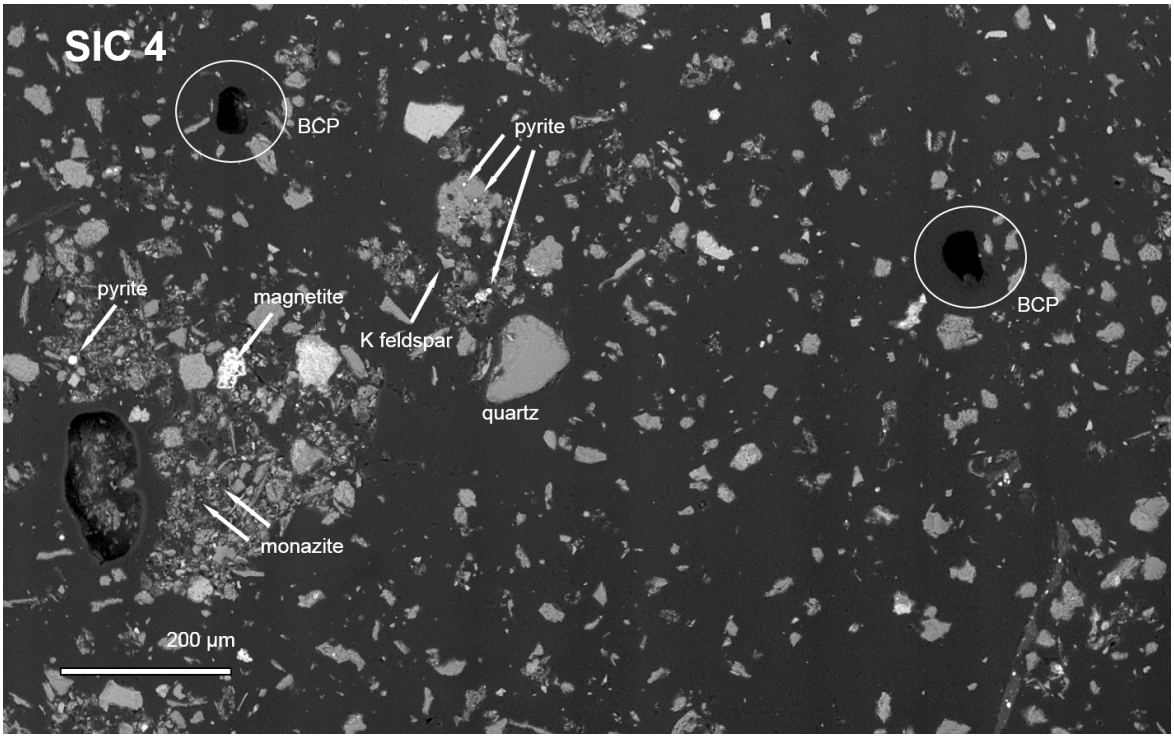


Fig. 1. Secondary electron image of uncoated dust sample SIC 4 from Storbreen. SEM; BCPs are shown circled. Courtesy Dr Monika Kusiak

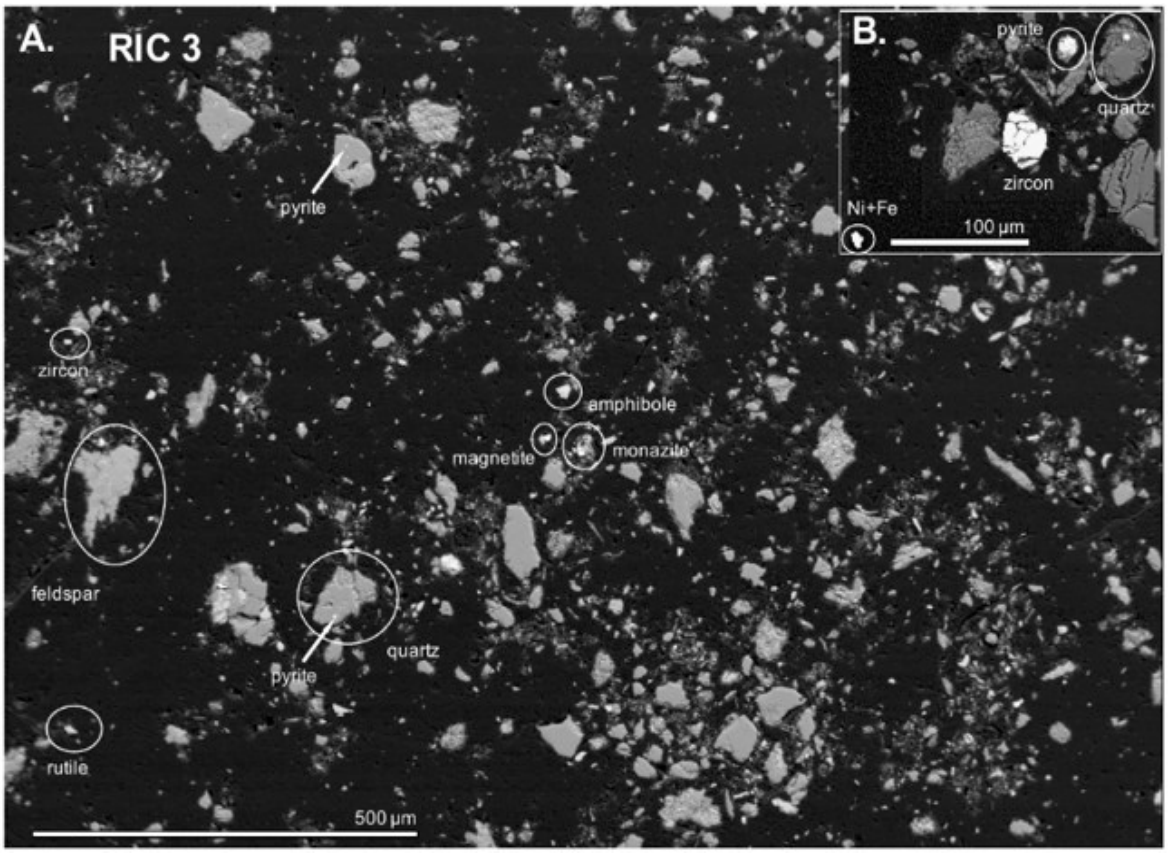


Fig. 2. Back scattered electron (BSE) image of the dust sample from Recherchebreen. Micrometeorite (?) and a zircon grain are seen in the sector B. Courtesy Dr Monika Kusiak.

2. Glaciated catchment components modelling

Podgórski, J., Głowacki, P.

The work in the task involves processing of digital observational data – sourced from field measurements with laser scanner, satellite imagery and global digital elevation models. Computer programming in Matlab and Python languages allows to draw meanigngful results and conclusions from large volumes of data. The objective of the task is to investigate dynamics of components of glaciated catchments, particularly changes of glacial cover. This is to give new insight into processes occurring in these environments.

The work is conducted in cooperation with two foreign institutions: Centro de Estudios Cientificos, Valdivie, Chile, and Université du Québec à Trois-Rivières, Trois-Rivières, Canada. Michał Pętlicki and Christophe Kinnard, from the two places respectively, are strongly involved in scientific work on the task.

In the year 2018 one scientific article was published in a peer-reviewed journal listed on the A list of the Ministry of Science and Higher Education of Poland: Cold Regions Science and Technology (Impact factor: 1.92) (Podgórski et al 2018). The paper describes an empirical model linking changes in reflectivity of a front of a tidewater glacier with time elapsed since a calving event happened. The work based on field data obtained by Michał Pętlicki on Greenwich Island, South Shetland Islands, Antarctica in 2013. The reflectivity has been measured with use of a terrestrial laser scanner, while calving events were registered with

use of a video camera. These observational data were processed with help of Matlab programming language to arrive at an exponential form of the relationship (Fig. 1).

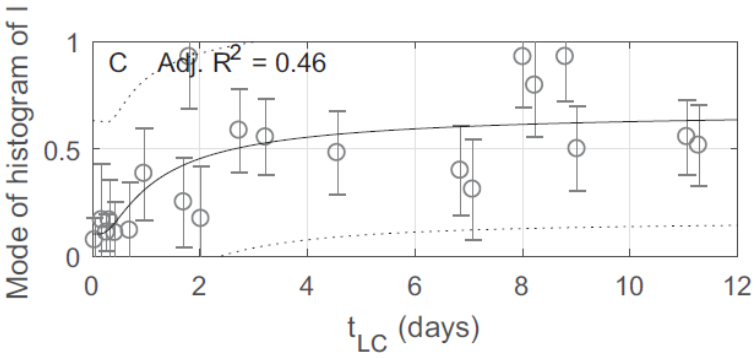


Figure 1: Exponential function fitted to the dataset of mode of reflection intensity histogram (vertical axis) and time since the last calving event (tLC, horizontal axis). Increase of the values indicates brightening of the ice surface.

Brightening of glacial ice with time since a calving event revealed it to the elements was found, an unexpected result. It was proposed, that formation of a layer of weathered ice on the ice cliff surface is responsible for the phenomenon. Description of the process of ice cliff weathering in quantitative terms is a scientific innovation brought by the paper.

Most of the work during the year was dedicated to investigation of geodetic mass balance of Universidad glacier, located in central Chile. TanDEM-X DEM digital elevation model, obtained from the German Space Agency in 2017 in a call for proposals, was the centerpoint of these efforts. This project had two objectives: one was to determine mass balance of the glacier in question in the 21st century, while the other was to ascertain how useful the new TanDEM-X DEM is for glaciological work. Three other elevation models were used in the study: SRTM and ASTER DEM are global datasets showing surface relief in 2000 and 2003, respectively. In addition an aerial laser scanning (ALS) based elevation model served as ground reference and accurate representation of surface elevation in 2013. The four models were compared to each another and measures of TanDEM-X DEM quality and Universidad glacier change were computed.

Both goals have been achieved. TanDEM-X DEM was shown as a high-quality dataset, well suited for glaciological change detection study. Its accuracy relative to the ALS-based DEM is 0.02+/-3.48 m. in the study area, a score better, than that of the older ASTER and SRTM. Discontinuities and noise was found in TanDEM-X DEM on steep slopes surrounding the glacier, but these had little to no impact on the mass balance results.

Universidad glacier has been shown to lose mass in nearly all its parts, with exception of limited accumulation in the highest parts of its accumulation zone. Particularly strong ablation was noted in the tongue of the glacier, where bands of debris are thick enough to hinder ablation and led to formation of troughs and ridges (Fig. 2). Overall the glacier has been losing 0.44+/-0.08 m of water equivalent per year between 2000 and 2013.

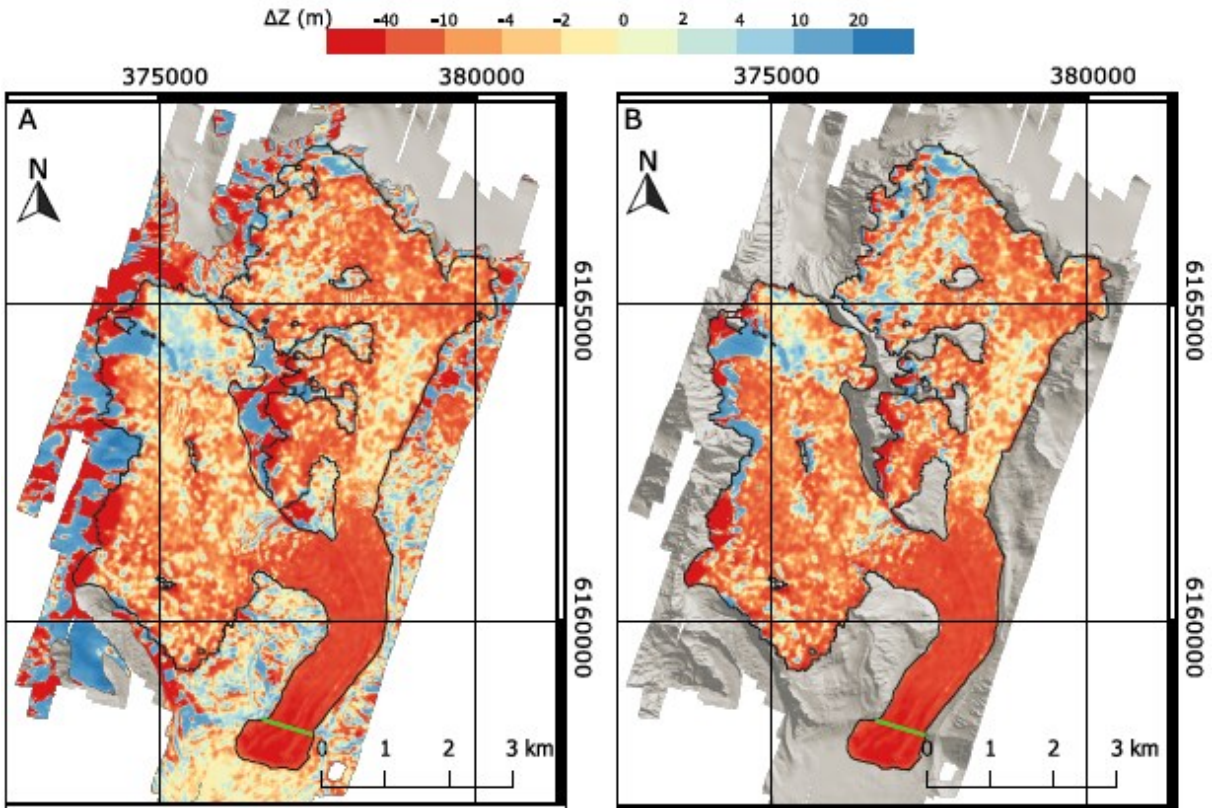


Figure 2: Maps of difference of surface elevation between 2000 (SRTM DEM) and 2013 (ALS DEM on Panel A and TanDEM-X DEM on Panel B). Red colour indicates strong lowering of surface and thus ice loss. Blue colour indicates thickening - result of ice accumulation or vertical movement of ice.

A manuscript of a scientific article summarizing the results of this part of the task was written and prepared for publication. It was accepted for publication in Remote Sensing, a peer-reviewed journal (Impact Factor 3.4). Revised version of the manuscript has been submitted close to the end of the year and the final decision on publication is pending now.

Reference:

Podgórski, J., Pętlicki, M. and Kinnard, C. (2018). Revealing recent calving activity of a tidewater glacier with terrestrial LiDAR reflection intensity. *Cold Regions Science and Technology*, 151, pp.288-301. doi: https://doi.org/10.1016/j.coldregions.2018.03.003

3. Hydrological and hydrochemical characteristics of glaciated and unglaciated catchments

*Osuch M., **Wawrzyniak T., Nawrot A.*** Diagnosis of the hydrology of a small Arctic permafrost catchment using HBV conceptual rainfall-runoff model. Hydrology Research, https://doi.org/10.2166/nh.2019.031

Changes in active layer thickness over Arctic and permafrost regions have an important impact on rainfall-runoff transformation. General warming is observed across Svalbard Archipelago and corresponds to increases in ground temperatures. Permafrost thaw and changes in active layer thickness due to climate warming alter how water is routed and stored in catchments, and thus impact both surface and subsurface processes. The overall aim of the present study is to examine the relationships between temporal changes of active layer depth and hydrological model parameters, together with variation in the catchment

response. The analysis was carried out for the small unglaciated catchment Fuglebekken, located in the vicinity of the Polish Polar Station Hornsund on Spitsbergen. For hydrological modelling, the conceptual rainfall-runoff HBV model was used. The model was calibrated and validated on runoff within subperiods. A moving window approach (3 weeks long) was applied to derive temporal variation of parameters. Model calibration, together with an estimation of parametric uncertainty, was carried out using the Shuffled Complex Evolution Metropolis algorithm. This allowed the dependence of HBV model parameters on active layer thickness to be analysed. Also, we tested the influence of model simplification, correction of precipitation, and initial conditions on the modelling results

- Stachnik Ł., Yde J.C., **Nawrot A.,** Uzarowicz Ł., Łepkowska E., Kozak K. **2018. Aluminum export from Werenskiöldbreen, Svalbard, shows association with glacier-derived nutrients (SiO2, Fe).** Hydrological Processes – under review

The aluminium cycle in glacierised basins has not received wider attention in biogeochemical cycles. As Al may be toxic for biota, it is important to investigate the processes leading to the release of Al to the environment. It has not yet been ascertained whether labile Al is incorporated into biogeochemical cycles due to its strong correlation with other glacier-derived labile nutrients (Fe, SiO_2). Our study aims to determine the relationship between the processes sourcing labile Al and glacier-derived labile nutrients (particularly Fe and Si) in glacierised basins. We investigated the Werenskiöldbreen basin (44.1 km^2, 60% covered by glacier) situated in SW Spitsbergen, Svalbard. In 2011, we collected meltwater from a subglacial portal at the glacier front and at a downstream hydrometric station throughout the entire ablation season. Our results show that labile aluminium concentrations (filterable <0.45 µm) in meltwater are significantly correlated to labile glacier-derived nutrients (Fe and SiO_2) concentrations for worldwide glaciers. The unchanged aluminium concentration between the subglacial system to the proglacial zone reveals that aluminosilicate weathering, as a source of labile Al, dominates under subglacial conditions. By examining the Al:Fe ratio against pH and sulphate mass fraction index, we have found that the proton source for subglacial aluminosilicate weathering is mainly associated with hydrolysis and to a lesser degree with sulphide oxidation. Aluminium and Fe dominate in the subglacial outflows and hydrometric station in a form of $Al(OH)_3$ and $Fe(OH)_4^-$. The labile Al yield (2.7 mmol m^{-2}) was of a similar magnitude as the other nutrient such as labile Fe yield (3.0 mmol m^{-2}) and lower by a factor of three than SiO_2 (8.7 mmol m^{-2}). We conclude that a potential bioavailable aluminium pool derived from glacierised basins may be incorporated in biogeochemical cycles, as it is strongly related to the concentrations and yields of glacier-derived nutrients.

- Zawierucha K., Buda J., **Nawrot A. 2018. Weather breakdown influence removal of invertebrates from cryoconite holes on an Arctic valley glacier (Longyearbreen, Svalbard).** Ecological Research - accepted

The question of why aquatic communities are often absent in suitable pools still remains a topic of debate and is often explained by dispersal limitation or biological barriers. Cryoconite holes (water-filled depressions on glaciers) as natural, simple, and dynamic habitats in a glacial biome seem to be a good model for explaining such issues. The main aim of our research was to investigate any links between changes in weather conditions and short temporal changes in invertebrate densities on glaciers. For this study, we selected cryoconite holes on the valley Longyearbreen and collected samples at two-day intervals from each hole in August 2016. During the sampling campaigns, we detected freezing, shrinking, and

ablation of cryoconite holes. In the samples, we found only two groups of invertebrates, Tardigrada and Rotifera. We had observed invertebrates in cryoconite holes until calm weather patterns were interrupted by wind and rainstorm, after which zero individuals were detected. Before the storm event, densities in the samples reached up to 149 tardigrades and 119 rotifers per millilitre of cryoconite. Additionally, we found a strong erosion of cryoconite granules, redistribution into sediments (mud-like forms), and the migration of sediments after rain, which confirmed the mechanical removal of invertebrates by streaming water. Water depth, pH or electrical conductivity were not important in shaping invertebrates communities. Their frequency and densities on valley glaciers depend on stochastic events, e.g. weather breakdown. Furthermore, these events may form of new niches for tardigrades and rotifers on polar glaciers, and their coexistence within cryoconite holes**.**

- Araźny A., Przybylak R., Wyszyński P., **Wawrzyniak T.**, **Nawrot A.**, Budzik T.2018. **Spatial variations in air temperature and humidity over Hornsund fjord (Spitsbergen) from 1 July 2014 to 30 June 2015.** (Geografiska Annaler series A Physical Geography. doi.org/10.1080/04353676.2017.1368832)

This article presents the variations in air temperature and humidity in the region of the Hornsund fjord for the period from 1 July 2014 to 30 June 2015. Based on measurements at 11 sites, it was established that significant topoclimatic differences were dependent on height above sea level, substrate type, distance from the sea, exposition, atmospheric circulation and the ice conditions. The thermal and humidity conditions of individual sites are presented in relation to the weather conditions at the Polish Polar Station in Hornsund (HOR). In the study period, the warmest annual mean air temperature occurred at Hyttevika (HYT), and the coldest on the summit of Fugleberget (FUG), respectively, +1.1 degrees C and -3.7 degrees C relative to HOR. Meanwhile, relative humidity differs from HOR values most strongly on Fugleberget, where it is greater by an average of 14%. Atmospheric circulation and ice cover were shown to have a significant impact on thermal and humidity conditions. The greatest spatial variations in air temperature (3.0 degrees C) in Hornsund region (between HOR and FUG) occurred in winter during anticyclonic advection from the northern sector. The greatest difference in relative air humidity (20%) relative to HOR occurred in FUG in autumn during cyclonic advection from the eastern sector. The east-west thermal and humidity gradients along the fjord are more pronounced when sea ice is present. Differences in air temperature and relative humidity between the sites located in the inner (TRE) and outer parts of the fjord (HG4 and HYT) rose by about 2.0-2.5 degrees C and 7-9%, respectively.

- Blaszczyk M., Jania J., Walczowski W., Prominska A., **Wawrzyniak T.**, Ignatiuk D., Ciepły M., Kolondra L., Pastusiak T., Kruss A., Grabiec M. **2018. Factors controlling tidewater glacier front fluctuations in Svalbard - Hansbreen as an example. (**Journal of Geophysical Research – in review)

An increase in retreat rates of marine-terminating glaciers was noticed across the Atlantic sector of the Arctic since the 1990s. Recession of glaciers in this region and its climatic controls are complex and differ across the Arctic. The aim of this paper is the identification of factors influencing the changes in ice-cliff position of Hansbreen, the marine-terminating grounded glacier in Hornsund, south-western fjord of Spitsbergen. We use remote sensing data to derive glacier front fluctuations between 1992-2015 and combine them with atmospheric and oceanographic condition, and water depth at the ice cliff. To compare seasonal and long-term Hansbreen front variability with atmospheric and ocean data we also

propose definition of cold, warm, and moderate years. Hansbreen retreated 917 m in 24 years, with the mean recession rate of 38.2 ma−1. The long-term glacier recession was interrupted by episodes of advancing, that occurred in cold years or in years with high PDD+ but low SST value. These advances occurred regardless of high or low frontal water depth. The major agents responsible for Hansbreen front fluctuations is PDD+, while SST and bathymetry at the front of the glacier are secondary factors. When analysis of warm and cold years are conducted separately, the significance of SST increases. Sea depth at the front amplifies the influence of the PDD+ and SST only in warm years. Although PDD+ represents the key factor responsible for magnitude of summer and annual retreat, duration of the retreat and advance period is strongly influenced by SST. Our results suggest further recession of Hansbreen due to the atmospheric warming and increase of sea water temperature carried by the West Spitsbergen Current into the Hornsundfjord.

- Aniśkiewicz P., Kosecki S., **Wawrzyniak T.,** Stramska M**.** 2018. **Climate changes related to SST trends in the North Atlantic, and long-term analysis of meteorological conditions in two fjords – Porsanger and Hornsund – based on data from 1983 to 2015.** (to be submitted)

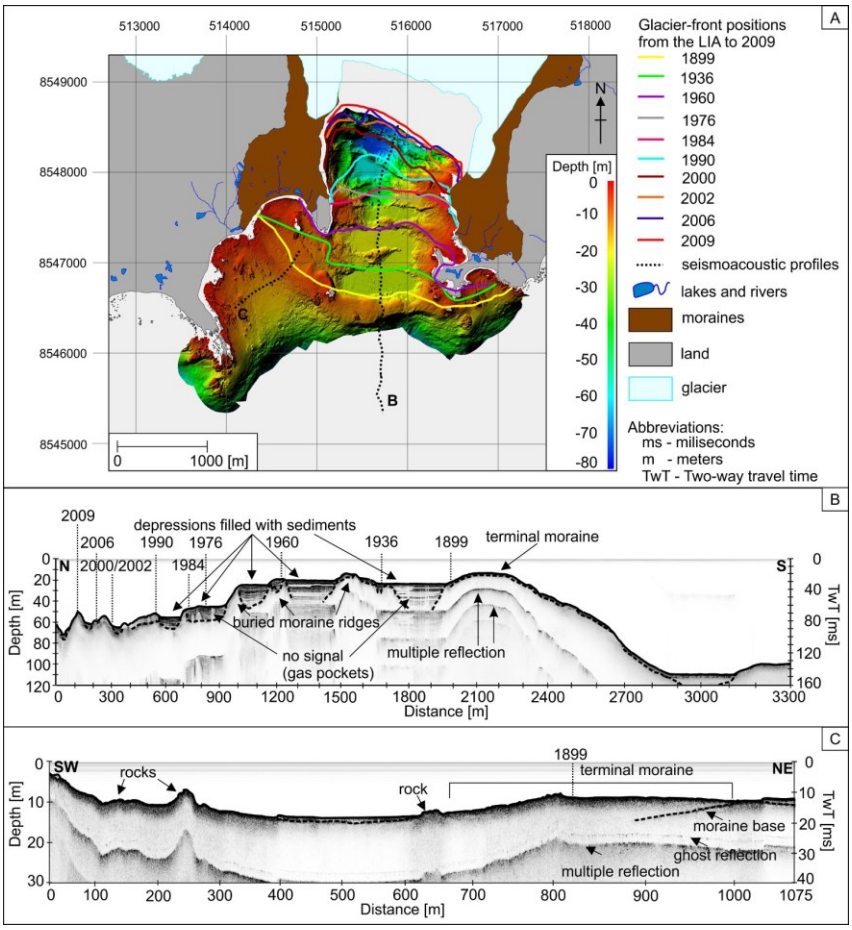
Changes in the multiyear SAT (the air temperature 2 m above the ground), SST (sea surface temperature) and WS (wind speed) were studied on the basis of monthly Era-Interim reanalyses, as well as analyses of local differences between the two high-latitude fjords, based on data from three meteorological stations. Lakselv (L), Honningsvåg (Ho), and Hornsund (Hr). The results showed SAT warming to be the strongest around Svalbard and to the east of it (0.15°C per year). SST trends were the strongest above Iceland (0.1°C per year). Interestingly, the strongest WS (wind speed) trends were negative and were recorded around the southern part of Spitsbergen and in northern Norway (-0.025 ms-1 per year). Local analysis revealed that the trend in the inner part of the Porsanger fjord (0.057°C per year) was twice as strong as in the outer part (0.031°C per year). In the Hornsund fjord, SAT warming was 0.095° per year. The WS trends based on annual averages were noticed for Lakselv (0.036 ms-1 per year) and Hornsund (0.016 ms-1 per year). L is strongly influenced by a continental climate, but Ho by maritime weather. In the Hornsund fjord, meteorological conditions are affected by both maritime and continental weather.

4. Geophysical methods in marine environment studies in polar and analogue areas

- **Ćwiąkała J.**, **Moskalik M.**, Forwick M., **Wojtysiak K.**, **Giżejewski J.**, Szczuciński W. **2018. Submarine geomorphology at the front of the retreating Hansbreen tidewater glacier, Hornsund fjord, southwest Spitsbergen.** (Journal of Maps doi.org/10.1080/17445647.2018.1441757)

A 1:10,000 scale bathymetric map as well as 1:20,000 scale backscattering and geomorphological maps of two bays Isbjørnhamna and Hansbukta in the Hornsund fjord (Spitsbergen) present the submarine relief that was primarily formed during and after the retreat of the Hansbreen tidewater glacier. Geomorphological mapping was performed using multibeam bathymetric data and seismoacoustic profiling. The identified landforms include two types of transverse ridges interpreted as terminal and annual moraines, flat areas that are depressions filled with glaciomarine sediments, iceberg-generated pits and ploughmarks, pockmarks and fields of megaripples. Most of the identified landforms are genetically related

to the retreat of Hansbreen since the termination of the Little Ice Age at the beginning of the twentieth century. Although Hansbreen has been speculated to be a surge-type glacier, no evidence of surging was identified in the submarine landform assemblage, which is in accordance with the absence of historically documented surges for that period.



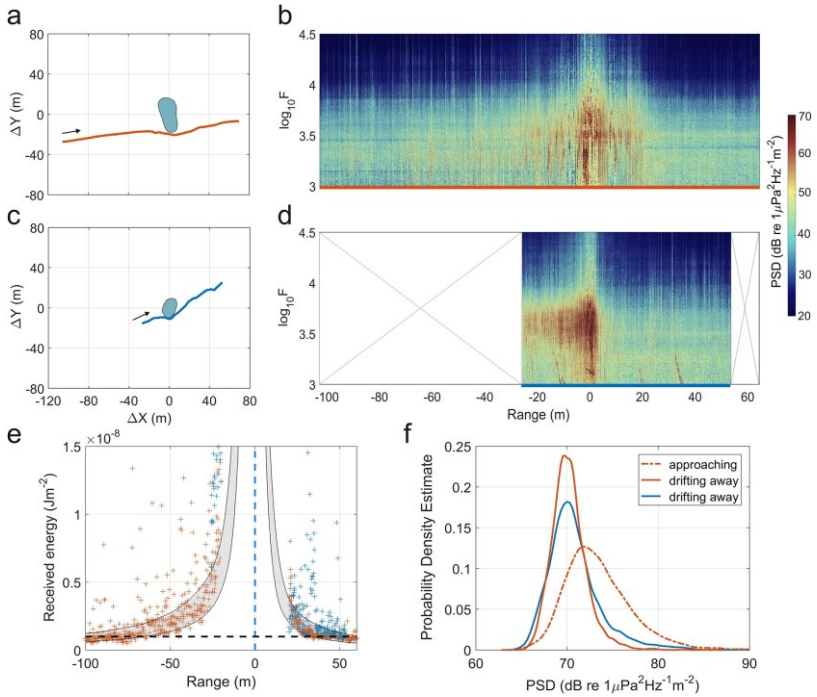
(A) *Bathymetric map of Isbjørnhamna and Hansbukta with marked glacier-front positions for selected years and the locations of the seismoacoustic profiles. (B) Seismoacoustic profile with interpretation in Hansbukta; (C) Seismoacoustic profile with interpretation in Isbjørnhamna. The numbers (years) provided in (B,C) refer to glacier-front positions. The distance scales on (B,C) differ.*

- **Głowacki O.**, Deane G.B., **Moskalik M. 2018. The Intensity, Directionality, and Statistics of Underwater Noise From Melting Icebergs** (Geophysical Research Letters doi.org/10.1029/2018GL077632)

Freshwater fluxes from melting icebergs and glaciers are important contributors to both sea level rise and anomalies of seawater salinity in polar regions. However, the hazards encountered close to icebergs and glaciers make it difficult to quantify their melt rates directly, motivating the development of cryoacoustics as a remote sensing technique. Recent studies have shown a qualitative link between ice melting and the accompanying underwater noise, but the properties of this signal remain poorly understood. Here we examine the intensity, directionality, and temporal statistics of the underwater noise radiated by melting icebergs in Hornsund Fjord, Svalbard, using a three- element acoustic array. We present the first estimate of noise energy per unit area associated with iceberg melt and demonstrate its qualitative dependence on exposure to surface current. Finally, we show that the analysis of

noise directionality and statistics makes it possible to distinguish iceberg melt from the glacier terminus melt.

Recent studies have demonstrated that impulsive underwater noise produced by tiny air bubbles released from melting glacier ice is a spectacular signal of the changing planet. A direct link between the melt rate and related noise would provide a first tool to study subsurface melting in a direct way. However, to make it possible, at first we need to better understand the properties of these sounds. To address this issue, we investigate intensity, directionality, and statistics of the melt noise. The results prove that icebergs can be automatically detected and tracked using several acoustic receivers immersed in water. Moreover, we provide the first estimate of acoustic energy produced by melting icebergs.



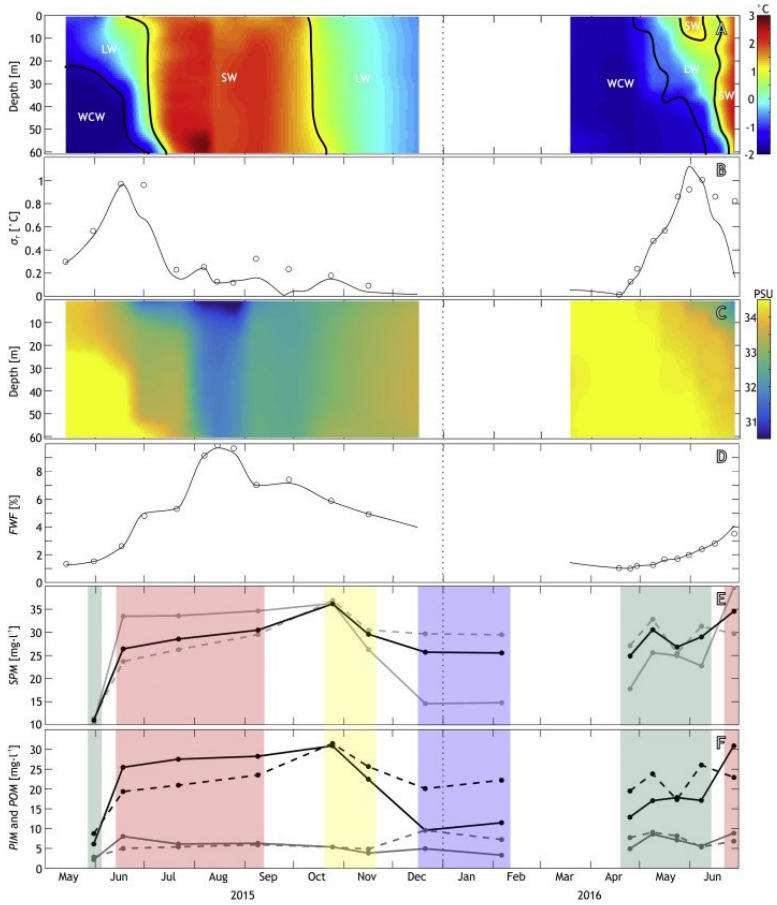
Comparison between acoustic emission of icebergs 1 and 5, tracked during deployments 20150606/1 (red) and 20150606/4 (blue), respectively. Upper panels show geometry of the experiments (a, c) and frequency dependence of power spectral density estimates per square meter of submerged ice area in relation to the distance between the boat and icebergs (b, d). Lower panels present received energy per square meter versus range (e), and probability density estimates of power spectral density per square meter, scaled to 1 m from the melting ice (f). Gray shaded area denotes transmission loss computed using Bellhop model for source frequency changing from 1 to 10 kHz and depths of 1 to 6 m. The data segment contaminated with a bearded seal call, visible between 32 and 36 m at plot (d), was removed before determining the probability density estimates of noise power.

- **Spatiotemporal changes in the concentration and composition of suspended particulate matter in front of Hansbreen, a tidewater glacier in Svalbard** (Oceanologia doi.org/j.oceano.2018.03.001)

  Moskalik M., **Ćwiąkała J.**, Szczuciński W., Dominiczak A., **Głowacki O.**, **Wojtysiak K.**, Zagórski P.

Tidewater glaciers supply large amounts of suspended particulate matter (SPM) and freshwater to fjords and affect oceanographic, sedimentological and biological processes. Our understanding of these processes, is usually limited to the short summer season. Here,

we present the results of a one-year-long monitoring of the spatial variability in SPM characteristics in a context of oceanographic and meteorological conditions of a glacial bay next to Hansbreen, a tidewater glacier in Hornsund (southern Spitsbergen). The observed range of SPM concentrations was similar to ranges measured in other sub-polar glaciated fjords, especially in Svalbard. The major source of SPM is the meltwater discharge from the glacier. The maximum water column-averaged SPM concentrations did not correlate with peaks in freshwater discharge and were observed at the beginning of the autumn season, when the fjord water transitioned from stratified to fully mixed. The observed spatiotemporal variations in the total SPM, particulate organic matter (POM) and particulate inorganic matter (PIM) are likely controlled by a combination of factors including freshwater supply, water stratification and circulation, bathymetry, the presence of sea ice, biological productivity and sediment resuspension. During the ablation season, the SPM maximum concentrations were located within the upper water layer, whereas during the winter and spring, the greatest amounts of SPM were concentrated in deeper part. Thus, typical remote sensing-based studies that focus on SPM distributions may not reflect the real SPM levels. POM and PIM concentrations were correlated with each other, during most of the time suggesting that they may have a common source.



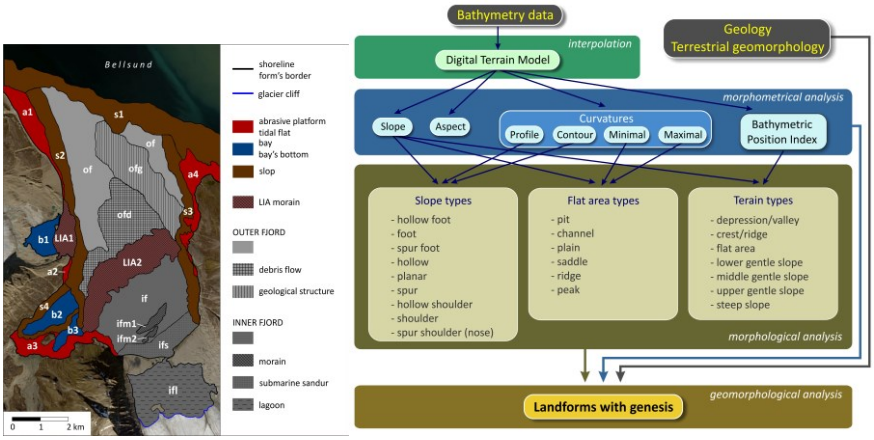
Annual changes in the oceanographic conditions and mean interpolated suspended particle matter (SPM) concentration and composition data. (A) Interpolated water temperature depth profile changes over time. The abbreviations refer to water mass types. WCW – winter-cooled water, LW – local water, and SW – surface water (see text for details); (B) standard deviations of water temperature (σT) from interpolated (black line) and measured (black circles) values; (C) interpolated water salinity depth profile changes over time; (D) the freshwater fraction (FWF) calculated from interpolated (black line) and measured (black circles) values; (E) the mean concentration of SPM from interpolated data over the total water column (black line), its surface concentration (grey line) and deeper subsurface

concentration (dashed grey line). The surface part of the water column refers to the layer from the surface to a depth of 10 m, and deep water refers to the layer from 20 to 50 m below surface; (F) average concentrations of the interpolated particulate inorganic matter (PIM – black lines) and particulate organic matter (POM – grey lines) within the surface (solid lines) and deeper subsurface (dashed lines) parts of water. The time intervals coloured on (E) and (F) represent measurements assigned to the spring (green), summer (red), autumn (yellow), and winter (blue) seasons.

- **Morphological characterization of Recherchefjorden (Bellsund, Svalbard) using marine geomorphometry** (Polish Polar Research doi.org/10.24425/118740)

  Moskalik M., Zagórski P., Łęczyński L., **Ćwiąkała J.**, Demczuk P.

Geomorphological research based on geomorphological mapping seeks to identify the origins and age of forms as well as to describe the process that created or transformed a particular form. One of the most important aspects of this study is the morphometry and morphology of the landscape. This also applies to the submarine areas, and issues related to marine geomorphometry. Bathymetric data used in this study were obtained from the measurements of the Norwegian Hydrographic Service and measurements conducted by the authors. Its main goal was: to determine the bathymetry of the Recherchefjorden (Bellsund, Svalbard), establish morphometric parameters for the analysis of the morphology of the bottom. The boundaries of zones, related to the specific character of bottom geomorphology linked with geological structure, tectonics and, in particular, the impact of glacial system, was delineated. The sets of landforms (areas) were distinguished based on the morphometric analysis resulting from the determined parameters: slopes, its aspects, curvatures and Bathymetric Position Index. Basically, this areas are concentrated in two zones: the main Recherchefjorden and its surroundings. The delimitation also takes into account the origins and location of theme in relation to the glacial systems. On this basis, moraine areas were distinguished. They are linked with the Holocene advances of two glaciers, Renardbeen and Recherchebreen, mainly during the Little Ice Age. They constitute boundary zones between areas with different morphometric parameters: outer fjord and inner fjord. Moreover, taking into account geology and terrestrial geomorphology it was possible to describe paraglacial processes in this area.

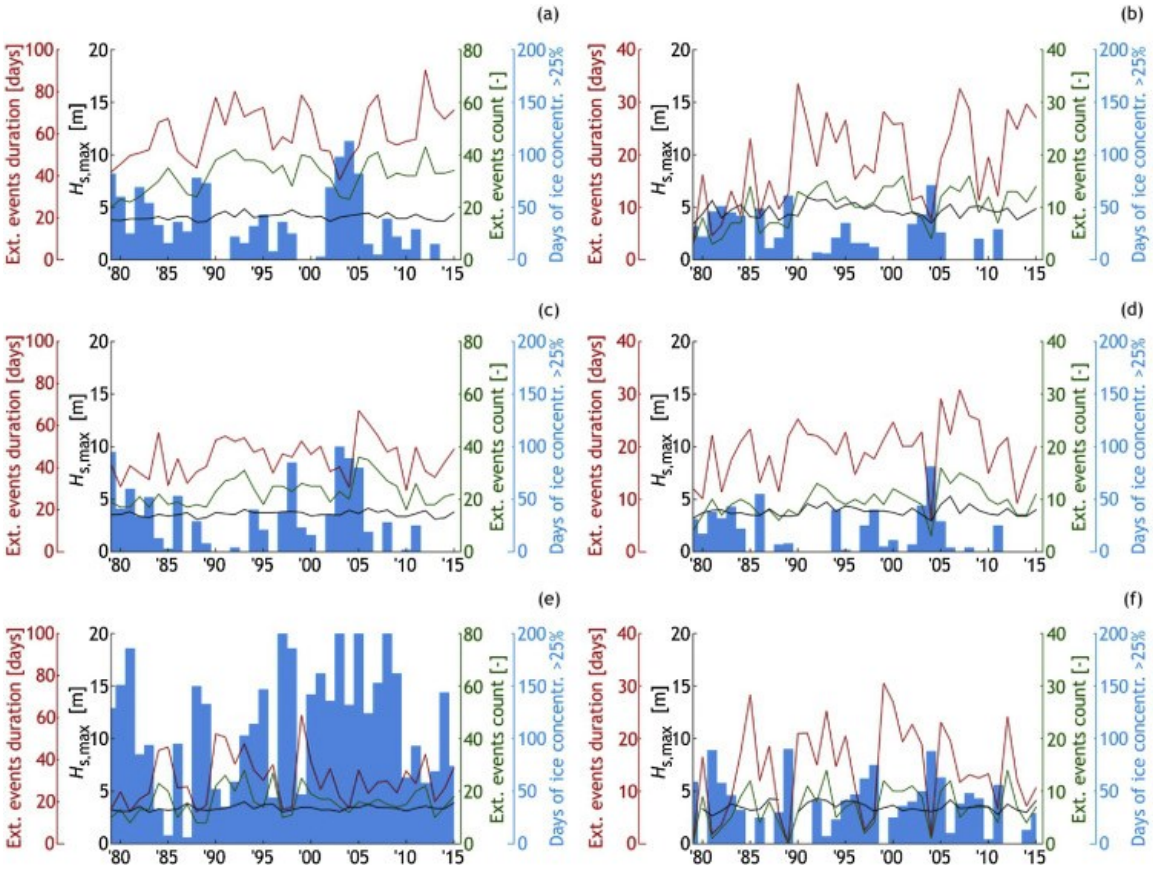


Sets of landforms obtained through morphometric study and ***Diagram of the steps of data processing and measurement results***

- **Wind wave climate of west Spitsbergen: seasonal variability and extreme events** (Oceanologia doi.org/j.oceano.2018.01.002)

  Wojtysiak K., Herman A., **Moskalik M.**

Waves are the key phenomenon directly influencing coastal morphodynamics. Facing insufficient observations, wind wave climate of the west coast of Spitsbergen can be characterized on the basis of the modelled data. Here we have used the results of spectral wave models: Wave Watch III (WW3) hindcast and WAM in ERA-interim (ERAi) reanalysis. We have observed the presence of seasonal cycle with difference of up to 1 m between significant wave heights in summer and winter. In wave-direction analysis we have noticed the southwestern swell component of remarkably narrow width, thus we expect unidirectional swell impact on the coastline. Extreme events analysis revealed that storms occur mainly in winter, but the most energetic ones (significant wave height of up to 9.5 m) occur in spring and autumn. We have identified positive trends in storms' frequency (2 storms per decade) and storms' total duration (4 days per decade) on the south of the study area. More storms can result in the increase of erosion rate on the south-western coasts of Spitsbergen, but this change may be highly dependent on the sea ice characteristics. Wave heights of wind sea and swell are correlated with the relevant atmospheric circulation indices, especially the North Atlantic Oscillation. In the recent decade, the correlation is stronger with WW3 than with ERAi data, at some locations explaining over 50% (over 30%) of the total variance of wind sea (swell) wave heights. In ERAi data, the relationship with circulation indices seems sensitive to the length of the analysis period.

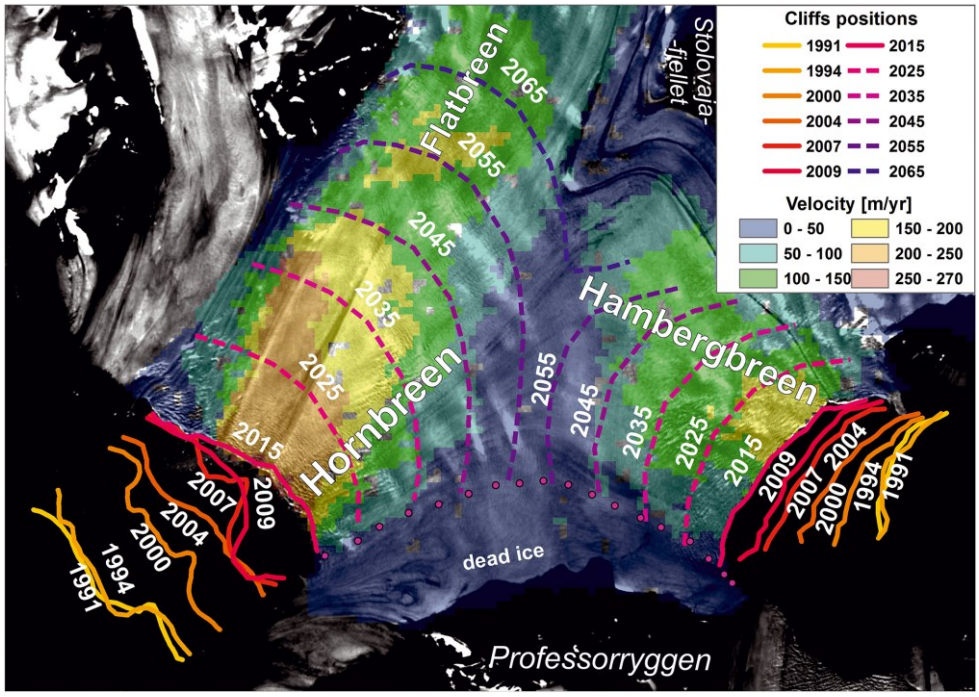


Extreme event parameters calculated from ERAi dataset for annual (a, c, e) and winter (DJF) (b, d, f) for points on south (a, b), centre (c, d) and north (e, f) part of Spitsbergen. Individual variables have separate y-axes to enable easy absolute value readout. Please note that the scales differ between annual and winter charts.

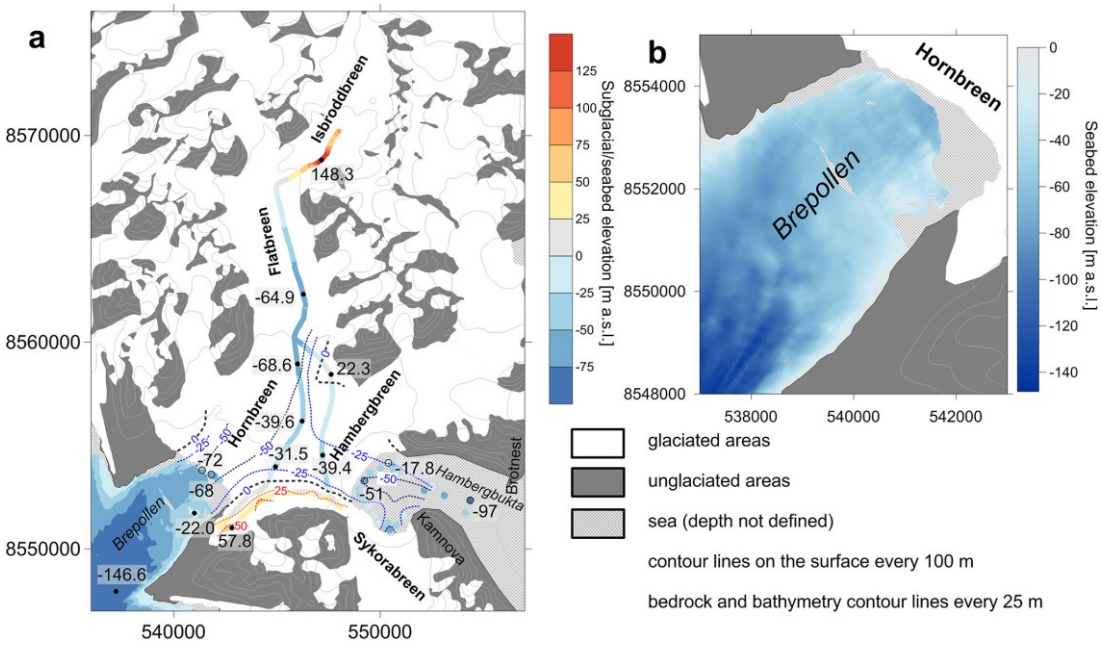
5. Attempt to prediction of environmental change after Barents sea-Greenland sea ice-barrier breakup

Grabiec M., Ignatiuk D., Jania J.A., **Moskalik M.**, **Głowacki P.**, Błaszczyk M., Budzik T., Walczowski W. **2018.** Coast formation in an Arctic area due to glacier surge and retreat: The Hornbreen–Hambergbreen case from Spistbergen (Earth Surface Processes and Landforms doi.org/10.1002/esp.4251)

Glaciered coasts undergo faster geomorphic processes than unglaciated ones. We have studied changes of the coastal area in southern Svalbard with the glacier bridge between Torell Land and Sørkapp Land since the beginning of the 20th century. The existence of a continuous subglacial depression beneath the Hornbreen–Hambergbreen glacier system has been debated since the 1960s, with inconclusive results. In this study we assess both the subglacial topography and the bathymetry of Hornsund Fjord and Hambergbukta bay. This included ~40 km of radar surveys over the glacial system and sea depth sounding. The extent of the glaciers from maps and satellite images together with digital terrain models and surface elevation data based on GPS profiling were used to analyse geometry changes of the glacier surfaces. The results confirm the existence of a continuous subglacial depression below sea level (c. 40 m deep) between Hornsund and the Barents Sea. The Hornbreen-Hambergbreen system has changed in shape over the past century, reflecting its dynamic origin and activity, also exemplified by the sequential surges identified since 1899. There was a pre- surge build- up event of Flatbreen causing a surge and subsequent lowering of the Hornbreen- Hambergbreen frontal parts by the 1960s. After, the entire surface lowered, albeit with a delay in the Hornbreen terminal zone. Since the year 2000, Hornbreen terminus has retreated at an average rate of 106 m a−1; ~50% faster than that of Hambergbreen. If the retreat continues at the 2000–2015 average rate, the ice bridge between Hornsund and Hambergbukta will be broken sometime between 2055 and 2065 and the Hornsund strait will separate Sørkapp Land from the Spitsbergen island. The processes and events described in this study, particularly the effects of the glacier surge, may provide a model for changes likely to occur in other coastal glaciated regions experiencing rapid change. (Copyright © 2017 John Wiley & Sons, Ltd.)



The extent of Hornbreen and Hambergbreen in the period 1991–2015 (continuous lines) and the retreat scenario for 2025–2065 (dashed lines). Background image Landsat 8 (2015–09- 17) with clearly visible foliation indicating the direction of ice movement. Ice surface velocity map for the period 1–13 October 2015 from Sentinel- 1.



Glacial bed along the GPR profiles from 2013 and 2014, depth of Hambergbukta (a) and inner Brepollen bathymetry (b). Selected depths and points marked. The dashed line represents probable contours of the subglacial topography and isobaths in Hambergbukta.

6. Science communication and education

- **Goździk A.** (2018). Research and education cooperation example: educational packages of ERIS project. In Finlayson, O.E., McLoughlin, E., Erduran, S., & Childs, P. (Eds.), Electronic Proceedings of the ESERA 2017 Conference. Research, Practice and Collaboration in Science Education, Part 5 (co-ed. Dimitris Psillos &

Nikos Papadouris), (pp. 734-744). Dublin, Ireland: Dublin City University. ISBN 978-1-873769-84-3

One very promising model of learning designs is the model of Research and Education Cooperation activities. ERIS project proposes exploitation of research results in school practice. ERIS is EU funded project (ERASMUS+) aiming to increase the interest of pupils in lower and upper secondary schools in science, and the choice of a scientific career. Thanks to the development, pilot implementation and dissemination of educational packages and methodological materials, research results will be exploited in the education systems of at least 3 European countries: Poland, Romania and France.
ERIS packages are dedicated to various topics, e.g.: glaciers, earthquakes, geomagnetism, meteorology in the Arctic, UV radiation, etc. They use freely available research databases or results published online, which may be analyzed by pupils with the help of instructions prepared by scientists. The packages include materials for teachers to work with pupils during classes or extracurricular activities. They contain worksheets for pupils and guidance for teachers. 30 packages were tested in schools in Poland, Romania and France. The results of evaluation studies are presented and discussed. Teachers found packages interesting and useful for school practice. They found the tasks for pupils rather difficult, as it was a challenge for pupils to apply a new approach, which wasn't taught at schools before. Pupils could not solve tasks in a schematic ways, which they often use when solving typical school exercises, and it might have caused difficulties. However, challenging tasks are developing interest and engagement. ERIS packages and proposed teaching approach may be considered as an efficient way of increasing pupils' interest in science and scientific topics.

National packages were tested in lower and upper secondary schools in partners' countries. Subsequently, English versions of packages were prepared and freely proposed to European secondary schools (not only in partners' countries). Each package was tested by at least 5 groups of students.
For each package online lessons were conducted by scientists, who prepared educational materials for packages. After lessons teachers and pupils were encouraged to work additionally with worksheets prepared for each package. Subsequently, they could have filled in the survey dedicated to the materials in the package. This survey contained some statistical questions (type of school, age of pupils, subject taught by a teacher, who participated in testing), four content questions (about importance of the topic, transparency of materials, sufficient explanations and level of difficulty), and two fields for suggestions. The results are based on 32 surveys obtained from teachers from secondary schools in Poland, who tested ERIS packages in Polish. Teachers declared that packages contain important educational materials (definitely yes: 81%, rather yes: 19%). They assessed the materials included in the packages as clear and transparent (definitely clear: 59%, rather clear: 41%). They also found explanations and instructions for the tasks sufficient (definitely sufficient: 59%, rather sufficient: 41%). Teachers assessed materials included in the packages as generally difficult (very difficult: 3%, rather difficult: 56%, rather easy: 41%).

The second step of the evaluation was dedicated to the assessment of the general impact of proposed materials and methods on pupils' skills and interests. This survey was conducted by each partner institution after finishing of testing packages in national languages in Poland, Romania and France. Teachers were requested to assess how many students developed the

ability to apply research methods in solving problems in the field of mathematics and natural sciences, and number of students, who developed skills of analytical and synthetic thinking. Moreover, they were also assessing the number of students, whose interest in scientific topics increased.
The results are based on 44 surveys obtained from teachers from secondary schools in Poland (18 surveys), Romania (23 surveys) and France (3 surveys), who tested ERIS packages in national languages. Teachers worked with 44 groups of students. Total number of students, who tested the packages was 1054 (356 students from Poland, 631 students from Romania and 67 students from France).
The results from the surveys show that the impact of the project on students skills and interest in scientific topics is significant. Teachers declared that for 70% of their students, who tested the packages, they observed increase of the ability to apply research methods in solving problems in the field of mathematics and natural sciences. They assessed that 70% of their students developed skills of analytical and synthetic thinking, with a slight difference between upper and lower secondary schools (result for lower secondary schools students is 71%, for upper secondary schools students – 69%). Moreover, teachers observed significant increase of students' interest in scientific topics. They declared that for 72% of their students interest increased. Some differences between younger and older students were observed. Students from lower secondary schools got more interested than those from upper secondary schools (73% compared to 70%).

V. SEMINARS and TEACHING

Seminars and Lecture (*only outside of IG PAS)*

Surname	The title of the lecture	Institution	City, Country	Data	Seminar Lecture Invited lecture Other
Dr Tomasz Wawrzyniak	How can Arctic and Antarctic research engage students to STEM education?	Federal University of Minas Gerais	Belo Horizonte, Brasil	May 2018	Invited lectures
Dr Agata Goździk, Dr Jerzy Giżejewski, Dr Tomasz Wawrzyniak, Prof. Piotr Głowacki, mgr Julian Podgórski, mgr Dagmara Bożek-Andryszczak, mgr Piotr Stankiewicz	1. Epoki lodowcowe 2. Przejście Północno – Zachodnie – historia eksploracji 3. "Flying penguins" 4. A story of maps 5. Arctic and Antarctic fauna - comparison 6. Arctic hydrology: Where does the water go? 7. Arktyka, kraina ludzi - Wprowadzenie 8. Bezpieczeństwo w Arktyce 9. Bilans masy	High Schools	58 countries	Jan-Dec. 2018	Webinars

	lodowców 10. Co to jest nauka obywatelska? 11. Drifting ice stations 12. Dryfujące stacje biegunowe 13. Dzień Polarnika 14. EARTH'S MAGNETIC FIELD 15. ERIS webinar: LODOWCE - cz. 1 16. ERIS webinar: LODOWCE - cz. 2 17. ERIS webinar: Pole Magnetyczne Ziemi 18. ERIS webinar: Pomiary meteorologiczne w Arktyce 19. ERIS webinar: Promieniowanie UV - czy zawsze jest wrogiem? 20. Frozen ground 21. Geografia obszarów okołobiegunowych cz. 1. 22. Geografia obszarów okołobiegunowych cz. 2. 23. Glacier processes and landforms 24. Glaciers and glaciations: introduction 25. Glaciospeleology: hobby, sport, or science? 26. Glacjospeleologia: hobby, sport czy nauka 27. How can ice cover of the Arctic Ocean influence on weather in Europe? 28. How glaciers shape the Earth's surface? 29. How it's made:				

	Satelite photos 30. Iceland: The land of air and water 31. Imperial Transantarctic Expedition - Ernest Shackleton 32. Imperialna Wyprawa Transantarktyczna – wyprawa Ernesta Shackletona 33. Islandia: Kraina wody i powietrza 34. LiDAR: Laser in humanity's service 35. Lodowce i zlodowacenia - część. 1 - CYKL "WYZWANIE DLA KLAS" 36. Lodowce i zlodowacenia (wstęp) 37. Ludy Syberii 38. Mass balance of glaciers 39. Na czubku Ryftu Atlantyckiego 40. Niedźwiedź polarny vs. pingwin 41. Nurkowanie swobodne: hobby, sport, nauka 42. Osadnictwo Svalbardu 43. People in the Arctic - Introduction 44. Polacy na biegunach 45. Polar bear - the king of Arctic 46. Polar bear vs. penguin 47. Polar Explorer Day 48. Polar Psychology 49. Pomiary meteorologiczne w Arktyce 50. Procesy i formy glacjalne 51. Psychologia polarna 52. Ruch lodowców (ćwiczenia				

	praktyczne) 53. Safety in Svalbard 54. Settlements in Svalbard 55. Siberian people 56. Strefy klimatyczne kuli ziemskiej 57. The Arctic, people's land 58. Turyści w stacji polarnej? 59. Volcanoes and humans 60. What is citizen science? 61. Wielkie wyprawy polarne – porównanie 62. Wszystko, co chcielibyście wiedzieć o mapach, ale baliście się zapytać 63. Wulkany i ludzie 64. Zlodowacenia górskie w Polsce 65. Бельгийская антарктическая экспедиция 66. День полярника				

Teaching

Surname	The title of the lecture	Institution	City, Country	Date	Seminar Lecture Invited lecture Other
Dr Tomasz Wawrzyniak	Introduction to geology and physical geography	Warsaw School of Information Technology	Warsaw, Poland	10-12.2018	Lectures and seminars

Thesis

Surname of the supervisor	Name and surname of master student	The title of the master thesis	Institution	City, Country

PhD (completed PhD thesis defense)

Surname of the supervisor	Name and surname of PhD student	The title of the PhD thesis	Institution	City, Country
Prof. Krzysztof Migała Dr Bartłomiej Luks (supporting supervisor)	Daniel Kępski	Wpływ rzeźby i pokrycia terenu na rozkład przestrzenny i dynamikę zmian pokrywy śnieżnej na tundrze w okolicy Polskiej Stacji Polarnej na Spitsbergenie	Institute of Geophysics PAS	Warsaw, Poland
Dr hab. Witold Szczuciński Dr Mateusz Moskalik (supporting supervisor)	Joanna Ćwiąkała	Zapis recesji uchodzącego do morza lodowca Hansa w świetle badań geofizycznych, geomorfologicznych i sedymentologicznych w zatokach Isbjørnhamna i Hansbukta, Hornsund, południowy Spitsbergen	Institute of Geophysics PAS	Warsaw, Poland
Dr hab. Robert Bialik	Joanna Sziło	Wpływ recesji lodowców na rzeźbę obszaru i warunki hydrologiczne zachodniego wybrzeża Zatoki Admiralicji (Wyspa Króla Jerzego)	Institute of Geophysics PAS	Warsaw, Poland

VI. VISITING SCIENTISTS (visiting in IGF PAN)

Name and surname	Institution	City, country	*Period of stay*
Arko Olesk	**Tallin University, Baltic Film, Media, Arts and Communication School**	**Tallin, Estonia**	**21-25.05.2018**
Michał Pętlicki	**Centro de Estudios Cientificos**	**Valdivia, Chile**	**7.07-13.08.2018**
Prof. Flavio Justino	**Universidade Federal de Viçosa**	**Viçosa, Brazil**	**15-20.10.2018**

VII. MEETINGS, WORKSHOP CONFERENCES and SYMPOSIA (please mark o=oral/p=poster)

Surname	Name of the meeting/ workshop/ symposium	The title of the presentation	City, Country	Data	Oral Poster	Meeting Workshop Symposium Conference
Piotr Głowacki	XXVIII Seminarium Meteorologii i Klimatologii Polarnej	CLIMEV – nowe narzędzie badawcze dla badań atmosfery w rejonach	Sosnowiec Polska	11-12 maja 2018		

		polarnych				
Piotr Głowacki, Jim Drummond	FARO Annual Meeting 2018	History of FARO	Davos, Szwajcaria	12 June 2018		
Piotr Głowacki Włodzimierz Sielski	International Conference POLAR 2018	The Hornsund Polish Polar Station, Spitsbergen, Svalbard – Access and infrastructure	Davos, Szwajcaria	20 June 2018		
Piotr Głowacki	Svalbard Science Forum Meeting	Polish research activity plan in 2018 at Svalbard	Longyearbyen, Norway	25 April 2018		
Piotr Głowacki	INTAROS Annual Meeting 2018	WP7 – Dissemination and outreach (Update of the first 12 months of activity & plan for the future proposals.	Helsinki, Finlandia	January 2018		
Piotr Głowacki	W cieniu szczytu COP24 – w Centrum Polarnym Sesja popularnonaukowa	Polarna szkoła doktorska a szkoła życia	Sosnowiec	6 grudnia 2018		
Tomasz Wawrzyniak	INTAROS Annual Meeting 2018	Unique long time meteorological data series collected at the Polish Polar Station Hornsund on Spitsbergen	Helsinki, Finlandia	January 2018		
Leena Leppänen, Juan Ignacio López Moreno, Ali Nadir Arslan, Pavla Dagsson Waldhauserova, Charles Fierz, David Finger, Ladislav Holko, **Bartłomiej Luks**, Christoph Marty, Ghislain Picard, Roberta Pirazzini, Aynur Sensoy Sorman, Ali Arda Sorman	POLAR 2018 SCAR/IASC Open Science Conference	Results from COST ES1404 Action for Harmonization of Snow Measurements in Europe	Davos, Szwajcaria	20.06.2018	p	conference
C.Larose, E. Barbaro, M.	POLAR 2018 SCAR/IASC Open	Lessons learned from	Davos, Szwajcaria	20.06.2018	p	conference

Björkman, J-C. Gallet, J. Kohler, K. Koziol, **B. Luks**, T. Martma, T. V. Schuler, A. Spolaor, C. Zdanowicz	Science Conference	interdisciplinary snow research in Svalbard				
Kępski D., Luks B., Migała K., Uszczyk A., Westermann S., Budzik T.	SnowHydro – International Conference on Snow Hydrology	Evolution of snow cover stratigraphy during ablation period in High Arctic tundra environment (SW Spitsbergen)	Heidelberg, Niemcy	14.2.2018	o	conference
Daniel Kępski, Bartlomiej Luks, Marzena Osuch**,** Andreas Dobler, Krzysztof Migala, Sebastian Westermann, Tomasz Budzik, **Tomasz Wawrzyniak**	IGS Cryosphere and Biosphere	Snow cover development in a High-Arctic coastal tundra environment: present state and predictions for the future	Kyoto, Japonia	16.3.2018	o	conference
Juan Ignacio Lopez-Moreno, Leena Leppänen, **Bartłomiej Luks**, Ladislav Holko, Alba Sanmiguel-Vallelado, Esteban Alonso-González, David C. Finger, Ghislain Picard, Katalin A. Gillemot, Roberto S. Azzoni, Christoph Marty, Andrea Soncini, Pavla Dagsson-Waldhauserova, Aynur S. Sensoy, A., Arda Sorman, Ali	Towards a better harmonization of snow observations, modeling and data assimilation in Europe	Differences on snow density and snow water equivalent estimation using different snow tubes: instrumental bias, variability induced by observers and influence of snow and terrain conditions	Budapeszt, Węgry	30.10.2018	o	conference

Nadir Arslan						
Bartłomiej Luks, Marzena Osuch	Towards a better harmonization of snow observations, modeling and data assimilation in Europe	Modelling snow water equivalent in the coastal zone of Hornsund fiord [poster]	Budapeszt, Węgry	30.10.2018	p	conference
Szczuciński W., Dominiczak A., Forwick M., Apolinarska K., Goslar T., **Moskalik M.**, Woszczyk M.	EGU General Assembly	Warming-controlled glaciers retreat and enhanced carbon burial – is there a negative feedback effect? - summary of multidisciplinary study in fjords of Svalbard	Wiedeń, Austria	8-13.04.2018		conference
Wawrzyniak T. (invited lecture), **Goździk A., Głowacki P.**	The International Symposium on The Cryosphere in a Changing Climate 5th Symposium APECS-Brazil	"How can Arctic and Antarctic Research engage students in STEM education?"	Belo Horizonte, Brazylia	15-18.05.2018		
Nawrot A., Luks B., Kozioł K., Stachnik Ł.	Harmosnow Workshop on Snow Chemistry Monitoring	Snow monitoring led by Polish Polar Station Hornsund	Kolm Saigum, Sonnblick, Austria	26.02-02.03.2018		workshop
Osuch M., **Nawrot A., Wawrzyniak T.,** Piotrowski A.P.	Nordic Water 2018	Water temperature modelling of small high arctic stream (Fuglebekken, SW Spitsbergen)	Bergen, Norway	13-15.08.2018		
Lewandowski, M. Nawrot A.	Sympozjum Polarne	Polish Polar Station Dobrowolski – past, present and future	Poznań, Polska	07-10.06.2018	o	
Wawrzyniak Tomasz, Osuch Marzena , **Nawrot Adam**	The 8th Global Friend-Water Conference	The influence of permafrost degradation on runoff generation in small arctic unglaciated catchment (Fuglebekken, Spitsbergen)"	Pekin, Chiny	6-9.11.2018		
Marzena Osuch, **Tomasz Wawrzyniak**	The 8th Global Friend-Water Conference	Projections of hydro-climatic conditions in	Pekin, Chiny	6-9.11.2018		

		small arctic unglaciated catchment Fuglebekken (SW Spitsbergen)				
Marzena Osuch, **Tomasz Wawrzyniak**	„Permafrost thermal state in Svalbard 2016-2017 (PermaSval)" SIOS,	"State of permafrost in Hornsund area, SW Spitsbergen",	The University Centre in Svalbard (UNIS)	13-16 marca 2018		
Agata Goździk	Krajowe Warszataty Scientix	"Co project Scientix oferuje polskim nauczycielom"	IGF PAN, Warszawa	25.04.2018	o	workshop
Agata Goździk	Druga Krajowa Konferencja Scientix	"Scientix w pigułce"	IGF PAN, Warszawa	23-24.11.2018	o	conference
Agata Goździk	Światowe Forum Wody – Konferencja PAN	"Wybrane inicjatywy z zakresu edukacji środowiskowiej I wodnej"	Polska Akademia Nauk, Warszawa	22.03.2018	o	conference
Agata Goździk	9th International Conference "Education, Research & Development"	EDU-ARCTIC competitions as an effective way to increase interest in STEM'	Elenite, Bułgaria	23-27.08.2018	o	conference
Agata Goździk	Societal relevance of polar research	"What do youngsters know about the Arctic – results of the EDU-ARCTIC survey"	Instytut Oceanologii PAN, Sopot	27-28.11.2018	o	conference
Agata Goździk	W cieniu COP24 – w Centrum Studiów Polarnych	"EDU-ARCTIC – atrakcyjne nauczanie bez granic"	Uniwersytet Śląski, Sosnowiec	6.12.2018	o	conference
Agata Goździk	Dzień Informacyjny Programu SWAFS Horyzont 2020	"EDU-ARCTIC – doświadczenia koordynatora projektu"	Krajowy Punkt Kontaktowy Programów Badawczych, Warszawa	11.12.2018	o	meeting
Julian Podgórski	Konferencja MATLAB 2018	„Badanie odbiciowości lodu lodowcowego przy pomocy LiDARu"	Warszawa, Polska	17.04.2018		

VIII. PUBLICATIONS (this part will be prepared by a scientific secretary based on PBN)

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INFORMACJE DO RAPORTU DLA POLSKIEJ AKADEMII NAUK za rok 2018

WYNIKI PRAC BADAWCZYCH:

- Wybrane 2 ważniejsze wyniki uzyskane w ramach projektów/ zadań badawczych (wymienić nawę projektu/ zadania) realizowanych lub zrealizowanych w roku sprawozdawczym (krótki opis, ok. 500 znaków ze spacjami).

Pył w lodowcach.
Celem projektu jest identyfikacja oraz charakterystyka możliwe pełnego inwentarza cząstek mineralnych i biotycznych, występujących w śniegu, firnir i lodzie wybranych lodowców Spitsbergenu. W residuach detrytycznych, pochodzących ze stopionych rdzeni lodowych, wykryto cząstki pochodzenia antropogenicznego (black carbon) oraz naturalnego (m.in. monacyty, cyrkony). Obecność tych minerałów, dzięki datowaniom izotopowym, umożliwia identyfikację obszarów źródłowych. Projekt o charakterze wieloletnim.

Intensywność, kierunkowość oraz statystyka szumu akustycznego generowanego przez góry lodowe
Głowacki O., Deane G.B., **Moskalik M.**
Prace realizowane przez naukowców z instytutu, wraz z specjalistami z jednej z bardziej renomowanych jednostek badań morza na świecie (Scripps Institution of Oceanography, US) ponownie wykazały skuteczność metod akustycznych w badaniach glacjologicznych. Z poprzednich prac tego zespołu wiemy, że jest możliwe wykorzystanie akustyki pasywnej bo badania pojedynczego cielenia lodowca, wraz z określeniem jego typu oraz wielkość. Aktualnie prowadzone prace wykazały, że jest możliwe rozróżnienie sygnałów generowanych przez wytapiające się góry lodowe od czoła lodowca pomimo, że mechanizm generowania dźwięku jest ten sam. Wynika to z ilości pęcherzyków gazu uwięzionego w lodzie. W przypadku dźwięków emitowanych przez góry lodowe jest ich mniej o jesteśmy w stanie rozróżnić pojedyncze dźwięki, a w przypadku klifu lodowca ich ilość już na to nie pozwala. Wyniki te okazały się interesujące dla świata nauki i oddźwięk tego jest nie tylko w publikacji naukowej w renomowanym czasopiśmie Geophysical Research Letters (doi.:10.1029/2018GL077632), ale także w licznych doniesieniach popularyzujących naukę, między innymi w:
- AGU Blogsphere
https://blogs.agu.org/geospace/2018/05/10/sounds-of-melting-glaciers-could-reveal-how-fast-they-shrink/
- Scientific American
https://www.scientificamerican.com/article/how-fast-are-glaciers-melting-just-listen-to-them/
- GlacierHub
http://glacierhub.org/2018/06/06/pioneer-study-sounds-out-iceberg-melting-in-norway/
- EARTHER
https://earther.gizmodo.com/how-sound-can-help-scientists-track-earths-vanishing-gl-1826079691?fbclid=IwAR3syGgUD-yyBd7K_p2WUntIEIcHdZZC6yigY5Mw6vxzNTunwphJeczXqtE

- Najważniejsze w roku sprawozdawczym osiągnięcie działalności naukowej jednostki o znaczeniu ogólnospołecznym lub gospodarczym związane z działalnością naukową lub twórczą, jeżeli zjawisko wystąpiło, (krótki opis, ok. 500 znaków ze spacjami).

- Wybrane 2 ważniejsze zastosowania wyników badań naukowych lub prac rozwojowych o znaczeniu społecznym (np. w zakresie ochrony zdrowia, ochrony środowiska i dziedzictwa przyrodniczego, ochrony zabytków i dziedzictwa kulturowego, inne) i gospodarczym (m.in. nowe technologie, wdrożenia, licencje); działania zwiększające innowacyjność, jeżeli zjawisko wystąpiło, (krótki opis, ok. 500 znaków ze spacjami).

DZIAŁALNOŚĆ JEDNOSTKI NA RZECZ TERYTORIALNYCH STRUKTUR SAMORZĄDOWYCH
(krótki opis)
- prowadzenie, wspieranie badań naukowych i prac rozwojowych z obszaru tematyki regionalnej;
- inicjowanie i prowadzenie prac oraz studiów koncepcyjnych związanych z regionem;
- inne formy działalności jednostki w zakresie współpracy z samorządem terytorialnym.

KSZTAŁCENIE I ROZWÓJ KADRY NAUKOWEJ
1 Udział pracowników Zakładu w różnych formach kształcenia podoktorskiego w instytucjach zagranicznych (studia, staże, stypendia, inne, ukończone w roku sprawozdawczym). Dotyczy osób, które będąc pracownikami Zakładu, uczestniczyły w tych formach kształcenia.
Krótki opis: imię i nazwisko pracownika; zagraniczny ośrodek naukowy; forma kształcenia; okres kształcenia, rok od-do; wybrane uzyskane najważniejsze rezultaty badawcze (ew. publikacje).

2. Opieka nad studentami

Liczba studentów odbywających praktyki w Zakładzie Ogółem:

1. Agnieszka Lisonek z Wydziału Geografii i Studiów Regionalnych Uniwersytetu Warszawskiego – praktyka pod opieką dr. B. Luksa
2. mgr Agnieszka Zawieja z Uniwersytetu im Adama Mickiewicza w Poznaniu - 3 miesięczny staż pod opieką dr. M. Moskalika

WSPÓŁPRACA Z ZAGRANICĄ
1. Umowy i porozumienia o współpracy naukowej zawarte z partnerem zagranicznym
Liczba ogółem:
z tego:

kraj	partner	nazwa dokumentu	okres obowiązywania
Australia	Geoscience Australia	Statement of Cooperation	2018 - 2023
Belgia	European Schoolnet	BRITEC Partnership Agreement	01-10-2018 - 30-09-2021
Belgia	Katholieke Universiteit Leuven (KU Leuven Association)	BRITEC Partnership Agreement	01-10-2018 - 30-09-2021
Estonia	Sihtasutus Tallinna Tehnika – ja Teaduskeskus (ENERGY Center)	ODYSSEY Partnership Agreement	01-10-2018 - 31-03-2021

Finlandia	Finlandia, Chiny, Rosja	"PEEX Pan-Eurasian Experiment" Agreement of co-operation	Od 02.2018
Francja	Universite de Versailles UVSQ	ERIS Partnership Agreement, EDU-ARCTIC Partnership Agreement	2016-2018 2016-2019
Grecja	GFOSS	BRITEC Partnership Agreement	01-10-2018 - 30-09-2021
Grecja	Hellenic Institute of Rhetorical and Communication Studies	ODYSSEY Partnership Agreement	01-10-2018 - 31-03-2021
Hiszpania	Departamento de Matemática Aplicada ETSI de Telecomunicación, Universidad Politécnica de Madrid	Agreement of co-operation	2015-2018
Hiszpania	Fundacion Ibercivis	BRITEC Partnership Agreement	01-10-2018 - 30-09-2021
Hiszpania	Universidad Autonoma de Madrid	BRITEC Partnership Agreement	01-10-2018 - 30-09-2021
Norwegia	University in Oslo oraz Research Council of Norway, współpartnerzy Nansen Environmental and Remote Sensing Center (NERSC), Alfred Wegener Institute, Potsdam (Niemcy), Center for Permafrost (CENPERM), University of Hokkaido	Simple collaboration agreement on project “NFR 239918 SatPerm – Satellite-based Permafrost Modelling across a Range of Scales”	06.2015-12.2018
Norwegia	The Norwegian Institute of Bioeconomy Research - NIBIO	EDU-ARCTIC Partnership Agreement	2016-2019
Republika Czeska	Institute of Rock Structure and Mechanics, Czech Academy of Sciences	Agreement of co-operation	2017- 2019
Rumunia	Uniwersytet Bukaresztański	ERIS Partnership Agreement	2016-2018
Serbia	Centar za promociju Nauke	ODYSSEY Partnership Agreement	01-10-2018 - 31-03-2021
USA	University of California Scripps	Memorandum of Understanding	Od 2016 roku

	Institution of Oceanography		
Wyspy Owcze	Faroese Geology and Energy Directorate FINI	EDU-ARCTIC Partnership Agreement	2016-2019

2. Zagraniczne instytucje naukowe, z którymi jest współpraca w sposób ciągły bez zawartego porozumienia – **liczba ogółem: 12**

- **Bartłomiej Luks (8);** Norwegian Polar Institute, Finnish Meteorological Institute, University of Oslo, Uppsala University, Centre National de la Recherche Scientifique - Ecole Centrale de Lyon, University of Gothenburg, Instituto Pirenaico de Ecología (CSIC) , Institute for the Dynamics of Environmental Processes - National Research Council of Italy
- **Julian Podgórski (2);** Centro de Estudios Cientificos, Valdivia, Chile, Université du Québec à Trois-Rivières, Trois-Rivières, Kanada
- **Mateusz Moskalik (2):** UNIS, Uniwersytet w Tromso

3. Tematy realizowane we współpracy z zagranicą – **liczba tematów ogółem:** 5

4. Uzyskane rezultaty współpracy:

– wybrane rezultaty współpracy, np. wspólne publikacje, patenty, nowe metody badawcze i technologie (krótki opis 2 wybranych wyników, na każdy opis – maks. 500 znaków ze spacjami).

- W ramach współpracy w sieci HARMOSNOW opracowano rozdział “Manual SWE instrument comparison 2 in COST Action HarmoSnow field 3 campaigns ” do książki “European Snow Booklet”, autorzy: Leena Leppänen, Juan I. Lopez Moreno, Katalin Gillemot, **Bartlomiej Luks** and others. W ramach grupy badawczej SnowNet opracowano protokoły oraz rekomendacje do prowadzenie pomiarów pokrywy śnieżnej: Gallet, J-C., Björkman, M.P., Larose, C., Luks, B., Martma, T., Zdanowicz, C., 2018. Protocols and recommendations for the measurement of snow physical properties, and sampling of snow for black carbon, water isotopes, major ions and microorganisms, Kortrapport 46, Norsk Polarinstitutt, 27 pp. oraz przygotowano raport “SIOS State of Environmental Science in Svalbard (SEES): Snow research in Svalbard”
- W ramach współpracy z Uniwersytetem w Tromso opracowano geomorfologię rejonu przedpola Hansbreen (**Ćwiąkała J.**, **Moskalik M.**, Forwick M., **Wojtysiak K.**, **Giżejewski J.**, Szczuciński W. 2018 Submarine geomorphology at the front of the retreating Hansbreen tidewater glacier, Hornsund fjord, southwest Spitsbergen. Journal of Maps 14(2), 123-134)
- W ramach współpracy z UNIS **Kacper Wojtysiak** (doktorant IGF PAN) realizował projekt AFG
- W ramach współpracy z SCRIPPS USA opublikowano pracę dotycząca charakterystyki szumów akustycznych generowanych przez góry lodowe (**Głowacki O.**, Deane G.B., **Moskalik M.** 2018. The intensity, directionality, and statistics of underwater noise from melting icebergs. Geophysical Research Letters 45(9), 4105-4113)
- W ramach współpracy z Centro de Estudios Cientificos, Valdivia, Chile oraz Université du Québec à Trois-Rivières, Trois-Rivières, Kanada, opracowano metodę szacowania czasu od odcielenia gory lodowej przy pomocy intensywności odbicia LiDARu. Podgórski, J., Pętlicki, M. and Kinnard, C. (2018). Revealing recent calving activity of a tidewater glacier with terrestrial LiDAR reflection intensity. Cold Regions Science and Technology, 151, pp.288-301. doi: https://doi.org/10.1016/j.coldregions.2018.03.003

MIĘDZYNARODOWE CENTRA NAUKOWE (DZIAŁAJĄCE W STRUKTURZE JEDNOSTKI)

1. Dane organizacyjne:
- nazwa centrum/rok założenia/ dyrektor/przewodniczący Rady Naukowej.

2. Działalność naukowa:
- łączna liczba opublikowanych prac;
- wybrane wyniki działalności naukowej (krótki opis 2 wybranych wyników, na każdy opis – maks. 500 znaków ze spacjami).

3. Działalność dydaktyczna:
- krótki opis działalności dydaktycznej.

4. Pozostałe informacje, wynikające ze specyfiki działania centrum (krótki opis).

UPOWSZECHNIANIE I PROMOCJA OSIĄGNIĘĆ NAUKOWYCH

1. Konferencje naukowe organizowane/ współorganizowane przez pracowników Zakładu w IGF PAN,

Liczba ogółem: 2
z tego:

Nazwa konferencji	Organizator,	Rodzaj konferencji		Liczba
miejsce, data	współorganizatorzy	krajowa	zagraniczna	wystąpień
Polar-CORDEX (Coordinated Regional Downscaling Experiment - Arctic and Antarctic Domains) Annual Meeting Warszawa, 17-19.10.2018	Marzena Osuch, **Tomasz Wawrzyniak** IGF PAN + Światowy Program Badań nad Klimatem oraz Klimat i Kriosfera (CliC)	-	tak	2
14 Science Projects Networking Event „Bringing Research into the Classroom”	European Schoolnet, IGF PAN, Jet-Propulsion Theatre, GFOSS		tak	1

W tabeli: liczba wystąpień – łączna liczba wszystkich rodzajów wystąpień konferencyjnych przedstawionych przez pracowników jednostki.

[Konferencja krajowa – konferencja, w której biorą udział przedstawiciele co najmniej 5 jednostek naukowych.
Konferencja międzynarodowa/zagraniczna – konferencja, w której co najmniej 1/3 czynnych uczestników prezentujących referaty reprezentuje zagraniczne ośrodki naukowe]

2. Udział pracowników Zakładu w przedsięwzięciach promujących i popularyzujących wyniki badań naukowych (np. festiwale i pikniki naukowe, wystawy i targi, w tym targi książki, artystyczne, inne): nazwa i miejsce imprezy, ewentualne wyróżnienia związane z udziałem w tej imprezie (krótki opis).
Piotr Głowacki – „Tajemnicze wnętrza lodowców” – wykład dla Wszechnicy Naukowej w Stacji terenowej Instytutu Nęckiego, Mikołajki 15 kwietnia 2018.

- Piotr Głowacki – „Co skrywają w swoich wnętrzach lodowce” – wykład w trakcie rejsu ze Spitsbergenu statku Horyzont II, 12 lipca 2018

- Piotr Głowacki – „Svalbard – why is it an unique place in the European Sector of the Arctic" – Svalbard expedition, t/r vessel Horyzont II, 14 July 2018
- Jerzy Giżejewski – "Wielkie wyprawy polarne" Festiwal Nauki Jabłonna 23.09.2019
- Jerzy Giżejewski – "Zlodowacenia górskie w Polsce" , Centrum Kształcenia Ustawicznego, Zespół Szkół w Wyszkowie
- Adam Nawrot -„Nowe technologie w Arktyce" Festiwal Nauki Jabłonna 22.09.2019
- Adam Nawrot – „Polska Stacja Polarna Hornsund" – Dzień Radiowca – 27-09-2018, Warszawa
- Tomasz Wawrzyniak „Razem dla Marty – misja Spitsbergen: Polska Stacja Polarna Hornsund na Spitsbergenie - laboratorium w sercu Arktyki" – wykład otwarty Tawerna Korsarz - 21.06.2018
- Tomasz Wawrzyniak – Scientific research at the Polish Polar Station Hornsund, Svalbard, dni otwarte dla młodzieży na Federal University of Minas Gerais (opisane w Informativo APECS-Brasil), Belo Horizonte, Brazylia
- Tomasz Wawrzyniak – Wstęp do geologii i geografii fizycznej – wykłady i laboratoria w Wyższej Szkole Informatyki Stosowanej i Zarządzania w Warszawie (24h) – semester zimowy 2018.
- Bartłomiej Luks, "Fire, and then the ice – pierwsza wyprawa paleomagnetyczna IGF PAN do Zimbabwe", Polskie Towarzystwo Geograficzne, Oddział Wrocławski, 14.12.2018, Wrocław
- Mgr Julian Podgórski „Wszystko, co chcielibyście wiedzieć o mapach, ale baliście się zapytać" wykład dla uczniów szkół oraz uczestników jubileuszu 90 lat obserwatorium geofizycznego w Raciborzu, 19.10.2018, Racibórz, Polska
- Mgr Julian Podgórski – prezentacja zdjęć sferycznych z PSP Hornsund: Festiwal Nauki Jabłonna 23.09.2019, Sympozjum pn. „Safeguarding our Climate, Advancing our Society", Katowice 10.12.2018

DZIAŁALNOŚĆ ZAPLECZA NAUKOWEGO JEDNOSTKI, O CHARAKTERZE OGÓLNOŚRODOWISKOWYM, W TYM:

1. Muzea, wystawy, kolekcje specjalne i eksponaty, banki zasobów m.in. genetycznych, i in. w strukturze jednostki

- eksponaty, kolekcje – działy, grupy – krótki opis nabytków w roku sprawozdawczym
- udostępnianie zbiorów kolekcji i zasobów (rodzaj zadań i usług specjalistycznych – krótki opis).

2. Laboratoria, stacje diagnostyczne, obserwatoria, prace terapeutyczne, itp.

- zadania, usługi, świadczenia (rodzaj zadań, usług i świadczeń – krótki opis);
- uzyskane certyfikaty za wdrożenia systemów jakości, międzynarodowych, przyjętych w UE (opis);
- uzyskane akredytacje Polskiego Centrum Akredytacji lub równorzędnego, systemy jakości (opis).

NAGRODY I WYRÓŻNIENIA NAUKOWE UZYSKANE PRZEZ PRACOWNIKÓW ZAKŁADU W ROKU SPRAWOZDAWCZYM

1. Nagrody krajowe i zagraniczne przyznane za działalność naukową

nazwa-rodzaj nagrody/za co przyznana/przez kogo/komu

(m.in. Prezydenta RP, Prezesa Rady Ministrów, nagrody PAN, nagrody akademii nauk i instytucji równorzędnych, nagrody resortowe, uczelni wyższych, fundacji, towarzystw, instytucji oraz osób działających na rzecz nauki, nagrody przyznawane przez jednostkę).

dr Oskar Głowacki – Nagroda Prezesa Rady Ministrów za wyróżnioną rozprawę doktorską obronioną w 2017 roku

dr Tomasz Wawrzyniak - Stypendium Profesora Kacpra Rybickiego za najlepsze osiągnięcia naukowe młodych naukowców IGF PAN

2. Nagrody i wyróżnienia przyznane za praktyczne zastosowanie wyników B+R

nazwa-rodzaj nagrody/za co przyznana/przez kogo/komu

(m.in. Prezydenta RP, Prezesa Rady Ministrów, nagrody PAN, nagrody resortowe, uczelni wyższych, fundacji, towarzystw, instytucji oraz osób działających na rzecz nauki, krajowych izb gospodarczych, medali i wyróżnień przyznanych na targach krajowych i zagranicznych, nagrody przyznawane przez jednostkę).

INNE FORMY ZRZESZENIA JEDNOSTEK NAUKOWYCH PAN
– powołane dla potrzeb wspólnych przedsięwzięć naukowych lub prac rozwojowych (centra doskonałości, centra PAN, sieci i konsorcja naukowe, centra naukowe uczelni wyższych, centra naukowo-przemysłowe instytutów badawczych, inne)

1. Działające w jednostce Centra Doskonałości:

Nazwa/data powołania Centrum/status nadany przez Ministerstwo Nauki i Szkolnictwa Wyższego

Centrum Studiów Polarnych – Krajowy Naukowy Ośrodek Wiodący

Powołane na okres 1.01.2014-31.12.2018

2. Przynależność jednostki do centrów PAN (definicja centrum stosownie do przepisów obowiązującej ustawy o Polskiej Akademii Nauk)

Nazwa/data powołania centrum PAN /specjalność naukowa/ jednostki naukowe tworzące centrum

3. Przynależność jednostki do sieci naukowych (definicja sieci naukowej stosownie do przepisów obowiązującej ustawy o zasadach finansowania nauki):

Nazwa/ data powołania sieci naukowej/ specjalność naukowa/ jednostki naukowe tworzące sieć

4. Przynależność jednostki do konsorcjów naukowych (definicja konsorcjum naukowego stosownie do przepisów obowiązującej ustawy o zasadach finansowania nauki):

Nazwa/ data powołania konsorcjum naukowego/ specjalność naukowa/ jednostki tworzące konsorcjum

Polskie Konsorcjum Polarne (PKPol) utworzone przez 18 jednostek naukowych reprezentujących uczelnie wyższe, instytuty PAN oraz jednostki branżowe.
PKPol zostało powołane 25 września 2014 roku w Katowicach.
Partnerzy Konsorcjum:

- Akademia Morska w Gdyni,
- Instytut Biochemii i Biofizyki PAN w Warszawie,
- Instytut Geofizyki Polskiej Akademii Nauk z siedzibą w Warszawie
- Instytut Nauk Geologicznych Polskiej Akademii Nauk z siedzibą w Warszawie,
- Instytut Oceanologii Polskiej Akademii Nauk z siedzibą w Sopocie
- Instytut Paleobiologii Polskiej Akademii Nauk
- Państwowy Instytut Geologiczny – Państwowy Instytut Badawczy w Warszawie,
- Politechnika Gdańska,
- Politechnika Warszawska.
- Uniwersytet Gdański z siedzibą w Gdańsku,
- Uniwersytet im. Adama Mickiewicza z siedzibą w Poznaniu

- Uniwersytet Jagielloński z siedzibą w Krakowie
- Uniwersytet Jana Kochanowskiego z siedzibą w Kielcach,
- Uniwersytet Łódzki,
- Uniwersytet Marii Curie Skłodowskiej z siedzibą w Lublinie
- Uniwersytet Mikołaja Kopernika z siedzibą w Toruniu,
- Uniwersytet Śląski z siedzibą w Katowicach,
- Uniwersytet Wrocławski z siedzibą we Wrocławiu,

5. Udział jednostki w pracach innych form zrzeszeń powołanych dla potrzeb wspólnych przedsięwzięć naukowych lub prac rozwojowych (centra naukowe uczelni wyższych, centra naukowo-przemysłowe instytutów badawczych, inne)
Nazwa/ data powołania/ specjalność naukowa/ jednostki tworzące

Polskie Multidyscyplinarne Laboratorium Badań Polarnych (PolarPOL)
PolarPOL powołane przez Ministra Nauki i Szkolnictwa Wyższego w 26 lutego 2011 roku. Funkcjonuje, jako Krajowy Ośrodek Badawczy w ramach Polskiej Mapy Drogowej Infrastruktur Badawczych i jako wydzielona jednostka Instytutu Geofizyki PAN oraz poszerza potencjał badawczy Centrum Badań Ziemi i Planet (GeoPlanet). Program badawczy będzie realizowany dzięki ścisłej współpracy z członkami Polarnej Sieci Naukowej, a Platformą koordynacji naukowej działań w całym środowisku polarnym jest Komitet Badań Polarnych PAN.
Celem Laboratorium jest rozwój technicznych i organizacyjnych możliwości prowadzenia interdyscyplinarnych badań naukowych zjawisk naturalnych w Arktyce. Laboratorium wzmocni polski udział w światowej sieci badań i monitorowania lądowych i morskich stref polarnych. Konsoliduje ono również, rozproszony obecnie potencjał naukowy polskich badaczy polarnych. PolarPOL zabezpieczy uczestnictwo Polski w międzynarodowym współzawodnictwie i kooperacji w międzynarodowych studiach polarnych. Ma to fundamentalne znaczenie dla pozycji Polski w sferze polityki zagranicznej państwa. Zadaniem PolarPOL jest wykorzystanie wyników badań podstawowych dla potrzeb aplikacyjnych m. in. w zakresie podmorskich zasobów surowców, korzystania z morskich zasobów biologicznych, oraz otwierających się nowych możliwości żeglugowych, a także działalności turystycznej. Szerokie spektrum dziedzin i dyscyplin naukowych stworzy także możliwość testowania oraz wdrażania nowych technologii i materiałów przez polskie podmioty gospodarcze.

Członkostwo we władzach i pełnione funkcje w zagranicznych lub międzynarodowych towarzystwach, organizacjach i instytucjach naukowych oraz komitetach redakcyjnych czasopism naukowych o zasięgu międzynarodowym (w tym pełnienie funkcji redaktora naczelnego)

1. członkostwo we władzach i funkcje pełnione przez pracowników Zakładu w zagranicznych lub międzynarodowych towarzystwach, organizacjach i instytucjach naukowych, których członkowie pochodzą co najmniej z 10 państw

L.p.	Imię i nazwisko	Stopień lub tytuł naukowy	Nazwa organizacji	Pełniona funkcja w okresie sprawozdawczym	Rok wyboru
1	Piotr Głowacki	Prof. dr hab.	Svalbard Integrated Arctic Earth Observing System	Członek Komitetu Sterującego	2010
2	Piotr Głowacki	Prof. dr hab.	Terrestrial Working Group International	Członek	2011

			Arctic Science Committee		
3	Piotr Głowacki	Prof. dr hab.	Forum Arctic Research Operators	Reprezentant narodowy, Członek EXCom	1998-2012 2017
4	Piotr Głowacki	Prof. dr hab.	Svalbard Science Forum	Reprezentant Polski	2006
5	Marek Lewandowski	Prof. dr hab.	SCAR	Przedstawiciel Polski w grupie roboczej Geosciences	2018

2. członkostwo i funkcje pełnione przez pracowników Zakładu w komitetach redakcyjnych czasopism naukowych znajdujących się w bazie JCR, w tym funkcje redaktora naczelnego

L.p.	Imię i nazwisko	Stopień lub tytuł naukowy	Nazwa czasopisma naukowego	Współczynnik IF	Nazwa bazy, w której jest umieszczone czasopismo	Pełniona funkcja, w tym redaktora naczelnego	Rok wyboru

3. członkostwo i funkcje pełnione przez pracowników Zakładu w komitetach redakcyjnych czasopism naukowych nieposiadających współczynnika IF, za publikacje w których przyznaje się co najmniej 8 pkt. Zgodnie z wykazem MNiSW, o którym mowa w § 14 ust.3 pkt 2 rozporządzenia, w tym funkcję redaktora naczelnego

L.p.	Imię i nazwisko	Stopień lub tytuł naukowy	Nazwa czasopisma naukowego	Pozycja w wykazie MNiSW	Pełniona funkcja, w tym redaktora naczelnego	Rok wyboru
1	Marek Lewandowski	Prof.	Volumina Jurassica	1985	Czł. komitetu redakcyjnego	2007

4. członkostwo pracowników Zakładu w zespołach eksperckich powołanych przez organy lub instytucje państwowe oraz instytucje zagraniczne lub międzynarodowe

l.p.	Imię i nazwisko	Stopień lub tytuł naukowy	Nazwa zespołu eksperckiego	Nazwa jednostki powołującej	Opis zadań ekspertów – do 250 znaków
1	Piotr Głowacki	Prof.dr hab.	Zespół „Diamentowy Grant” oraz Iuventus Plus	Ministerstwo Nauki i Szkolnictwa Wyższego	Preselekcja, recenzowanie i opieka nad złożonymi projektami z dziedziny Nauk o Ziemi oraz z zakresu problematyki polarnej
2	Piotr Głowacki	Prof. dr hab.	Rada Naukowa Biebrzańskiego	Minister Środowiska	Opiniowanie programów i zadań

			Parku Narodowego		ochronnych na terenie Parku Narodowego. Analiza i zatwierdzanie tematów badawczych realizowanych na terenie Parku.
3	Piotr Głowacki	Prof. dr hab.	Polish Polar Task Force	Minister Spraw Zagranicznych	Przygotowywanie analiz naukowego zaangażowania Polski w rejonach polarnych. Prezentacja aktywności polskich polarników - naukowców na arenie międzynarodowej
4	Piotr Głowacki	Prof. dr hab.	Zespół ewaluacyjny	Narodowa Agencja Wymiany Akademickiej	Preselekcja, recenzowanie i opieka nad złożonymi projektami w zakresie Nauk o Ziemi i Środowisku
5	Marek Lewandowski	Prof. dr hab.	Polish Task Force	Minister Spraw Zagranicznych	Rewitalizacja stacji im. B.A. Dobrowolskiego; program badań i ekspedycji na kolejne 10 lat
6	Marek Lewandowski	Prof. dr hab.	Komitet Ewaluacji Jednostek Naukowych KEJN	Minister Nauki i Szkolnictwa Wyższego	członek
7	Marek Lewandowski	Prof. dr hab.	Research Fracking in Europe, ReFINE	Durham University, UK	członek
8	Agata Goździk	dr	Zespół ewaluacyjny	Narodowa Agencja Wymiany Akademickiej	recenzowanie projektów w zakresie promocji i upowszechniania nauki (akceptacja do bazy ekspertów, na razie bez działań)
9	Agata Goździk	dr	Polish Polar Task Force	Minister Spraw Zagranicznych	Członek (prezentacja działań z zakresu upowszechniania

					badań polarnych i edukacji)
10	Bartłomiej Luks	dr	European Cooperation in Science and Technology COST Expert		Ewaluacja projektów złożonych do sieci COST