Country Reports

Reports from the Adhering Bodies of the International Permafrost Association

2018

ISSN 2221-3775

Table of Contents

Reports are provided by the country members and are minorly edited for compilation.

Other country members: China, Denmark, Iceland, Italy, Kyrgyzstan, Mongolia, the Netherlands, Portugal, Romania, South Korea, and Sweden.

Argentina (and South American Partners)

At the end of 2017, a one week International Course on South American Geocryology in the Andes was held at the Universidad Nacional de San Juan, Province of San Juan, Argentina. Participants were postgraduate students from Argentina and Chile.

In June, Dario Trombotto was invited to explain about mountain permafrost on the public TV show *There is a Reason for Everything*, hosted by German Paoloski, Buenos Aires.

At the end of 2017, the *Facultad de Ciencias Exactas Físicas y Naturales, Universidad Nacional de San Juan*, created the Unit for Studies of Geocryology, Glaciology, Nivology and Climate Change with Magister Silvio Pastore as coordinator. In the course of the current year this research unit continued with the monitoring studies and field campaigns of the Provincial Glacier Inventory in the San Juan river basin. A helicopter flight (with the participation of Dario Trombotto Liaudat) and geophysical studies were made. A technical and economic proposal was also prepared to update the Provincial Inventory of glaciers and rock glaciers in San Juan with special emphasis on the instrumentation and measurement of the physical parameters, indicated in level 3 of detail of the national guide for the execution of inventories.

In the framework of two international scientific projects the research unit of Geocryology from Mendoza keeps working in the Andes:

1) **Permafrost in the Andes of Argentina – a significant hydrological resource** (*Deutsche Forschungs Gemeinschaft*), together with the University of Bonn (Germany, Prof. Lothar Schrott)

2) ***The Mountain permafrost carbon feedback: the Central Andes and global synthesis***, together with Prof. Peter Kuhry from Stockholm University, in Sweden. The topics are: a) to assess soil organic carbon storage in current mountain permafrost environments and b) to assess soil organic carbon storage in the Patagonian Andes during the Last Glacial Maximum.

In March 2018 Carla Tapia Baldis (Mendoza) successfully defended her PhD thesis: *Distribution and Characteristics of the periglacial environment in the west of Calingasta, Province of San Juan, Argentina,* at the *Universidad Nacional de San Juan*.

Erini Makopoulou presented her MSc Thesis: *Periglacial and glacial landform mapping in the Las Veguitas catchment, Cordillera Frontal in the Andes (Argentina),* at the University of Stockholm, Sweden, under the direction of Prof. Peter Kuhry and Dr. Dario Trombotto Liaudat (National Research Council of Argentina).

The team directed by Dr. Ahumada at the *Instituto de Geología de Cuaternario, Miguel Lillo Foundation*, San Miguel de Tucumán, finished the evaluation of the use of the present periglacial landscape for tourism to offer local settlers the possibility of an educational and sustainable job in poor regions that are endangered by the effects of global warning. They published their results: *"Quantification of the geological heritage of a potential educational geotour in the Sierra of Santa Victoria, Salta, Argentina"* (Ibañez Palacios G, Ahumada AL, Toledo MA, and Páez SV, ISSN 1695-7121). In May 2018 the group took part in the official presentation of the end of the National Inventory of Argentina.

This year Dario Trombotto had the honor to continue as a member of the *CLIC (Climate and Cryosphere, World Climate Research Program*, Geneva, Switzerland*) Scientific Steering Group* until the end of 2019.

Figures 1 & 2: Rock glaciers in the Central Andes of the province San Juan, Argentina. Photos provided by Silvio Pastore.

Report prepared by Dario Trombotto Liaudat

Austria

Permafrost-related activities relevant for Austria and Austria's scientists

The General Assembly 2018 of the European Geosciences Union (EGU) took place again in Vienna (since 2005), Austria, during the period 8-13th April 2018. 15,075 scientists from 106 different countries (734 thereof from Austria) participated in this huge scientific event. 4,776 oral presentations, 11,128 posters, and 1,419 PICO presentations were given in 666 different scientific sessions (http://www.egu2018.eu). The word "permafrost" appears in 79 sessions either in the title, in the description or in one of their contributions, particularly in the sessions of the program groups "Cryopheric Sciences (CR)" and "Geomorphology (GM)".

The 5th European Conference on Permafrost (EUCOP 2018) was held in Chamonix-Mont Blanc, France, during the period 23rd June to 1st July 2018. Several scientists from different research Institutions in Austria – Graz, Innsbruck, Korneuburg (near Vienna), Salzburg, and Vienna – participated in this event.

Reports from the different working groups working on permafrost research in Austria

Salzburg

Long-term deep borehole monitoring of mountain permafrost was continued at the "Open-Air-Lab Kitzsteinhorn" (3.203 m asl), Hohe Tauern Range, in 2018 by the private company GEORESEARCH (Ingo Hartmeyer, Markus Keuschnig). As measured by the temperature sensors in the boreholes, the maximum active layer thickness at the Kitzsteinhorn north face reached 3.9 m in late August to early September 2018 and hence exceeded the one of the previous year by 0.2 m. Temperatures below the ZAA are in the order of -1.8 °C.

In the permafrost-affected randkluft (i.e. the crevasse between the head of the glacier and the adjacent rock wall) below the Kitzsteinhorn north face, comprehensive monitoring was initiated, which comprises bedrock and glacier ice temperature measurements, acoustic emission recordings of frost cracking and a suite of meteorological parameters (funding provided by the Austrian Academy of Sciences). Further permafrost-related research activities at the Kitzsteinhorn included crack deformation measurements, rockwall monitoring with UAVs and terrestrial LiDAR, and load monitoring at rock anchor heads (Fig. 1).

Figure 1: Maintenance works near a permafrost borehole in the Kitzsteinhorn north face, Hohe Tauern Range. Note the two persons for scale (Photo: Robert Delleske, Date: 01.08.2018).

In the Sattelkar cirque, located west of the Kitzsteinhorn site, the disintegration of a former rock glacier and subsequent debris flow activity is monitored by the same company with multi-temporal remote sensing data and some 30 ground-surface temperature sensors.

The PERSON-GCW long-term monitoring project investigates the spatial distribution of permafrost in the Sonnblick region. PERSON-GCW is funded by the Austrian Federal Ministry for Sustainability and Tourism, and carried out by the 'Zentralanstalt für Meteorologie und Geodynamik' (S. Reisenhofer, C. Riedl). The project aim is to identify the driving permafrost parameters in the Sonnblick region, whereas geological, geomorphological, orographical and climatic parameters are evaluated. On this basis the current spatial-temporal permafrost behaviour as well as potential future scenarios will be assessed.

The PERSON-GCW network consists of 42 ground surface temperature loggers and six shallow boreholes with depths up to 140 cm to monitor near-surface temperatures. Furthermore, the basal temperature of snow (BTS) is determined annually. In March 2018 the BTS was measured for 104 locations. Additionally, two thermistor chains were installed in shallow (1 m) boreholes in the Sonnblick north face. The thermistor chains exhibit temperature sensors every 0.2 m. Within the construction works for the new Sonnblick cable car in summer 2018, another thermistor chain was installed in a 12 meter deep borehole on the south-facing slope of the Sonnblick summit. This thermistor chain features six temperature sensors in varying depths (0.4, 0.7, 1.1, 2.8, 5.7 and 8.5 m).

The SeisRockHT project was the start of a long-term rock fall monitoring initiative at the Sonnblick north face. In the period 2015-2018 a continuous operating seismological network was installed. The seismological network is supplemented by regular terrestrial laser scans of the north face. In spring 2019 the relationship

between the so-far gathered seismic data and permafrost and climatic data of the Sonnblick will be assessed. SeisRockHT was funded by the Austrian Academy of Sciences (ÖAW) and carried out by the Zentralanstalt für Meteorologie und Geodynamik, Mertl Research GmbH and Georesearch Forschungsgesellschaft mbH.

Graz

The Institute of Geodesy of the Graz University of Technology (Viktor Kaufmann) has successfully continued its annual geodetic measurements at the five rock glaciers Dösen, Hinteres Langtalkar, Weissenkar, Leibnitzkopf and Tschadinhorn. On Tschadinhorn rock glacier a UAV-based aerial survey was carried out for the third time. At this time overflights using two different UAVs were accomplished supporting a joint research project of Graz University of Technology (Institute of Geodesy) and University of Graz (Department of Geography and Regional Science). Using this image data and older orthophotos, an image-based change detection analysis will be carried out.

In summer 2018 a terrestrial photogrammetric survey of the Äußeres Hochebenkar rock glacier was carried out. Image data was collected using three different camera systems (Fig. 2). The data will be compared with respective data from an older survey (2015) also focusing on change detection analysis.

Figure 2: Terrestrial photogrammetric survey of the Äußeres Hochebenkar rock glacier, Ötztal Alps, accomplished jointly by the Institute of Geodesy and the Institute of Applied Geosciences, both Graz University of Technology (Photo: Viktor Kaufmann, Date: 01.08.2018).

Research within the project “RGHeavyMetal - Water resources management issues of rock glaciers in alpine catchments of the Eastern Alps - storage capacity, flow dynamics and hydrochemistry in particular heavy metal pollution” was continued in 2018 and is going to be finalized in 2019. Research in this project is accomplished by a research group of the Institute of Earth Sciences of the University of Graz (Gerfried Winkler, Thomas Wagner, Alexander Brodacz, Roswitha Pleschberger, and Simon Kainz) together with colleagues of the Department of Geography and Regional Science (Andreas Kellerer-Priklbauer, Gerhard Karl Lieb). In addition, their work was supported by colleagues from the University of Innsbruck (Karl Krainer, Markus Ribis) and the University of Freiburg, Germany (Stefan Hergarten).

First nation-wide and homogenous rock glacier and rock glacier catchment inventories of the Austrian Alps based on digital elevation model with a resolution of 1 m (airborne laser scan data) were completed, integrating earlier regional inventories (Wagner et al., 2018; DOI:10.1553/np_symposium2017). A related publication describing the mapping procedure, the attribute tables and relevant results is currently in progress. The monitoring and data acquisition to improve our understanding of the discharge behavior and storage capacity of (relict and intact) rock glaciers and their spring water hydrochemistry was intensified with natural and artificial tracer analyses (Winkler et al., 2018a; DOI:10.25680/8822.2018.82.81.168; Winkler et al., 2018b; DOI:10.1553/np_symposium2017; Winkler et al. 2018c; SINA Meeting 2018).

The thermal behavior of the active layer of intact rock glaciers and the surface layer of relict ones was investigated in more detail by installing temperature logger at different depths up to 1.5 m below surface. The results will help to understand the permafrost thawing in rock glaciers in relation to climate warming (Wagner et al., 2018 – Pangeo ISSN:1017-8880). A final report of the RGHeavyMetal project is going to be published in the first half of 2019.

Permafrost-related research at the Department of Geography and Regional Science, University of Graz (Andreas Kellerer-Pirklbauer, Gerhard Karl Lieb, Oliver Sass, Michael Avian, Wolfgang Sulzer, Gernot Seier, Joachim Götz, Wolfgang Schöner, and Gernot Resch) was carried out at eleven sites in the Central Alps of Austria. Research activities are accomplished in close collaboration with the Institute of Geodesy of the Graz University of Technology, the Institute of Earth Sciences, University of Graz, and the ZAMG (see above). Permafrost monitoring in the Hohe Tauern Range is currently carried out within the framework of the two projects “Permafrost monitoring in the Hohe Tauern national park of Carinthia” and “Long-term monitoring of abiotic processes in the Hohe Tauern National Park”. Both projects aim, amongst other issues, to gather long-term data on permafrost (temperature data series) and periglacial processes (rock glacier displacement data series). The latter project is briefly presented in Lieb &

Kellerer-Pirklbauer (2018; DOI:10.1553/np_symposium2017).

Field work and monitoring device maintenance was accomplished at five active rock glacier sites (Dösen, Hinteres Langtalkar, Leibnitzkopf, Weissenkar, and Tschadinhorn), one active rock fall site (Mittlerer and Hoher Burgstall, near Pasterze Glacier), and four marginally permafrost sites (Hochtor area, Fallbichl area, Hintereggen valley, Hochreichart area). Measurements of the relative age of the Leibnitzkopf and Tschadinhorn rock glaciers were successfully carried out (results to be published). In addition, new monitoring instruments were installed at these two active rock glaciers. Finally, a third UAV-survey was jointly accomplished with the Graz University of Technology at the Tschadinhorn rock glacier (see above).

A new permafrost monitoring network consisting of 18 individual monitoring sites was installed at the summit pyramid of the Innerer Knorrkogel mountain (2828 m asl), located in the Tyrolean part of the Hohe Tauern National park. This network is part of the "Long-term monitoring of abiotic processes in the Hohe Tauern National Park" initiative and aims to monitor surface temperatures, near-surface temperatures at different depths as well as air temperature at different slope aspects and elevations around the summit pyramid of this mountain peak (Fig. 3).

Figure 3: Drilling activities at one of the new rock temperature monitoring sites at the Innerer Knorrkogel, Hohe Tauern Range in Austria. At this particular site, temperature sensors were installed at 3, 10 and 40 cm below the rock surface (Photo: Andreas Kellerer-Pirklbauer, Date: 16.08.2018).

In the framework of the DFG (German Research Foundation) funded project PermARG ("Rockglacier permafrost in the Central Andes of Argentina", 11/2015-10/2018) the research group of Lothar Schrott (University of Bonn, Germany) in cooperation with Dario Tromotto (IANIGLA, Mendoza, Argentina) conducted field campaigns at the Morenas Coloradas and Dos Lenguas rock glacier complexes in 2016, 2017, and 2018. The main objective of this project is to quantify water storage capacities of rock glacier permafrost in the semi-arid Andes of Argentina. Field work was carried out by Lothar Schrott, Christian Halla, Jan Blöthe (all University of Bonn), Joachim Götz (University of Graz), Estefania Bottegal and Carla Tapía (IANIGLA, Mendoza). In an effort to communicate the research objectives and findings to the wider public, a popular science article was recently published in the Geographische Rundschau (Halla et al., 2018).

Innsbruck

Within the project "ChangeLake" (supported by eurac research, Bozen/Bolzano; collaborators Ulricke Tappeiner, Roberta Bottarin), researchers from the Institute of Ecology of the University of Innsbruck (Karin Koinig, Boris Ilyashuk, Elena Ilyashuk., Roland Psenner, Bernd Fritz) continued monitoring the impact of rock glacier melt-water on lakes and ponds in the surroundings of the valley of Matsch (Matscher Tal), Ötztal Alps. They are especially interested in the long-term change in limnochemical parameters in relation to recent warming. Monitoring also includes lakes and ponds without rock glacier inflow as reference sites. The monitoring is linked to the LTER site Matscher Tal (http://lter.eurac.edu).

The Institute for Interdisciplinary Mountain Research (Austrian Academy of Sciences) and the Verein Gletscher Klima continued their long-term monitoring program of surface displacement at Äußeres Hochebenkar rock glacier (Andrea Fischer, Martin Stocker-Waldhuber). The annual velocity measurements were carried out on 10th September 2018. Results for 2017/18 indicate flow velocities very similar to the ones of the previous years.

Research activities within the project "RGHeavyMetal - Water resources management issues of rock glaciers in alpine catchments of the Eastern Alps - storage capacity, flow dynamics and hydrochemistry in particular heavy metal pollution" were continued at the University of Innsbruck, Institute of Geology, by Karl Krainer and Markus Ribis in cooperation with the University of Graz (see above).

Vienna

The Permafrost Information System which provides data from earth observation derived datasets has been completed as part of the ESA DUE GlobPermafrost project (led by Annett Bartsch, system hosted by AWI). The datasets have been evaluated in cooperation with a wide range of researchers (e.g. Strozzi et al., 2018; DOI: 10.3390/rs10091360). Dedicated field work has been also carried out at the northern part of the Ural Mountains in cooperation with the Russian

Academy of Science (Fig. 4). A new ESA project, CCI+ Permafrost (Science lead A. Bartsch), kicked off in June 2018 (2018-2021, http://cci.esa.int/Permafrost). Focus will be on the production of global permafrost maps and their application.

Figure 4: Soil and vegetation survey (note the group of people in the central part of the photo) in the discontinuous permafrost zone at the foot of Northern Ural mountains (Photo: Annett Bartsch, Date: 08.09.2017).

The fifth anniversary of the Austrian Polar Research Institute (APRI) was celebrated in April 2018. APRI is interdisciplinary and several of its members are contributing to HORIZON2020 Nunataryuk, investigating the impacts of thawing coastal permafrost. Aspects of anthropology (P. Schweitzer, University Vienna), soil processes (A. Richter, University Vienna) and circumpolar monitoring with satellite data (A. Bartsch, b.geos) are covered. Dedicated fieldwork has been carried out by APRI members in several Arctic settlements and along the Beaufort Sea coast in 2018.

Within a PhD project at University of Salzburg, a new monitoring tool for subground temperatures during frozen conditions across the Arctic, based on microwave satellite data, has been proposed (Bergstedt et al., 2018; DOI:10.3390/rs10010142).

In the framework of the ANR (The French National Research Agency) funded project PRISM (Permafrost, Rock, Ice and Snow Monitoring in the Austre Lovén glacier basin, RIS:6815, Svalbard) and with additional funding of the RCN (Research Council of Norway) the Institute of Applied Geology (University of Natural Resources and Life Sciences, Vienna) took part in two expeditions in 2017 and 2018 to support the long-term monitoring at the Austre Lovénbreen basin. The project is led by Florian Tolle and Eric Bernard (both Université de Franche-Comté, ThéMA CNRS). The main objective of the project is to investigate the spatial distribution and evolution of slope processes over time in high-arctic glacier basins (Fig. 5). Research is carried out by Florian Tolle, Eric Bernard, Jean-Michel Friedt (Université de Franche-Comté, FEMTO-ST CNRS), Alexander Prokop (The University Centre in Svalbard, Norway), Christian Zangerl and Erik Kuschel (both University of Natural Resources and Life Sciences, Vienna) and Saskia Eppinger (Technical University Munich).

Figure 5: Scanning the slopes of the Slattofjellet and front of the Austre Lovénbreen glacier with a Riegl VZ-6000. (Photo: Erik Kuschel, Date: 24.09.2018)

Report prepared by Andreas Kellerer-Pirklbauer, Department of Geography and Regional Science, University of Graz (andreas.kellerer@uni-graz.at)

Canada

Intro

Highlights this past year included the incorporation of the Canadian Permafrost Association (CPA). More details on this are provided below. Planning also got underway for the 8th Canadian Permafrost Conference to be held in Quebec City August 18-22 2019 (https://www.agora-inscription.ca/iccre-cpc-2019). The conference will be held with the 18th International Conference on Cold Regions Engineering (ICCRE) and is jointly sponsored by the Canadian National Committee for the International Permafrost Association (CNC-IPA), the Canadian Permafrost Association, the Canadian Geotechnical Society and the Eastern Quebec Regional Section of the Canadian Geotechnical Society. The CNC-IPA and CPA are also providing support for up to 20 student and 2 northern resident travel bursaries to encourage their participation at the conference.

Canadian Permafrost Association

The Canadian Permafrost Association (CPA) was officially incorporated as a non-profit organization in March 2018, with a mission to bring communities, researchers, and practitioners together to advance understanding of permafrost environments. The organization is run by members of the permafrost community, and includes government and academic scientists and engineers. The first and second Board of Directors were approved at the CPAs first stand-alone conference and Annual Business Meeting in Whitehorse this past October.

The current (and past) 9-member Board of Directors includes:

President - Antoni Lewkowicz, University of Ottawa, Ottawa
Vice-Chair - Lukas Arenson, BGC Engineering, Vancouver (Richard Trimble, Tetra Tech, Yellowknife)
Treasurer - Barbara Fortin Tetra, Tech, Yellowknife (Lukas Arenson BGC Engineering, Vancouver)
Secretary – Peter Morse, Geological Survey of Canada, Ottawa
Communications Director – Ashley Rudy, Geological Survey of Canada, Ottawa
Early Career Representative – Carolyn Gibson, University of Guelph, Guelph
Member-at-large – Panya Lipovsky, Yukon Geological Survey, Whitehorse
(Isabelle de Grandpré, Government of the Northwest Territories, Yellowknife)

Top: CPA members get hands-on experience collecting ERT data in the field. Bottom: Dr. Fabrice Calmels spoke about the impacts of thawing permafrost on infrastructure with CPA members and Whitehorse locals.

Member-at-large – Wayne Pollard, McGill University, Montreal
Ex-officio member (non-officer) – Chris Burn, Carleton University, Ottawa

The CPA had a great first year! As of January 2019, the CPA has 101 members, 5 Corporate sponsors, and 3 Institutional members. The CPA's first official event was held at the Yukon College from October 10–12, 2018. The meeting included a hands-on electrical resistivity tomography (ERT) workshop followed by two days of oral presentations, the Annual Business Meeting, and a local field excursion. A total 15 oral presentations and two plenary talks were given, representing a mix of natural and social scientists, engineers, and First Nation and Government Organizations. The final day of the conference brought together CPA members and Whitehorse locals for a field trip led by Dr. Fabrice Calmels and Louis-Philippe Roy of the Northern Climate Exchange.

The CPA has signed an MOU with the organizers of the 18th International Conference on Cold Regions Engineering and the 8th Canadian Permafrost Conference that will be held August 18-

22, 2019 in Quebec City. This will be the location of the 2nd CPA Annual General Meeting.

For more information on the current activities and future plans for the CPA please visit www.canadianpermafrostassociation.ca.

Submitted by Ashley Rudy, Communications Director CPA

Standards and Guidelines

Canadian permafrost scientists and engineers have been active on expert working groups and advisory committees tasked with the development of standards and guidelines.

Technical Guide: Infrastructure in permafrost: A guideline for climate change adaptation (New Edition)

The first edition of the Technical Guide (CSA Plus 4011-10) was published in 2010. The draft for a new edition was posted for public review in late January 2019 and comments received by March 11 2019 will be considered in finalizing the document. This document is a guideline for community decision makers and geotechnical engineers with roles in planning, designing, developing, or managing community infrastructure in permafrost regions. It concerns structures that require foundations. It is not a design text book for building in permafrost regions. It is intended to equip community decision makers with the ability to ensure that the impacts of climate change on permafrost are considered during the siting, design, and management of new community infrastructure. The text has been revised to reflect changes in scenarios of future climate and new building standards that have become available since the first edition was published in 2010. An expert working group co-chaired by Chris Burn and Don Hayley was tasked with preparing the updated document. The document is included under the second phase of the Northern Infrastructure Standardization Initiative (NISI) which will include new standards with comprehensive permafrost sections as well as updates to existing standards.

Northwest Territories Good Building Practice Guideline

The Government of the Northwest Territories, Department of Infrastructure is updating it's Good Building Practice guideline. It is scheduled for release on March 31, 2019. The previous edition of the guideline can be accessed at: https://www.inf.gov.nt.ca/sites/inf/files/good_building_practice_for_northern_facilities.pdf

Canadian Highway Bridge Design Code (CHBDC) Update

The CHBDC is currently being updated. The update will include permafrost provisions and is expected to be released in 2019.

New Edition of the Periglacial Environment

Hugh M French, The periglacial environment, 4E, 515 pp, Wiley Blackwell, ISBN 9781119132783 (pbk.), ISBN 9781119132813 (epub.)

First published in 1976, this undergraduate-level text provides an overview of the cold non-glacial (periglacial) environments of the world. The text is updated to early 2017 and is now divided into Five Parts.

Part One describes the extent of the periglacial domain, its climates and its ecosystems. Part Two, entitled Frozen ground and permafrost, is a primer on geocryology; it consists of chapters devoted to ground freezing (Chapter 4), permafrost distribution and stability (Chapter 5), ground ice and cryostratigraphy (Chapter 6), aggradational permafrost landforms (Chapter 7) and thermokarst processes and landforms (Chapter 8).

Part Three, entitled Periglacial geomorphology, describes cold-climate weathering (Chapter 9), mass wasting processes and active-layer phenomena (Chapter 10), azonal processses and landforms (Chapter 11), and slope development and landscape evolution (Chapter 12).

Part Four, consisting of three chapters, is an introduction to the cold non-glacial environments of the Pleistocene. It describes the faunal and stratigraphic evidence commonly used to infer previously-frozen ground, such as yedoma '(ice complex') sediments, loess and various frost-induced and/or modified sediments and structures.

Part Five, consisting of two chapters, is an introduction to the urban and social infrastructure and geotechnical problems associated with human occupancy of areas underlain by frozen ground. The text is also suitable as reference material for those with research, professional or administrative interests in cold non-glacial environments.

The full table of contents is available at: https://www.wiley.com/en-us/The+Periglacial+Environment%2C+4th+Edition-p-9781119132783

Geocryology: Characteristics and Use of Frozen Ground and Permafrost Landforms

The recently published book Geocryology (editors S. Harris, A. Brouchkov, C. Guodong) has been nominated by the Association of American

Publishers as a finalists for 2019 PROSE Awards. The Prose awards honor scholarly works published in 2018.

Monitoring freeze-thaw cycles on a railway track

Climate change might increase the frequency of events such as heat waves, freeze-thaw cycles, and flooding. These climate hazards are expected to have an impact on railway track performance across the country. There is currently very little publicly available data that quantifies the effects of such events on railway operations. Such quantitative data is essential for determining when, where and to what extent climate adaptation measures are needed. GKM Consultants worked in collaboration with the National Research Council to design and commission a monitoring system that combines structural health monitoring of the tracks with geotechnical monitoring of the grade and subgrade. The monitoring system provides dynamic measurements that are triggered by each train passage in addition to long term monitoring. The expertise that has been acquired over the course of this project will be invaluable for the design and future implementation of this type of monitoring in cold regions, including permafrost regions. Results from this project will be presented at the 18th ICCRE/8th Canadian Permafrost Conference.
For further information contact: Stephane-Eric Thivierge, GKM Consultants

Railway monitoring system

Report Prepared by: Sharon Smith, Geological Survey of Canada, Natural Resources Canada Secretariat, Canadian National Committee for the International Permafrost Association

Finland

Finnish Meteorological Institute (FMI)

FMI (Space and Earth Observation Centre, Director J. Pulliainen) investigates the feasibility of various Earth Observation satellite data sources for the monitoring of the circumpolar cryosphere, including permafrost areas. A major topic is the use of microwave observations to retrieve information on soil frost and thaw, and the satellite data-based mapping of hemispheric snow mass and extent. Additionally, these information are used together with climate/ecosystem models and situ data to analyze the processes related to carbon and water cycle. In particular, the SMOS (Soil Moisture and Ocean Salinity) satellite of the European Space Agency (ESA) is used to provide products and near-real-time services on soil frost evolution. The GlobSnow initiative coordinated by FMI provides time series on hemispheric daily snow mass (snow water equivalent) at the spatial resolution of 25 km starting from 1979. This Climate Data Record (CDR) is widely used by the permafrost research community. More information from http://space.fmi.fi/main/earth-observation-for-cryosphere/

FMI (T. Laurila), together with Arctic and Antarctic Research Institute (V. Kustov, A. Makshtas), St. Petersburg, Russia measured soil temperatures and soil heat flux at the Research station "Ice Base Cape Baranova" (79°16.82'N, 101°37.05'E), which is located at the very northern part of the Bolshevik island to the north from Taimyr. The site is arctic desert on stony landscape about 100 m from the shoreline of Shokalsky strait opening to the Laptev Sea. Annual average soil temperature in the 20-100cm depth soil profile was -9.5°C and active layer depth was 50 cm.

FMI (T. Laurila, M. Aurela, J.-P. Tuovinen) has conducted measurements of GHG fluxes and GHG and aerosol concentrations in Tiksi in northeastern Russia since 2011. The Tiksi station has been run in collaboration with Roshydromet (AARI: V. Kustov, A. Makshtas and MGO units) and the National Oceanic and Atmospheric Administration (NOAA, U.S.A.). The flux station is located at 71.5943°N, 128.8878°E, 7 m above sea level, ca. 500 m from the shoreline of the Laptev Sea and ca. 50 km from the Lena River delta. Typical of permafrost tundra, the landscape around the Tiksi flux station is highly heterogeneous, comprising patches of different plant communities, water bodies, and other land cover types. The surface heterogeneity generates high variability in the ecosystem-atmosphere fluxes of GHGs. The spatial variation of soil and plant attributes was examined within the area and evaluated possibilities to capture this variation by remote sensing for the benefit of carbon exchange measurements and their landscape-scale extrapolation (University of Helsinki: T. Virtanen, J. Mikola). The soil temperature profiles measured in three contrasting microecosystems types show drastically different patterns during a course of a year. The influence of methane flux variability was further investigated and a method was developed for estimating land-cover-specific fluxes from the micrometeorological measurements. Combined with remote sensing data, these fluxes provide a means for deriving regionally representative GHG balances.

A comparison of temperature regimes of the active soil layer measured at four different areas of the tundra in HMO Tiksi region shows significant differences for sites separated by no more than 1 km and influenced by common atmospheric conditions. Differences between tundra areas covered by vegetation and tundra areas with shale (typical also for the Bolshevik Island) is clearly evident. In rocky areas the amplitude of seasonal temperature variation has twice the magnitude and the duration of the zero curtain effect (a measure of the energy transfer between the atmosphere and underlying surface) is attenuated by a factor of 3-7 times.

University of Helsinki and University of Oulu

M. Väliranta (University of Helsinki) coordinates a project entitled “Response of high-latitude peatlands to past and recent warming – predictions for future climate feedbacks”. The project is funded by the University of Helsinki, Academy of Finland, and Chinese Scholarship Council (CSC) and the approach is palaeoecological. To contribute to the development of past and predictive carbon models this project provides vegetation, microbial, hydrology and peat growth rates data derived from a series of high-latitude study sites, which form a circum-arctic transect. Peatlands (Fig. 1) play a key role in global carbon cycle and they are sensitive to environmental changes. Briefly, dry peatlands are effective C sinks but wet peatlands also release C to the atmosphere in a form of methane. We do not yet fully understand how direct the relationship between climate and carbon dynamics is. There is growing interest to model C budgets back in time to facilitate creation of predictive models. Study areas have experienced several notable temperature changes during the last centuries. These changes provide a valuable setting to investigate peatland-climate relationship. First results suggest there is no single environmental factor that alone drives permafrost peatland carbon accumulation. This is manifested by the pattern where in some of the studied permafrost peatlands, warming since 1850 AD has increased carbon accumulation rates while elsewhere there is a slight decrease in carbon accumulation over the same period. These divergent trends suggest that there are alternative response directions to warming in the

future and that also an overall decrease in the C sequestration ability may occur for permafrost peatlands. Moreover, preliminary modelling results, carried out in collaboration with scientists from Finnish Meteorological Institute and University of Eastern Finland highlight importance of arctic peatlands in atmospheric greenhouse gas forcing in long-time scales.

Figure 1: Permafrost peatland coring in Seida, Russia (photo by M. Väliranta).

The INFRAHAZARD (Geomorphic sensitivity of the Arctic region: geohazards and infrastructure, 2015–2018) research project (J. Hjort & O. Karjalainen, University of Oulu, and M. Luoto, J. Aalto & A.-M. Virkkala, University of Helsinki) was finalized successfully. The project focused on the modelling of the Arctic Earth surface systems (ESSs) in a changing climate and production of geographic information system (GIS) based infrastructure risk maps for decision making and land use planning (circumpolar mean annual ground temperature and active layer thickness predictions, https://datadryad.org/resource/doi:10.5061/dryad.886pr72 and circumpolar geohazard indices, https://doi.pangaea.de/10.1594/PANGAEA.893881 at ca. 1 km resolution).

Spatial ensemble prediction of permafrost thaw, soil carbon and ground-ice in the Arctic (ArcticSHOC) project (2018–2022) was funded by the Academy of Finland (J. Hjort & O. Karjalainen, University of Oulu). The ArcticSHOC project continues the work of the INFRAHAZARD project and will provide spatially high-resolution predictions of soil organic carbon (SOC) and ground-ice content across the Northern Hemisphere. The sensitivity of permafrost and its relation to SOC pool and ground-ice is explored across the Arctic region at ca. 1 km resolution. Key data sets will be available through open-access databases for the use of the Arctic research community.

Temperature monitoring (J. Hjort) of a palsa in NW Finland (close to Peera) continued.

University of Eastern Finland

The Department of Geographical and Historical Studies, University of Eastern Finland (T. Kumpula, A. Colpaert, E. Lotsari, M. Verdonen) have conducted annual high accuracy RTK GPS measurements in two palsas in Laassaniemi and Peera since 2007 (Kilpisjärvi area). The both studied palsas have about 150 plots from which XYZ and active layer depth are measured annually in the end of the August and beginning of the September. In Peera palsa mire, also temperature and soil moisture monitoring with loggers have been going on since 2011. Unmanned Aircraft System (UAS) have been used in monitoring of palsa mires between Markkina and Kilpisjärvi since 2015 (T. Kumpula, P. Korpelainen, M. Verdonen). At the moment, 15 different palsa mires are annually monitored with UAS drones in the early June and at the end of August. In summer 2018, drone flight campaign was conducted and as a result, totally about 20 km^2 of palsa mire (Fig. 2) orthophotomosaics and DEM with 3 cm resolution was created.

Figure 2: Collapsing palsa in Nierivuoma, Northern Finland (photo by T. Kumpula).

Report prepared by Jan Hjort, Geography Research Unit, University of Oulu (Jan.Hjort@oulu.fi)

France

5th European Conference on Permafrost (EUCOP5)

In 2018, the EDYTEM and PACTE laboratories (CNRS - University Savoie Mont Blanc and University Grenobles Alpes, respectively) have organised the 5th European Conference on Permafrost (EUCOP5) in Chamonix (June 23-28) in collaboration with the Universities of Fribourg and Lausanne (Switzerland), and the Agenzia Regionale per la Protezione dell' Ambiente Valle d'Aosta (Italy). More than 450 scientists attended this event, which started with the 2-day workshop of the Permafrost Young Researcher Network (about 150 attendees). The EUCOP5 accounted for 3 days of presentations (267 orals, 217 posters), 2 days of local excursion, at the Brevent, Montenvers (Mer de Glace) and the Dérochoir rock glacier, and was followed by three field trips: one in Valle d'Aosta (Italy), one in the Swiss Valais and one in the French Écrins massif.

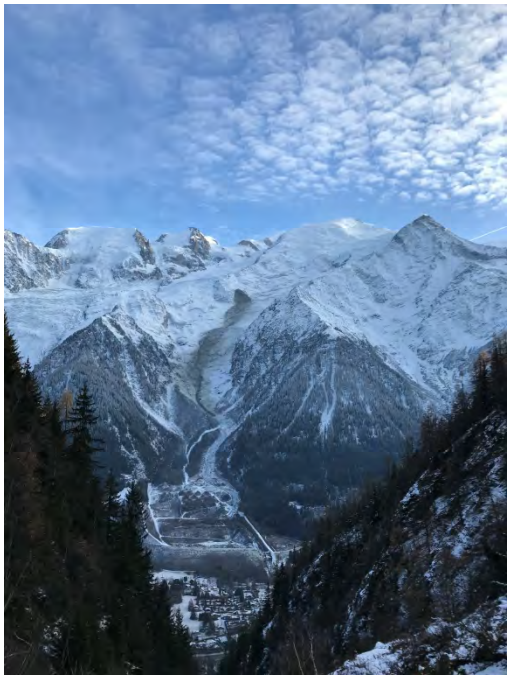


Figure 1: The rockfall of Taconnaz (Mont Blanc massif) of November 24, 2018 mobilized 50,000 m3 of rock. The depot was stopped 160 m from a construction site of a hydroelectric plant.

EDYTEM and PACTE laboratories

Apart from this conference, EDYTEM and PACTE groups mainly worked on long-term observations and various research projects. Regarding rock face permafrost in the Mont Blanc massif, they focused on surface and ground temperature measurements, extensometry analysis, rockfall survey and the role of ice cover on underlying permafrost in north faces. Existing boreholes (three 10-m-deep at the Aiguille du Midi, 3842 m a.s.l, and one 17-m-deep borehole at the Aiguille des Grands Montets, 3290 m a.s.l.) have been maintained. The rock fall inventory conducted since 2007 has been updated with more than 120 events observed in 2018 (total number since 2007 is now greater than 800) among which two exceed 40 000 m3. One of them produced a deposit that moved to the immediate vicinity of infrastructure in the Chamonix Valley (Figure 1).

An important work on the stability of the infrastructure supports is being finalized (P.-A. Duvillard's PhD, 2016-2019). It has not only made it possible to identify all the infrastructure elements present in context of permafrost in the French Alps but also to study the evolution of the damages, but also to calculate a risk index for each infrastructure and to develop geophysical methods to characterize the permafrost thermal state.should be a 1 cm indent to start following paragraphs within the same section.

Regarding rock glaciers, studies are conducted at various spatial and temporal scales. In the framework of the PermaRisk POIA project (ERDF funded), an exhaustive inventory of destabilizing rock glaciers in the whole French Alps was completed and the possible climatic and topographic controls analysed (M. Marcer's PhD, 2015-2018). Based on that, a spatial modelling of the degrading ice-rich permafrost has been proposed. Regionally (Vanoise massif, Ubaye valley), reconstructions of rock glaciers displacements, including destabilized landforms, have been done based on old airphoto (back to the 40's). A multi-temporal inventory of thermokarstic features has also been started and it is expected to make the GIS dataset available through a webportal. Remote sensing techniques for measuring rock glaciers dynamics are currently tested and validated (D. Cusicanqui's PhD, 2018-2021).

Locally, the long-term monitoring of the Laurichard rock glacier was complemented with a terrestrial stereo-photogrammetric timelapse device, including a processing chain that produces repeated 3D models and displacement fields. The Laurichard rock glacier is affected by slight deceleration for the last two years.

An IGS-SAO (section Alpes occidentales) field excursion in the semi-arid Andes of Chile and Argentina was conducted in January-February 2018, with 17 participants and 8 local researchers involved, from IANIGLA (Mendoza, Argentina) and CEAZA (La Serena, Chile) (Figure 2).

Figure 2: The Llano de la liebre rock glacier, in the Chilean Andes, and, in the foreground, Sebastian Vivero (Uni. Lausanne) close to grab its Phantom drone at landing (after a succesfull survey of the Olivares theta destabilized rock glacier).

GEOPS

A team from Geosciences Paris Sud conducted field study in Central Yakutia (Eastern Siberia) in September (Figure 3) with aims to study carbon (gas and dissolved) released from thermokarst lakes. The project funded by Université Paris Saclay involved also scientists from METIS and EcoLab and LSCE laboratory. The objective of this work was to constrain the dissolved inorganic and organic carbon as well as the origin of the gas (CH4 and CO2) in relation to the age of thermokarst lakes (from Holocene to modern age) in Central Yakutia, one of the highest ice-content of permafrost in the subarctic region. Other studies reveal that a large fraction of permafrost carbon is vulnerable to release in case of abrupt thaw. Preliminary results show that 1) dissolved organic carbon in recent and active lakes is much higher than numerous lakes across the Arctic; 2) 'alas' lakes are net CO2 sinks but strong CH4 sources.

Figure 3: Studied site in ice-rich permafrost area in Central Yakutia (eastern Siberia).

LSCE, Université Paris-Saclay

LSCE (Laboratoire des Sciences du Climat et de l'Environnement) from Université Paris-Saclay is active with GEOPS Laboratory (Univ. Paris-Saclay) and the Melnikov Permafrost Institute (Yakutsk) at the Syrdakh field site in Central Yakutia (Siberia). The field work in September 2018 at the Syrdakh site has complemented yearly field surveys. The site consisting of a river within an alas valley has been monitored thermally (air, river and soil) and hydraulically (river, ground water levels, soil water content) since October 2012 across a valley cross section. The purpose is to study the inter-annual evolution of the thermal imprint of the river. The main achievements of the 2017 field work are 1) geophysical surveys (Radar & ERT) on various river-valley cross-section to study the thermal imprint variability along the river course; 2) soil water content (SWC) monitoring network downloading for the first operating year complementing the hydrological characterization; 3) complement the near surface soil temperature measurements network providing insights into the thermal evolution of other landscape features than the river valley; 4) preliminary equipment of the Upper Lake in view of a lake hydrological and thermal budget. The 2012 – 2018 Syrdakh dataset is now being organized as a geo-spatially referenced database for easy access to the data. The next phase will deal with numerical simulation of the heat and water transfers along 2D cross sections of the river-valley system.

Figure 4: The Syrdakh field site in Central Yakutia (Siberia).

The InterFrost Benchmark project (wiki.lsce.ipsl.fr/interfrost) is now in its second phase focusing on the validation of codes through an experiment in the cold room at GEOPS inspired from the TH2 Academic Case. Preliminary results of this very challenging experiment were presented during the EUCOP 2018 meeting to the community involved raising strong interest and propelling improvements to the now third experimental set up. The implementation has been ongoing since then.

Geosciences Environment Toulouse

PermaFoam at GET (), is a high performance computing modeling tool for the numerical

simulation of thermo-hydrological dynamics of permafrost at the watershed scale, has been applied to the study of the coupled transfers of heat and water in the active layers of a forested, permafrost dominated catchment in Central Siberia (Orgogozo et al., 2019). In order to perform multi-annual simulations on this 40 km2 watershed, the efficient use of modern supercomputing capabilities (OpenFOAM®* finite volumes framework and EOS supercomputer of the CALMIP** regional supercomputing center) has been necessary. In order to tackle larger time and space scales, such as the temporal scale of on-going climate change or the regional scale, even larger supercomputing facilities will be required. Thus in the beginning of the year 2019, assessments of the parallel computation performances up to 4000 cores has been done successfully on the Occigen supercomputer of the CINES*** national supercomputing center (Figure 5).

* www.openfoam.com

** www.calmip.univ-toulouse.fr

*** www.cines.fr/calcul/materiels/occigen/

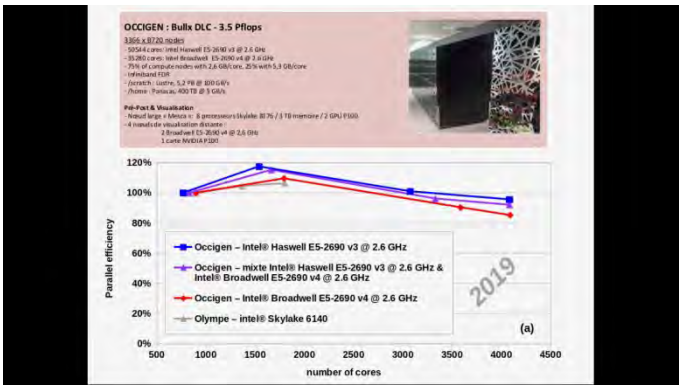


Figure 5: Strong scaling curves obtained with permaFoam (Orgogozo et al., 2019) on Occigen and Olympe supercomputers : good parallel efficiency up to 4000 cores

Reported prepared by:
Francois Costard
francois.costard@u-psud.fr

Germany

Action groups from Germany

Permafrost and Culture (PaC): Integrating environmental, geo-, and social sciences to assess permafrost dynamics and indigenous land use. Currently, the Action Group is in the third phase of activities. Central Yakutia was the regional focus of the first phase (2014-16); thereafter the group shifted the focus towards the tundra areas near the Polar Urals, notably near Vorkuta (2016-2018); and third is the permafrost observatory at Terelj northeast of Ulaanbaatar the capital of Mongolia. A workshop will be conducted in March 2019. The current situation is one of contraction of migration routes and animals (sheep, cattle, goats) in certain areas. Scientific research about permafrost conditions and pastoralism has thus far rarely come together; initial studies synthesizing these two aspects have been carried out in the Khangay mountains west-southwest of Ulaanbaatar, but need to be enhanced, corroborated and complemented by research in the Khentiy mountain range and the borderlands of Mongolia towards Russia, also taking in account appropriation of lands for agriculture (e.g. in the Selenge Region). Contact: mathias.ulrich@uni-leipzig.de; Otto.habeck@uni-hamburg.de .

Towards a Permafrost Thaw Subsidence Product within the GTN-P database (2018-2019): The kick-off meeting in June 2018 resulted in a fruitful exchange about processes causing land surface subsidence in permafrost regions and what methods can be employed for measuring them. Shortly afterwards in September 2018, a well-attended workshop dealing with Sentinel-1 radar interferometry for land surface elevation change has been organized during the 15Th Int. Circum Polar Remote Sensing Symposium in September 2018. As characteristics of lateral and vertical ground ice distribution provide the potential for thaw subsidence, it has been suggested to initiate a survey dealing with these aspects, in order to identify potential key sites out of the GTN-P network, where standardized long-term data series of subsidence monitoring will focus on first. Contact: frank.guenther@awi.de

A Frozen-Ground Cartoon: Explaining international permafrost research using comic strips". Under the lead of Frédéric Bouchard (University of Laval, Canada) the project successfully finished and produced a series of thematic cartoons as education and outreach material about permafrost research conducted in the field. The project aims at making permafrost science fun and accessible to children, their parents and teachers. The priority is to fill the gap between indigenous knowledge, complex scientific results and outreach to the general public. Frozen-Ground Cartoons can be downloaded for free in English, French, Swedish, and in German (https://frozengroundcartoon.com/). The action group has moved on and has developed into a funded Cross-Cutting Activity by the International Arctic Science Committee (IASC). More educational products will be developed, such as videos, a digital board game and 3D permafrost drawings as augmented reality elements attached to the cartoons. Contact: Michael.Fritz@awi.de

University of Cologne (UoC)

Members of the Organic Geochemistry and Radiocarbon Group continued their investigation of carbon cycling in permafrost environments of the Lena River Delta and Svalbard. The overall aim is to assess the degradability of soil organic carbon (SOC) in thawing permafrost soils at different latitudes combining methods such as lipid biomarker analyses and ^{14}C dating of dissolved and particulate organic carbon (DOC/POC), and of CO_2 in the soil pore space and CO_2 emitted from the active layer. The work in 2018 focused on seasonal changes of the ^{14}C concentration of respired CO_2. This data may give valuable information on how microbes metabolize different substrates dependent on temperature, precipitation and vegetation productivity. In the Lena River Delta, PhD students from UoC together with colleagues from the German Centre for Geosciences, Potsdam, and the University of Hamburg took up previous work on freshly thawed Ice Complex (Yedoma) deposits of Kurungnakh Island within the framework of the German-Russian research project “Carbon in Permafrost”. From mid-July to late August DOC at the permafrost table, pore space CO_2 and respired CO_2 were sampled several times. The results of the ongoing ^{14}C analysis of the DOC may explain relatively young carbon in the pore space CO_2 of the late Pleistocene Yedoma deposits. In addition, three field trips were undertaken to the Bayelva River catchment near Ny-Ålesund. A pilot study in July 2017 revealed that CO_2 emitted during peak summer is considerably younger than bulk SOC in the active layer, suggesting preferential degradation of recently fixed substrates. However, old carbon sources contributing to overall soil gas emissions may be masked by young autotrophic respiration during the growing season. We therefore sampled respired CO_2 and pore space CO_2 from June to early November with pore space sampling also going on over winter. First ^{14}C analyses indicate that also carbon pools with longer turnover times are prone to microbial degradation and may contribute to a permafrost carbon feedback upon increasing thaw and decomposition. Contact: janet.rethemeyer@uni-koeln.de

University of Bonn

In the framework of the DFG (German Research Foundation) funded project PermARG ("Rockglacier permafrost in the Central Andes of Argentina", 11/2015-10/2018) the research group of Lothar Schrott (University of Bonn, Germany) in cooperation with Dario Tromotto (IANIGLA, Mendoza, Argentina) conducted field campaigns at the Morenas Coloradas and Dos Lenguas rock glacier complexes in 2016, 2017, and 2018 (Figure X). The main objective of this project is to quantify water storage capacities of rock glacier permafrost in the semi-arid Andes of Argentina. Field work in the past years was carried out by Lothar Schrott, Christian Halla, Jan Blöthe (all University of Bonn), Joachim Götz (University of Graz), Estefania Bottegal and Carla Tapía (IANIGLA, Mendoza). In an effort to communicate the research objectives and findings to the wider public, a popular science article was recently published in the Geographische Rundschau (Halla et al. 2018). Contact: christian.halla@uni-bonn.de

Figure 1: Figure X: View to the northwest towards the headwalls above the Morenas Coloradas rock glacier complex, situated ~60 km southwest of the city of Mendoza. Note the group of people standing at the foot of a lobe front (Foto: Jan Blöthe, Date: 21.02.2018).

Technical University of Munich

The Landslide Research Group of Prof. Dr. M. Krautblatter investigated permafrost affected slopes in the European Alps (Germany, Austria, Switzerland) as well as in Norway, Canada, Ecuador and New Zealand.

PhD student Riccardo Scandroglio started working on deciphering critical hydrostatic pressure levels in permafrost rock for the HydroPF project at the Zugspitze (D) and Gemsstock (CH). He combines (i) snow and water infiltration modelling, (ii) the development of a sound benchmark method to derive hydrostatic pressure and (iii) mechanical modelling of the impact of sudden hydrostatic pressure variations on rock instability (http://www.igsse.gs.tum.de/index.php?id=191).

PhD student Philipp Mamot focused on rock-ice-mechanical processes in a shallow rockslide at the Zugspitze summit crest and developed a thermo-mechanical failure model for degrading permafrost rock slopes. He published a paper on a new failure criterion for ice-filled permafrost rock joints based on extensive laboratory work (https://doi.org/10.5194/tc-12-3333-2018).

PhD student Regina Pläsken continued her research on a mechanical model of the Kitzsteinhorn (A) considering the mechanical interaction of permafrost rock and alpine infrastructure.

Funded by the Elite Network of Bavaria, PhD student Tanja Schröder combined rock-ice-mechanical testing in our freezing laboratory with geophysical monitoring at the Zugspitze summit, providing a better rock-ice-mechanical process understanding concerning rock-slope failures in Alpine regions. She developed a thermal model of the Zugspitze summit crest showing permafrost distribution and evolution during the last decade.

The Cryowall project, funded by the Norwegian Research Council, was processed by the TUM (PhD candidate Benjamin Jacobs) in cooperation with the University of Oslo and further partners. Benjamin focused on the development of long-term dynamics and stability of extreme fjord topographies.

Theresa Raab studied secondary lahars at the Cotopaxi volcano in Ecuador. The possible effect of permafrost degradation was considered as one potential trigger of climatically-induced lahars. Her PhD research is part of the RIESGOS project (www.riesgos.de) funded by the German Federal Ministry of Education and Research.

The PhD student Saskia Eppinger started working on giant retrogressive thaw slumps on Herschel Island (Canada). This research is part of a long-term project of the AWI-Potsdam, supported by the German Federal Environmental Foundation (https://www.awi.de/forschung/geowissenschaften/permafrostforschung/stationen/herschel-island.html).

Dr. Daniel Dräbing visited Massey University, New Zealand, for two months as a guest lecturer and realized field work in the Mueller Glacier foreland and at the Mueller rockslide. In the course of the project Alpine Rock Slopes he performed field work in the Gaisberg Valley (A) and Turtmann Valley (CH) applying geophysical and sedimentological measurements on moraines. The outcome was condensed in two publications (https://doi.org/10.1002/ldr.2983) and (https://doi.org/10.1002/ldr.3140) .

MOSES

To address rapid permafrost thaw events, a module within the Modular Observation Solutions for Earth Systems (MOSES, http://www.ufz.de/moses/) project of the German Helmholtz Association was

developed. This novel, modular and mobile observing system comprises highly flexible and mobile observation modules which are specifically designed to investigate the interactions of short-term events and long-term trends across Earth compartments. As a first test campaign in 2018, scientists, technicians and students of the MOSES event group "Thawing Permafrost", worked together in the North Western Territories, Canada with Canadian Colleagues from the Canadian Geological Survey, Aurora Research Institute, University of Guelph and Wilfrid Laurier University (https://blogs.helmholtz.de/moses/).
Contact: Julia.boike@awi.de

Alfred Wegener Institute (AWI)

Celebrating 20 years of Russian-German Expeditions LENA

The joint Russian-German LENA Expeditions have been organized annually since 1998 with a geographic focus on the Lena River Delta, the New Siberian Islands and the coastal zone of the Laptev Sea. The island Samoylov in the central Lena Delta and its research station has frequently been used as a scientific and logistical base for field work during the Lena Expeditions and hosts several Long-term Environmental Observatories. Multiple third-party projects were attracted to participate and benefit from this institutional research collaboration, including projects funded under BMBF, DFG, HGF, ESA, ERC, EU as well as RSF and RFBR programs. As a result of the past 20 years of cooperation, more than 150 joint scientific articles were published, more than 250 datasets were created and archived and more than 85 students finished their thesis in various natural sciences disciplines within these projects. For the 20th anniversary of this unique and successful bilateral research cooperation, a scientific symposium was held at the Arctic and Antarctic Research Institute (AARI) in St. Petersburg from 17 to 19 October 2018. It provided an excellent forum to present major results of the past 20 years of joint research and to discuss goals for future collaborations. The anniversary was also celebrated with a festschrift summarizing the history of 20 years of Russian-German LENA Expeditions and providing colorful insights into individual expeditions and research findings. The 205 page festschrift was published in three languages (Russian, German, English) and was presented during the opening ceremony of the symposium.
(https://www.awi.de/en/science/geosciences/permafrost-research/conferences/international-symposium-20-years-of-lena-expeditions.html). The field work during the LENA Expeditions aims at investigating the evolution of the region's geology, climate, and biology during the Quaternary with a special focus on the interaction of the permafrost landscapes with recent climate warming and its consequences. Several long-term measurement sites for the monitoring of permafrost conditions, micrometeorology, trace gas exchange, and biology are installed on the island and have been providing important data for the expeditions and the research community as a whole, for example through their publication via data portals such as PANGAEA (https://www.pangaea.de) or their integration into international databases, such as the Global Terrestrial Network for Permafrost (GTN-P; http://gtnp.arcticportal.org). Contact: Hans-Wolfgang.Hubberten@awi.de

AWI expeditions in Siberia 2018

In 2018, 87 scientists, technicians and students participated in the LENA expedition, which took place from April 1st to September 18th in the Lena River Delta and the Laptev Sea coastal zone. Topics of investigations included micrometeorological long-term monitoring; development of river taliks and subsea permafrost; local investigation of vertical and horizontal fluxes of water, carbon, nitrogen and nutrients; regional quantification of energy and carbon fluxes; degradability of active layer, organic carbon and nitrogen in permafrost; microbiology and methane cycle; hydrology and hydrobiology of lakes and river channels; permafrost degradation by thermal erosion; surface subsidence; geomorphology of permafrost landscapes; ground truth for remote sensing of permafrost landscapes. In April 2018, a long-term monitoring of the hydrogeochemical properties of Lena River water was implemented. Part of the water samples are analyzed at the joint Russian-German Otto Schmidt Laboratory for Polar and Marine Research in St. Petersburg. Contact: Anne.Morgenstern@awi.de

Russian-German collaboration: Carbon turnover and greenhouse gas release from thawing permafrost in Northeastern Siberia under changing environmental and climatic conditions (2017-2020)

Field work in the Lena Delta was conducted in summer 2018, focusing on soil carbon stock studies in different landscape settings of the Lena Delta, vegetation and biomass characteristics, and remote sensing ground truth data collection for scaling both vegetation/biomass data and soil carbon stocks. Remote sensing studies focused on field spectral measurements in the Lena Delta and the comparison of spectral characteristics of tundra and boreal surfaces in Siberia using Landsat and Sentinel-2 multispectral same-day imagery to enhance spectral trend analysis. With the interdisciplinary AWI team, the Central Siberian Botanical Garden, the Forest Institute Krasnoyarsk and the INTERACT Team University of Poznan, Poland (research focus on shrub

dendrology and soil-vegetation interaction) the Lena Delta expedition generated a wealth of valuable field data. Contact: empfeiffer@uni-Hamburg.de, guido.grosse@awi.de

ERC project "Rapid Permafrost Thaw in a Warming Arctic and Impacts on the Soil Organic Carbon Pool" (PETA-CARB) finished

The ERC PETA-CARB project was completed end of 2018. Focusing on study regions in Alaska and Siberia, we conducted systematic studies of rapid permafrost thaw by thermokarst, investigated its spatial and temporal dynamics, and analyzed its interactions with the permafrost soil organic carbon (SOC) pool. We quantified deep SOC pools in the permafrost regions and within various landscape specific components, thereby significantly reducing uncertainties in first-order estimates of permafrost-carbon climate feedbacks. We identified previously unaccounted for large permafrost carbon pool components and assessed their vulnerability to rapid permafrost thaw and climate change. We created or contributed to several new synthesis datasets of high relevance to understand Panarctic permafrost carbon pools or dynamics. In particular, we strongly expanded the knowledge on carbon pool size, distribution, characteristics, and vulnerabilities in deep permafrost soils, Yedoma deposits, thermokarst lake deposits, and Arctic river deltas of Alaska and Siberia. Due to their size and vulnerability to thaw and mobilization these carbon pools are of global relevance in a warming Arctic. Excellent contributions were made to quantitatively and qualitatively better understand thaw and carbon dynamics of thermokarst lake systems in modern and paleo-environmental contexts from the lake scale to the panarctic scale. Our permafrost carbon vulnerability assessment includes the first-time implementation of thermokarst processes in a panarctic-scale model, also taking into account the contribution of deep carbon pools to future carbon fluxes from permafrost regions. PETA-CARB directly or indirectly trained six postdocs, six PhD students, eleven Master students, and one technician. The team led or contributed to 65 publications on permafrost carbon pool characteristics and dynamics, thermokarst lake dynamics and related carbon fluxes, remote sensing of permafrost landscape changes, and paleo-environmental assessments of permafrost degradation. Contact: Guido.Grosse@awi.de

ESA GlobPermafrost and ESA CCI+ Permafrost: Permafrost region disturbances were mapped across four major permafrost transects in Siberia and North America, covering a total of 2.5 Mill km^2, using Landsat-based trend analysis of multispectral indices for the period 1999-2014. Remote Sensing based lake change studies were conducted in four major lake districts in Siberia and Alaska. The ESA Permafrost Information System PerSys was implemented in the Arctic Permafrost Geospatial Centre, an open access data portal for permafrost geospatial datasets hosted at AWI. PerSys and APGC now host many of the ESA GlobPermafrot datasets. Contact: Birgit.Heim@awi.de, Heidrun.Matthes@awi.de, Guido.Grosse@awi.de

Changing Arctic Carbon cycle in the cOastal Ocean Near-shore (CACOON)

In April 2019 the CACOON team sampled the Lena Delta water below the ice in the Lena main channel near Stolp Island. The projects focus, Delta and nearshore region of the Kolyma and Lena rivers, is already reacting to rapid climate warming and the amount of freshwater delivered to the ocean from the Arctic mainland is increasing here. Together with the Kolyma which will be sampled in 2019, these rivers drain landscapes containing huge stocks of carbon, currently locked up in frozen soils and ice. CACOON studies what will happen to this ancient carbon as it travels from land-to-ocean. Contact: Jens. Strauss@awi.de

The Samoylov Deep Drilling Spring Campaign 2018 aimed to retrieve a deep, frozen sediment core from Samoylov Island with the goal to better understand the deep sedimentary underground and permafrost conditions, as well as to reconstruct fluvial and deltaic history of the central Lena Delta region. A 65-m-long sediment core was retrieved and transported to Germany for analysis. A temperature chain was installed in the borehole in summer 2018 as part of the Samoylov Long Term Permafrost Observatory.

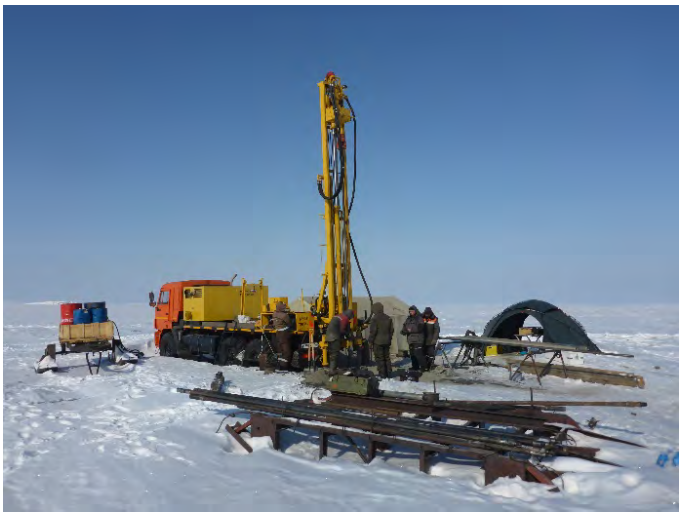


Figure 2 The Russian URB drill rig on Samoylov Island in April 2018. Photo by J. Strauss

NUNATARYUK

Since November 2017 AWI in Potsdam coordinates the **Horizon2020 EU-project "NUNATARYUK: Permafrost thaw and the changing Arctic coast;**

science for socioeconomic adaptation" (https://nunataryuk.org/). The project has a duration of 5 years (2017-2022) and a budget of 11.5 million EUR bringing together 26 partners from 11 countries. NUNATARYUK brings together world-leading specialists in natural science and socio-economics to: (1) develop quantitative understanding of the fluxes and fates of organic matter released from thawing coastal and subsea permafrost; (2) assess what risks are posed by thawing coastal permafrost to infrastructure, indigenous and local communities and people's health, and from pollution; and to (3) use this understanding to estimate the long-term impacts of permafrost thaw on global climate and the economy. Permafrost thaw is the core focus of Nunataryuk and will be used as the common thread for early consultations with community representatives and other stakeholders at the local and global level. Contact: Hugues.Lantuit@awi.de

Field work in NW Canada took place in July and August 2018 and was led by George Tanski from AWI in Potsdam under the guidance of Hugues Lantuit and Michael Fritz. Under the framework of the recently started EU project NUNATARYUK fieldwork focused on coastal permafrost erosion, organic carbon and nutrient release to the Arctic nearshore zone. The work on Herschel Island and Yukon mainland coast was performed in cooperation with many partners, including the Geological Survey of Canada, University of Amsterdam, University of Stockholm, University of Vienna, University of Lisbon, University of Venice and the University of Québec in Montreal. The AWI boat FS „Christine" was used as platform to conduct sampling of the seafloor sediments, shallow seismic and oceanographic monitoring. Contact: Hugues.Lantuit@awi.de, Michael Fritz@awi.de

PermaRisk Simulating erosion processes in permafrost landscapes under a warming climate – a risk assessment for ecosystems and infrastructure within the Arctic

The PermaRisk project aims to provide novel tools for the simulation of erosion and mass wasting processes in permafrost landscapes under a warming climate. Current land surface models used to simulate permafrost dynamics are not capable to represent soil erosion and mass wasting. Thus, current model assessments are most likely far too conservative in their estimates of permafrost thaw impacts. The following research questions have not yet been answered and are therefore at the focus of our project founded by the Federal Ministry of Education and Research (BMBF):

• How does climate warming affect the intensity of erosion and mass wasting processes?
• How does erosion and mass wasting affect infrastructure and ecosystem functions such as the energy, water, and nutrient cycles in the Arctic?
• What are the interactions between erosion-induced landscape changes and permafrost degradation?

In order to answer these crucial questions we will extend and improve the permafrost model CryoGrid3 developed by the Alfred Wegener Institute in cooperation with the University of Oslo. To ensure realistic model development, we will use field measurements as well as satellite data from three key research sites in Alaska, Canada, and Siberia for model validation. Contact: Moritz.Langer@awi.de

Japan

The Japanese Permafrost Association (JPA) membership in 2018 includes 2 student members, and 26 regular members. Kazuyuki Saito (JAMSTEC) became the new president, and Atsushi Ikeda (Univ. Tsukuba) the new Secretary.

ACOP2017 abstract publication

The local organizing committee of the Asian Conference on Permafrost 2017 (ACOP2017) held in Sapporo initiated to compile the abstracts presented at the conference to publish with a DOI, which is to be public in early 2019.

Overseas Research Activities

Svalbard

In Svalbard, N. Matsuoka (Univ. Tsukuba) and T. Watanabe (Kitami Institute of Technology) completed automated ice-wedge monitoring collaborated with H.H. Christiansen (UNIS, Norway). An open access paper published in PPP (issue 3 of 2018) highlights the major outcomes of this 12-yr monitoring. Multi-method monitoring of the dynamics of a polar rock glacier (since 2005) has further been extended.

Swiss-Japan collaboration 'UV2-project'

A Swiss-Japan collaboration 'UV2-project', which aims to compare geomorphic dynamics at seasonal to post-glacial timescales between U-shaped valleys in the Swiss Alps and V-shaped valleys in the Japanese Alps, has proceeded to the second year. Field campaigns in 2018 explored postglacial history of paraglacial and periglacial slope dynamics using terrestrial cosmogenic nuclides, as well as modern slope processes (permafrost creep, frost weathering, rockfalls, landslides and debris flows) by dendrochronology and instrumental monitoring. Participants for 2018 are N. Matsuoka, F. Imaizumi, Y. Matsushi, Y. Kariya, A. Ikeda, R. Nishii, H. Osawa and T. Kizuki (Japanese universities), and M. Stoffel and J. Ballesteros (University of Geneva).

Campaign with Argentine on Antarctica

Joint collaboration between Argentine Cryologia (Chief: J. Strelin) and Hokkaido Univ. (T.Sone) continued its observations on rock glacier dynamics and subsurface thermal regime in Marambio (Seymour Island), James Ross Island, and King George Island.

Mongolian Altay

M. Ishikawa (Hokkaido Univ.), A. Dashtseren and M. Walther (Institute of Geography and Geoecology, MAS, Mongolia) carried out borehole-based monitoring of permafrost temperatures and UAV-based topographic survey of rock glacier in Mongolian Altay. They are compiling rock glacier inventories for validating permafrost distribution of this region (Figure 1).

Figure 1: Talus-derived rock glacier at the northern slope of Tsengel Mts. (Photo taken by A. Dashtseren)

Churapcha, Sakha

Collaborative researches between Japan and Sakha, Russia have published scientific article on thermokarst subsidence processes detected based on the analyses by fine scale mapping using UAV with historical land use change analyses in Churapcha area (H. Saito, Y. Iijima, A. N. Fedorov, P.Y. Konstantinov, and N. Basharin).

Ice-rich permafrost impacts

As the final year of the 3-year project "Assessing and projecting greenhouse gas release from irreversible permafrost degradation", ground ice cores were sampled at Stuphallet area near Ny-Alesund, Svalbard and vicinity of Chukurdakh, Russia for analyses of gas content and methane concentration.

A simple two-box model to simulate the soil organic carbon and ground ice for the recent 125 thousand years was developed and evaluated. Terrestrial physico-BGC model was augmented to include GHG release from ice-rich permafrost degradation for assessment of additional impacts on future climate (K. Saito, H. Ohno, G. Iwahana, T. Yokohata).

Workshop for northeastern Asian collaborations

The second workshop on Permafrost Carbon-Climate Feedbacks: Abruptness and Irreversibility, organized by Prof. J. Ahn of Seoul University, Korea, was held on October 26 to discuss enhancement of international collaborative engagement of northeastern Asian research on permafrost degradation and greenhouse gas emission in eastern Siberia. Researchers from Korea, USA, and Japan joined (unfortunately,

Russian participation was canceled due to traffic situations), and gave inputs of their research to the key endeavor with the focus on permafrost. The next workshop in Korea is planned within one or two years. The first WS was in March of 2016 (J. Ahn, H. Park, Y. Iijima, K. Saito, G. Iwahana, Y. Kim).

Domestic Research Activities

Monitoring on Mt. Fuji

For the permafrost monitoring on Mt. Fuji, 2018 was a troubled year. Both abnormally warm storm in mid-winter and lightning in mid-summer damaged the main borehole. The irregularly long-lasting rainy season in the autumn prohibited the recovery work from being completed. Ground temperature under such meteorological conditions would be worth to be compared with the data in other years. There is still some hope of data salvage in 2019. (A. Ikeda, Univ. Tsukuba).

Outreach program by measuring frost depth in Japan

Since November 2011, the outreach project named 'Frost tube in Japan' has been conducted under the collaboration with the 'Permafrost Outreach Programs' project operated by K. Yoshikawa (WERC/INE/UAF). Frost tubes have been set at 35 schools until 2018 winter in Hokkaido area, northern Japan, and frost depths measured at schools by children and teachers. (K. Harada, Miyagi Univ, haradak@myu.ac.jp)

Soil column experiments for unfrozen water potential near freezing front to model improvement

To investigate heat, water and solute transport in freezing and thawing soils, series of soil column experiments were conducted. Using a micro-chilled-mirror hygrometer, unfrozen water potential near freezing front in the soils were measured and the lag to reach equilibrium potential after a soil temperature change was estimated. The column experiments were then calculated to improve a numerical soil freezing model. And the thermal exchange coefficient was formulated with the water content of surface soil water content before freezing. (K. Watanabe, Mie Univ.)

Moss process coupled to a land surface model

Mosses strongly affect water and heat fluxes due to their high water capacity and insulation. A land surface model, CHANGE was coupled with a moss process module and applied to a tundra site, Tiksi in northeastern Siberia. The modeled results were validated with in situ observations and indicated a high level of insulation by the moss, resulting in warmer winter and cooler summer soil temperature (Tsoil) and smaller active layer thickness (ALT). The sensitivities of Tsoil and ALT to moss coverage and thickness showed that an increase in moss thickness lowered the summer Tsoil by 0.9–2.1°C and reduced ALT by 9–20cm relative to a moss-free experiment (Figure 2). The moss-induced cooler Tsoil in the root zone limited the productivity of vegetation by reducing water availability to plant roots because of the presence of ice. This limitation increased as moss layer thickness and coverage increased. These results were published on JGR-Biogeosciences by H. Park et al. (2018, doi:10.1029/2018JG004491).

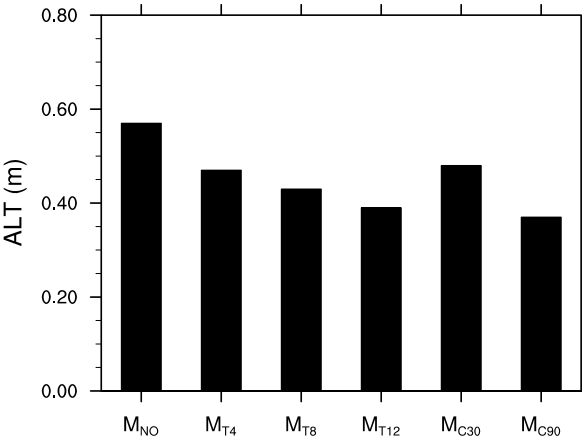


Figure 2: Comparisons of annual mean active layer thickness (ALT) among the model experiments for the 1980–2013 simulation period. M_{NO}: moss free, $M_{T4, 8, 12}$: 4, 8, 12 thickness of moss layer, and $M_{C30, 90}$: moss fractional surface coverage of 0.30 and 0.90.

Mt. Taisetsu

Boring survey was conducted to investigate the thermal state near the lower limit of permafrost under wind-beaten bare ground in the Mt. Taisetsu. Area of palsa shows a decreasing trend. (T. Sone, Hokkaido Univ.)

Observations has been continued at the plain areas of the summit, where the frost cracking polygons are developing. (T. Watanabe, KIT; T. Sone, Hokkaido Univ.)

Slope creeping in Goreibitsu

Mass movement due to intra-seasonal freeze/thaw on the slope at the Goreibetsu Pass, Fukushima, was documented and monitored. (T. Sone, J. Mori; M. Seto, Fukushima Univ.)

Fuketsu (Wind hole) Summit

The 5th Annual Fuketsu (Wind hole) Summit was held in Shimonita, Gumma, in August, including excursion to Arafune Fuketsu (Cold Storage), a UNESCO World Heritage. The maintaining mechanism, and history of wind hole usage were discussed. (T.Sone, J.Mori)

Report prepared by Kazuyuki Saito, JAMSTEC (ksaito@jamstec.go.jp).

New Zealand

SouthCOP 2019

New Zealand is excited to be hosting the first Southern Hemisphere Regional Conference on Permafrost in Queenstown, in the Southern Alps of New Zealand, from the 4-14 December this year.

A pre-conference fieldtrip will travel from Christchurch to Queenstown via Mt Cook National Park (Figure 1) and Central Otago, from Wed 4 to Fri 6th December. Participants on the pre-conference fieldtrip will meet in Christchurch on the afternoon of Tuesday 3 December. On Saturday 7th Dec we will have PYRN activities and interest group business meetings in Queenstown (Figure 1), along with an icebreaker event in the evening. The main conference in Queenstown will run from the morning of Sunday 8th of December to Wednesday 11 December with a fieldtrip in the local area on Tuesday 10th. The post-conference fieldtrip will depart Queenstown on Thursday 12 September and travel via Haast Pass, the West Coast, Franz Joseph Glacier and Arthurs Pass to return to Christchurch late on Saturday 14 December.

We would like to thank those who have offered to convene sessions at the conference – it looks like it will be an exciting and interesting programme. We also have a number of key note and plenary speakers in mind who we are confident will bring some interesting, enjoyable and challenging thinking to you all.

Figure 1: The Mount Cook National Park in the heart of the Southern Alps is one of the places we will visit on the preconference fieldtrip.

We know New Zealand is a long way to come so we hope you will be able to take some time to see a little of our country and we will be working hard to ensure you have an enjoyable and productive conference. Registration and abstract submissions are open now. Check out the website at https://southcop19.com/. Abstracts close on April 7th and Early-bird Registration closes on 20 October. These dates may seem a long time ahead of the conference but we want to give people certainty about their abstract acceptance so they have time to book well ahead to secure good deals on travel.

2018-19 Summer in Antarctica

Scott Base redevelopment

Antarctica New Zealand are commencing work towards a major redevelopment of Scott Base (you will hear more about that at SouthCOP) and preliminary work is being undertaken to gather baseline data for environmental impact reporting (Figure 2) as well as understanding potential issues with undertaking the construction on permafrost.

Figure 2: One of the dust monitoring samplers Tanya O'Neill is helping install as part of the base-line environmental monitoring for the Scott Base redevelopment. Photo: Tanya O'Neill.

Soil permafrost temperature monitoring

Chris Morcom (University of Waikato) and Pierre Roudier (Maanaki Whenua - Landcare Research) travelled to Antarctica to undertake the annual maintenance and data down-load for our 9 soil climate stations (Figure 3), four of which have been running since 1999. They also downloaded the two 30 m borehole temperature strings which we run in collaboration with Mauro Guglielmin from Italy. The data contribute to the CALM (circum-polar active layer monitoring) programme as well as to the GTN-P (Global Temperature Network-Permafrost).

While they were "on the ice" Chris and Pierre also collected samples from 34 locations dotted across the McMurdo Dry Valleys. These samples will fill major gaps in the existing soil sample collection of the region, in order to calibrate a digital soil model of functional soil properties of the region."

Figure 3: Chris Morcom and Pierre Roudier downloading the soil climate monitoring station at Marble Point. Photo: Jon Tyler.

Southern Alps

Previously unexplained observations of cyclic and seasonal ground surface motion (up to ~5 cm) were made through a continuous GPS (cGPS) network, the Southern Alps Geodetic Experiment New Zealand (SAGENZ). A recently completed Master of Science thesis by Nicolas Oestreicher (Victoria University of Wellington) investigated the cyclic motion in relation to possible environmental drivers of seasonal and transient deformations on shorter timescales in the region. Reversible ground deformation in the central Southern Alps appears strongly correlated with precipitation as rain and snow. Observed seasonal fluctuation, and transient motion after storm events, can be explained by simple mathematical models of groundwater fluctuations in fractured mountain bedrock. An asymmetric shape of cyclic seasonal motion and delayed responses observed following precipitation are explained by simple reservoir-runoff models. In the near complete absence of wells for monitoring bedrock groundwater in New Zealand, the cGPS data have potential to provide information on groundwater storage and fluctuations within fractured bedrock of the Southern Alps. Collaborators on the project were Simon Cox (GNS Science), John Townend (Victoria University of Wellington) and Paul Denys (Surveying School, Otago University). The work is now being written up for publication in a geophysical journal.

Report prepared by Megan Balks

Norway

Obituaries

Dr. Kaare Flaate (PhD) died on October 26, 2018 almost 90 years old. Kaare was one of the pioneers within the field of frozen ground and permafrost engineering in Norway. As a research director at the Norwegian Public Roads Administration he was one of the initiators of the research programme *Frost Actions in Soils* 1968-1976. Publication no.17 from 1976 is still a reference manual for frost protection of roads, embankments, pipelines and structures in Norway. Kaare was active in IPA and was the Norwegian representative to the IPA Council until 2008. When the 5th International Conference on Permafrost was organised in Trondheim, Norway in 1988. During the 1988 permafrost conference in Trondheim, Kaare was the chair of the organising committee. Through his professional life he worked for a continued engineering focus in IPA and was a great inspiration for younger engineering professionals interested in frost actions in soil, frost protection and permafrost engineering.

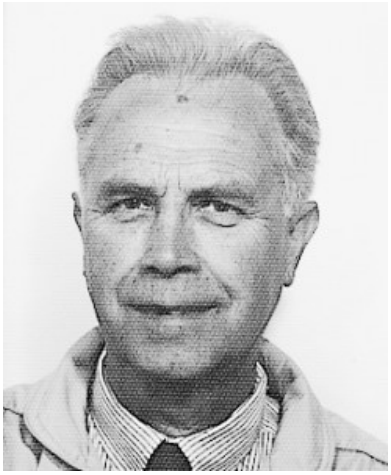


Photo: The Norwegian Technical Academy of Science (www.ntva.no)

Professor Johan Ludvig Sollid passed away March 29, 2019, almost 87 years old. He graduated (Cand. Real.) in physical geography at the University of Oslo in 1962, and subsequently worked in the Department of Physical Geography, where in 1984 he achieved full professorship. His scientific work within glacial and periglacial environments resulted in active membership of the IPA and several other international and national committees. Together with colleagues, Sollid published over 100 scientific papers in national and international journals. Sollid began his scientific career with mapping of glacial and periglacial landforms in Norway and recognised their relation to the dynamics and thermal regime of the last continental ice sheet and deglaciation. He was a pioneer of applications of geographical information systems (GIS) and digital remote sensing. He was also at the forefront in studies of permafrost and periglacial landforms and spent a lot of summers in Svalbard. Sollid was the leader of the Norwegian research group within the EU-funded PACE (Permafrost and Climate in Europe) project . The long-term temperature monitoring in deep boreholes on Svalbard and in the mountains in Scandinavia started through PACE, has made unique contributions to the documentation of past and present changes in permafrost and climate in the higher mountains of Scandinavia and on Svalbard.

PACE site, Janssonhaugen. Photo: Ketil Isaksen

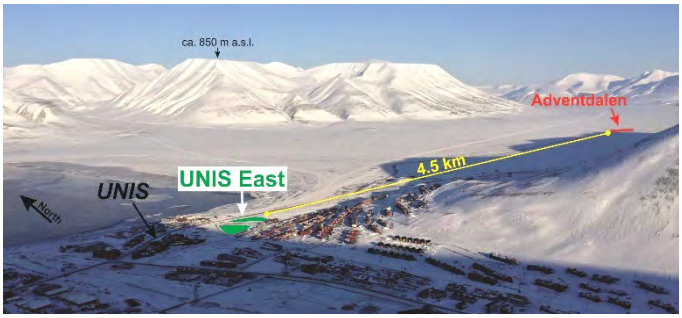
The University Centre in Svalbard (UNIS) – Longyearbyen

UNIS is responsible for the upgrading the permafrost observation infrastructure in the SIOS InfraNOR project over a 5 year period. Work started in 2018. As part of the SIOS activities Hanne H. Christiansen led the project 'Permafrost thermal state in Svalbard 2016-2017' PermaSval, funded by SIOS, in which a first regional permafrost thermal state analysis for existing permafrost observations in Svalbard for the period 2016-2017 was done. This is part of the first State of the Environmental Science in Svalbard, SESS report. Partners from Italy, Russia, Poland, Germany and Norway all with permafrost observation infrastructure in Svalbard participated in this project, which had a kick-off workshop at UNIS in March 2018. The project managed to integrate

and analyse permafrost temperatures and active layer thickness data from the Longyearbyen, Kapp Linne, Barentsburg, Ny Ålesund and Hornsund areas.

The INTPART project FROZEN CANOES 'Landscape & infrastructure dynamics of frozen environments undergoing climate change in Canada, Norway and Svalbard' funded by the Norwegian Research Council, led by Hanne H. Christiansen, kick-off at UNIS in October 2018. The aim is to develop a joint research-based educational field-based programme, combining geoscience and engineering to address perennially and seasonally frozen ground undergoing climate change, using innovative educational knowledge from both the Norwegian (UNIS & NTNU) and Canadian (Laval Uni., Carleton Uni. And Yukon College) partners. From UNIS both geotechnical and geological staff is involved. Three interdisciplinary and complementary master level field-based courses will be developed and run in the project.

The Norwegian GeoTest Sites (NGTS) project (see https://www.ngi.no/eng/Projects/NGTS-Norwegian-Geo-Test-Sites) has now completed a unique testing facility with five reference test sites in Norway and Svalbard available for at least 20 years. In Longyearbyen, two permafrost sites have been instrumented in close vicinity to UNIS. The sites are readily available for the entire geotechnical and permafrost engineering profession for the purpose of basic and applied research and education. Investigations have focused on drilling and sample retrieval, ground thermal monitoring, and determining index parameters and secondary geotechnical testing. The purpose of this contribution is to introduce the NGTS project and possibilities for future collaboration on Svalbard and to present preliminary findings from field and laboratory investigations. Adjunct professor Arne Instanes, UNIS, (arne.instanes@unis.no) is the coordinator for the permafrost sites in Longyearbyen.



NGTS Permafrost sites in Longyearbyen (UNIS East and Adventdalen) Photo: Graham Gilbert, UNIS

University of Oslo – Department of Geosciences – Oslo

At the Department of Geosciences, UiO, we work on three main topics: (a) monitoring and modelling mountain permafrost (Bernd Etzelmüller, S. Westermann, J. Czekirda), (b) remote sensing techniques in permafrost mapping (S. Westermann, A. Kääb) and (c) numerical modelling of landscape development in permafrost lowlands (S. Westermann).

Concerning (a) we maintained our borehole network in Norway and Iceland, which have been operative since 2004. Within the Research Council of Norway (RCN) funded CRYOWALL project (coord. Bernd Etzelmüller), cooperation between UiO, TU Munich, Norwegian Geological Survey and the Road administration, we have employed 25 rock wall loggers all over Norway. These data have been used to analyse thermal dynamics in rock walls, make prediction maps based on the data and for validation of transient numerical modelling (Florence Magnin). The permafrost probability map made with this data has interesting potential to analyse the link between rock instabilities and permafrost, as well as geomorphic processes such as the forming of rock glaciers and headwall thermal dynamics. In addition, electrical resistivity tomography soundings have been done during summer 2018 through the backscarp of the unstable site of Mannen (Romsdal area, 1295 m a.s.l), in cooperation with the "laboratoire EDYTEM", CNRS France.

In cooperation with NVE we attempt to apply the two-dimensional transient heat flow model CryoGrid 2D to the unstable rock slab "Veslemannen" (J. Czedirda), who has caused much problems with evacuation etc the recent years. The movement is certainly related to the thermal regime, which we now try to model, at least during the recent 50-year period.

In cooperation with the Meteorological Institute of Iceland we used CryoGRID2 to model the ground temperature evolution in Iceland in the period 1960-2016 at 1-km spatial resolution (J. Czekirda). We run three realizations of the model to account for wind-redistribution of snow. According to the model output, the three- to four- decade-long warming trend in Iceland has led to the recent permafrost warming or degradation. Projected climate warming will likely lead to further warming or degradation of permafrost in Iceland, thus the frequency of the permafrost-induced landslides might potentially increase in Iceland.

In northern Norway we (lead: Karianne Lilleøren) continued investigating some rock glaciers in northern most Finnmark which end at sea level

(Nordkynn peninsula, Hopsfjorden). Those rock glaciers turn out to be active, indicating permafrost down to sea level. We have done some long ERT profiles and new laser scans incl. drone overflights.

(b) In the framework of RCN-funded SatPerm projects (Lead: Westermann), we have presented different techniques to infer the ground thermal state using remote sensing data, from globally applicable schemes. These techniques were and are applied operationally in projects funded by the European Space Agency. Within the framework of the ESA GlobPermafrost project (www.globpermafrost.info) (lead: Kääb), J.Obu and S.Westermann performed global modelling of permafrost temperatures and extent were with CryoGrid 1 model. The near-final datasets were produced for all the potential permafrost areas for both Northern and Southern Hemisphere by the end of the year. A publication on the modelling for the Northern Hemisphere was submitted in the mid of October to Earth-Science Reviews. The data are can be visualized with the AWI WebGIS service. http://maps.awi.de/map/map.html?cu=globpermafrost_overview#home

This modelling effort was continued in the new ESA CCI+ Permafrost project, where transient permafrost modelling will be performed globally to infer changes of ground temperatures and permafrost extent in the last decade.

(c) As part of the RCN-funded PERMANOR project, researchers at the Department of Geosciences at UiO have developed methods for representing small-scale permafrost processes in numerical land surface models. This work has been guided by field measurements from peat plateaus in Northern Norway, and has led to both better understanding of the sensitivity of these vulnerable permafrost features to for instance small-scale differences in snow accumulation and soil water conditions, and a proof-of-concept method for how this might be accounted for in coarse resolution Earth System Models (L. Martin, K. Aas, H. Kristiansen). During fieldwork in early September, Sebastian Westermann and Kjetil Aas also visited local high-schools in Finnmark to talk about the relevance of permafrost for the global climate system and show practically how permafrost research is conducted in their county.

Frans-Jan Parmentier kicked off his Young Research Talent project WINTERPROOF, funded by the Norwegian Research Council. PhD student Marius Lambert started last November to work on this project, and he will work closely together with the PhD student from a sister project at Lund University in Sweden. Marius will improve the representation of wintertime processes in CLM, in particular the release of greenhouse gases from permafrost soils during the cold season and winter damage to vegetation.

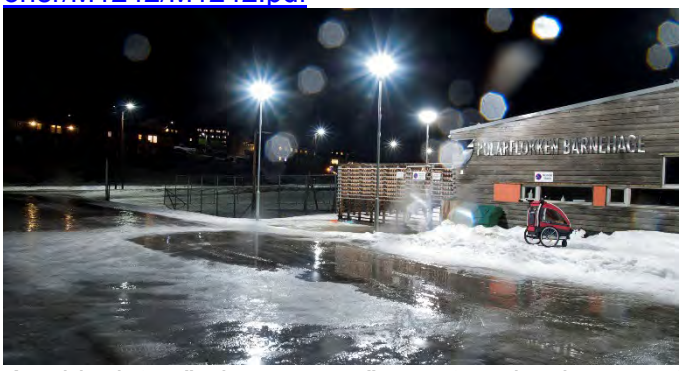
Finally, we have educational exchange funded by the Norwegian centre for internationalization of education (SIU) with three Japanese institutions (Sapporo, Kitami and Tsukuba). In 2018 we organised a joint work shop in Longyearbyen, Svalbard, and offered a common course in cryospheric modelling at the Arctic Centre, Hokkaido University, Sapporo.

Norwegian Centre for Climate Services (NCCS)

The NCCS has recently issued the report «Climate in Svalbard 2100». The report, commissioned by the Norwegian Environmental Agency, concludes that under medium to high climate change scenarios, the annual mean air temperature on Svalbard is projected to increase by 7ºC to 10ºC by the end of this century. This will, among others, cause near-surface permafrost to thaw in coastal and low-land areas. Increases in the active layer thickness and permafrost temperature will speed up slope processes controlled by permafrost, with a marked increase in slope instability. Present and future permafrost warming and degradation will affect coastal erosion processes, especially where the coastline consists only of sediments.

The NCCS is a collaboration between the Norwegian Meteorological Institute, the Norwegian Water Resources and Energy Directorate, NORCE Norwegian Research Centre and the Bjerknes Center. The following institutions have also contributed to the report: The University of Bergen, the Institute of Marine Research, the University Centre in Svalbard, the Norwegian Geotechnical Institute, the Nansen Center, the Norwegian Mapping Authority, the Norwegian Polar Institute and the University of Oslo.

The «Climate in Svalbard 2100» report can be downloaded here:
http://www.miljodirektoratet.no/Documents/publikasjoner/M1242/M1242.pdf

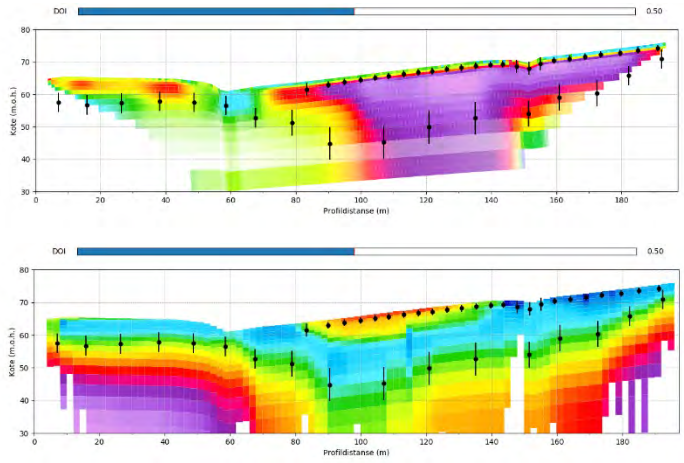


A mid-winter "rain on snow" event and subsequent icing in the centre of Longyearbyen. Photo: Ketil Isaksen/MET.

Norwegian Geotechnical Institute – Oslo

NGI carried out two geophysical measurement campaigns (Electrical Resistivity Tomography and Induced Polarization) in Longyearbyen and Barentsburg, both in the context of a risk assessment related to the new establishment of waste landfills. The work in Barentsburg was commissioned by the Norwegian Environmental Agency, whereas the work in Longyearbyen is funded through the Svalbard Environmental Protection Fund.

One of the aims of the study is to investigate whether or not permafrost can act as bottom and side seals for waste landfills in the context of future climate change.



ERT (upper panel) and IP (lower panel) profile near waste dump. The lower rows of markers in the two panels show the depth to bedrock while the upper rows of markers show active layer depths.

Norut, Northern Research Institute - Tromsø

Norut research applied to permafrost and periglacial environments focuses on remote sensing measurements and interpretation of displacements related to ground freeze and thaw. In 2018, studies were performed on Ádjet rock glacier and Nordnesfjellet in northern Norway, and Adventdalen in Svalbard. This work has been done in collaboration with The University Centre in Svalbard (UNIS), The Arctic University of Norway (UiT) and the Norwegian Water Resources and Energy Directorate (NVE).

In Skibotndalen, Eriksen et al. documented the kinematics of Ádjet rock glacier based on 62 years of remote sensing observations, combining aerial, Synthetic Aperture Radar (SAR) and ground-based radar images. Recent acceleration of the landform has been evidenced. Analysis of the spatial-temporal trends suggests a progressive detachment of the faster front and the climatic analysis showing an increase of temperature and precipitation suggests that the rock glacier is affected by permafrost warming and increase of available water (Eriksen et al., 2018, doi.org/10.1029/2018GL077605).

At Nordnesfjellet, Eckerstorfer et al. applied SAR Interferometry (InSAR) for mapping the spatial variability of ground displacements. By combining two SAR geometries, 2D information can be retrieved and compared with detailed geomorphological mapping. The study shows that 2D InSAR correctly depicts displacement rates generally associated with periglacial landforms over flat or inclined areas within or below the regional permafrost limit (Eckerstorfer et al., 2018, doi.org/10.1002/esp.4380).

As part of the PhD project FrostInSAR (NFR Romforskning, 2017–2021), Rouyet et al. applied multi-sensor and multi-geometry InSAR to detect seasonal frost-related displacements in the permafrost landscape of Adventdalen, Svalbard (Rouyet et al., 2018, hal.archives-ouvertes.fr/hal-01816115). Comparison with geomorphology highlights specific displacement patterns for different typical materials and landforms. Comparison between InSAR and ground temperature time series shows a correspondence between displacement patterns (thaw subsidence and frost heave) and temperature variations. In addition, in a project funded by Svalbards Miljøvernfond, InSAR has been applied to map unstable areas around and in Longyearbyen, in areas with potentially impacted infrastructure and population (Rouyet et al., 2017, www.sysselmannen.no/globalassets/svalbards-miljovernfond-dokument/prosjekter/rapporter/2018/17-59-terrengstabilitet-lyr.pdf).

Poland

Adam Mickiewicz University in Poznań

In January and February of 2018, scientists from Adam Mickiewicz University accompanied colleagues from Wrocław University in participating in investigations of the evolution of rocky coasts in permafrost conditions on King George Island, Antarctica. From July to September they continued the long-term program of permafrost research on the eastern coast of Petuniabukta, central Spitsbergen, Svalbard, based on the year-round registration of ground temperatures in the profile of raised marine terrace sediments down to a depth of 1.5 m in two locations comprising wet (floodplain) conditions (2 m a.s.l.) and dry terrace surface (5 m a.s.l.). In both cases, permafrost active layer thickness was also measured at the end of the summer season, reaching from 1.5 to 2.3 m. The spatial distribution of active layer thickness and temperature, rockwall weathering, slope and aeolian processes were all observed in the surrounding Ebba valley. In August, dendrochronological and dendrogeomorphological studies of arctic shrubs (*betula, salix, larix, alder* and *rhododendron*) and conditions of their growth in permafrost-affected areas (max ALT = 0.5 m) were performed in the Lena River Delta (Siberia), in collaboration with scientists from the Alfred Wegener Institute and Russian Academy of Sciences.

Institute of Geophysics, Polish Academy of Sciences

The presented seismic studies show seasonal changes which affect the cryospheric components of the Hornsund area of Spitsbergen. The two datasets, from autumn 2017 and spring 2018, were gathered during two expeditions, to directly compare the state of permafrost in different seasons (Fig. 1). To obtain the results, 3 km of seismic lines were shot near the Polish Polar Station in Hornsund. The seismic profiles were designed to record both refracted and reflected waves, without sacrificing the surface waves record.

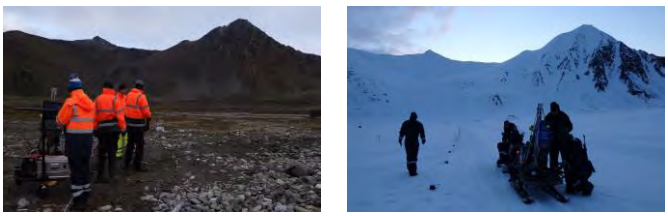


Figure 1. *Seismic data acquisition during 2017 (left) and 2018 (right). Different seasonal conditions strongly affect measurement results*

Complex seismic analysis, which maximally utilized the gathered data by using multiple interpretation methods, allowed to seasonal changes to be imaged in the post-glacial geological structures and permafrost (Fig. 2). During 2018, the authors processed the data to estimate the main physical properties of the research area, which was necessary for the further imaging of the structures with seismic reflection. The first results show the high impact that seasonal changes have on the datasets. Data from 2018 have muted surface waves because of the snow cover. However, frozen active was less attenuated, which increased the penetration range and overall quality of the signal. In 2019, data imaging and interpretation work will be continued to equalise the data quality between the two datasets, and to directly compare the results.

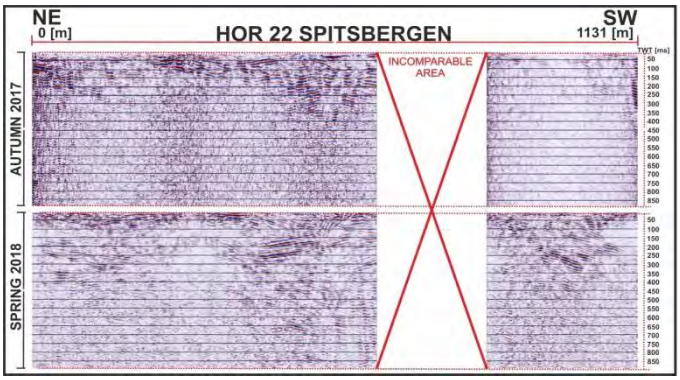


Figure 2. *Early seismic stack comparison of the datasets from HOR22 profiles, gathered during 2 seasons. On the upper image, the data from autumn 2017, where no snow coverage was present. The image below presents the data from spring 2018, where the surface is covered by snow.*

Gdańsk University of Technology

In 2018, scientists from Gdańsk University of Technology studied the influence of permafrost degradation on water chemistry. Other than water chemistry, they also analyzed the interaction between bacterial abundance and the concentration levels of selected pollutants. The investigations provided a better picture of the relationship between cryosphere and biosphere.
In 2018, water was taken from the shore of Bellsund Fjord (Svalbard, Arctic), the Revelva river (Hornsund Fiord) and the western shore of Admiralty Bay (Maritime Antarctica) and analyzed. This work was carried out in cooperation with Kazimierz Wielki University in Bydgoszcz, the Institute of Biochemistry and Biophysics of the Polish Academy of Science (Warsaw), Maria Skłodowska-Curie University in Lublin, and the Institute of Geophysics of the Polish Academy of

Sciences (Warsaw). The results of the work are presented in four papers (see the list of publications).

Nicolaus Copernicus University in Toruń

In 2018, monitoring of the thickness of the permafrost active layer continued at a few fixed measurement points on the Kaffiøyra Plain around the Nicolaus Copernicus University (NCU) Polar Station. These research points are part of the CALM program network and represent among the few points located in the High Arctic region. The points subject to measurement represent typical Kaffiøyra sites: a sandy beach (*B, Beach*), a tundra plain (*T, Tundra*) and a moraine rampart (*M, Moraine*). Measurements of the size of ground thawing and the thickness of the permafrost active layer have been performed every 7–10 days since 1996.
The measurements of the temperature of the active layer (ground) were made. For this purpose, automatic temperature loggers were installed at the measurement points at various depths (up to 150 cm). The temperature was recorded continuously throughout the year at the measurement points on the moraine (*M*) (since 2006), on the beach *(B)* (since 2012) and on the tundra (*T*) (since 2006).
In 2018, factors controlling permafrost table degradation in the area of the Waldemar River outwash fan (NW Spitsbergen, Svalbard) were recognized. These include thermal and mechanical river bank erosion and permafrost table degradation as a result of channel lateral migration. Factors and thresholds controlling these processes were investigated in 2018. Due to this, bankfull channel width and depth were measured in the field, in addition to which, the grain-size distribution of surface sediments was determined in 38 selected field sites. Moreover, the rate of lateral erosion of streams was measured at two sites in middle and distal zones of the Waldemar River outwash fan. Additionally, thermoabrasive niches were investigated (developed due to the progradation of the thawing zone within the frozen river bank). The morphometry of these niches (length, height and depth) were measured in the middle zone of the Waldemar River outwash fan.

University of Wrocław

In 2018, the project *'Spatial and temporal controls on the active layer of dynamics in an Arctic mountain valley'* under the leadership of Marek Kasprzak (University of Wroclaw, Poland) was continued on Wedel Jarlsberg Land (SW Spitsbergen). The project is financed by the National Science Center (Poland) and registered in the Research in Svalbard database under the number (RiS –ID) 10615.

The aim of the project is to study thermal conditions of near-surface ground using thermistors installed in different topographic positions in a hydrologically monitored Arctic catchment (Fig. 3). Fieldworks were carried out in June and September 2018 and included readings of previously installed thermistors and the collecting of meteorological and hydrological data to determine conditions of ground ice ablation. The data obtained in 2017 were interpreted using spatial analysis to find the correlations between ground temperature and selected land surface and energy parameters that can be determined on the basis of DTM or LANDSAT scenes and to build regression models of ground temperature spatial distribution. The progress of the research has been presented in abstracts at two international conferences:

- The 5th European Conference On Permafrost (Chamonix, France, 23 June – 1 July, 2018): Kasprzak M., Tábořík P., Waroszewski J., Głowacki Tadeusz, Marszałek H., Marciniec K., Łopuch M., Spatial and temporal controls on active layer dynamics in an Arctic mountain valley: project assumptions and preliminary results. In: P. Deline, Xavier Bodin and Ludovic Ravanel (eds), Book of Abstracts, 575-576.

- Geomorhometry 2018 (Boulder Colorado, USA, August 13–17, 2018): Kasprzak M, Szymanowski M., 2018, Terrain determinants of permafrost active layer thermal conditions: a case study from Arctic deglaciated catchment (Bratteggdalen, SW Spitsbergen), PeerJ Preprints 6:e27119v2 https://doi.org/10.7287/peerj.preprints.27119v2

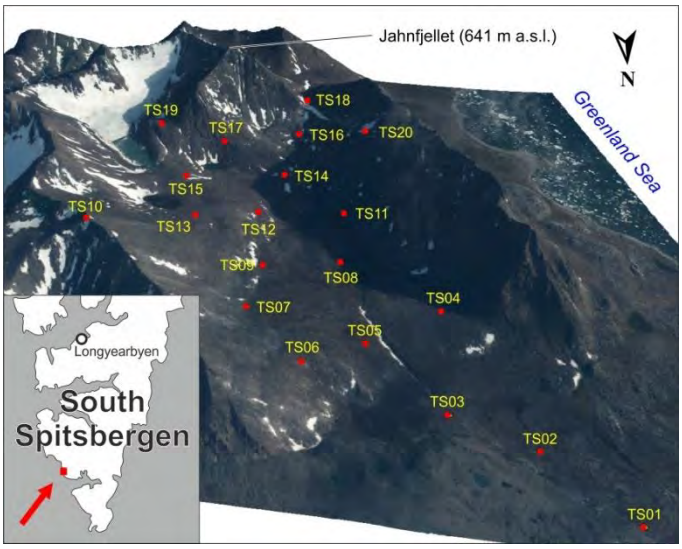


Figure 3. *Perspective view on Brattegg valley and thermistor (TS) positions. SfM-derived digital terrain model obtained from stereographic aerial*

photographs purchased from Norwegian Polar Institute.

List of publications:

- Danuta Szumińska, Małgorzata Szopińska, Sara Lehmann-Konera, Łukasz Franczak, Waldemar Kociuba, Stanisław Chmiel, Paweł Kalinowski, Żaneta Polkowska. Water chemistry of tundra lakes in the periglacial zone of the Bellsund Fiord (Svalbard) in the summer of 2013; Science of the Total Environment 624 (2018) 1669–1679
- Klaudia Kosek , Katarzyna Kozak, Krystyna Kozioł, Katarzyna Jankowska, Stanisław Chmiel, Żaneta Polkowska, The interaction between bacterial abundance and selected pollutants concentration levels in an arctic catchment (southwest Spitsbergen, Svalbard); Science of the Total Environment 622–623 (2018) 913–923
- Małgorzata Szopińska, Danuta Szumińska, Robert Józef Bialik, Stanisław Chmiel, Joanna Plenzler, Żaneta Polkowska, Impact of a newly-formed periglacial environment and other factors on fresh water chemistry at the western shore of Admiralty Bay in the summer of 2016, Science of Total Environment, 613-614 (2018) 619-634.
- Sara Lehmann-Konera, Łukasz Franczak, Waldemar Kociuba, Danuta Szumińska,Stanisław Chmiel, Żaneta Polkowska, Comparison of hydrochemistry and organic compound transport in two non-glaciated high Arctic catchments with a permafrost regime (Bellsund Fjord, Spitsbergen), Science of the Total Environment 613–614 (2018) 1037–1047.

Report prepared by Rajmund Przybylak (rp11@umk.pl) based on reports submitted by Marek Kasprzak, Mariusz Majdański, Żaneta Polkowska, Grzegorz Rachlewicz and Ireneusz Sobota.

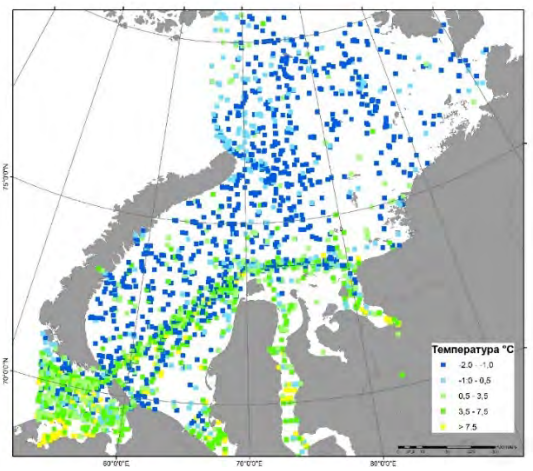
Russia

Earth Cryosphere Institute, Tyumen Scientific Centre, Siberian Branch, Russian Academy of Science (**ECI Tyumen Scientific Centre SB RAS**) **http://www.ikz.ru/**

1. For the first time, CO_2 hydrates with water conversion into hydrate more than 90% were formed in a quiescent reactor without any mixing. An additive of sodium dodecyl sulfate (SDS, anionic surfactant) in an amount of 0.1 mas% was used. The capillary-driven hydrate growth well-known for hydrocarbons gaseous was observed for the first time for CO_2 hydrate growth in the presence of SDS. Conditions of capillary-driven CO_2 hydrate growth were determined. The obtained data are important for further insights into mechanism of gas hydrate growth and may be used for increasing the efficiency of hydrate-based technologies for capture and sequestration of carbon dioxide as carbon dioxide hydrate.

References: *Molokitina N.S., Nesterov A.N., Podenko L.S., Reshetnikov A.M. Carbon dioxide hydrate formation with SDS: Further insight into mechanism of gas hydrate growth in the presence of surfactant // Fuel. -2019. -V.235. -P.1400-1411.*

2. A working version of the temperature distribution GIS map of the southeast part of Barents Sea seabed and also the Kara Sea was compiled under supervision of Prof. Dr. A.A. Vasiliev. This database and map will be used in the future for the analysis of current trends in the subaqual cryolithozone evolution of the western sector of Russian Arctic.

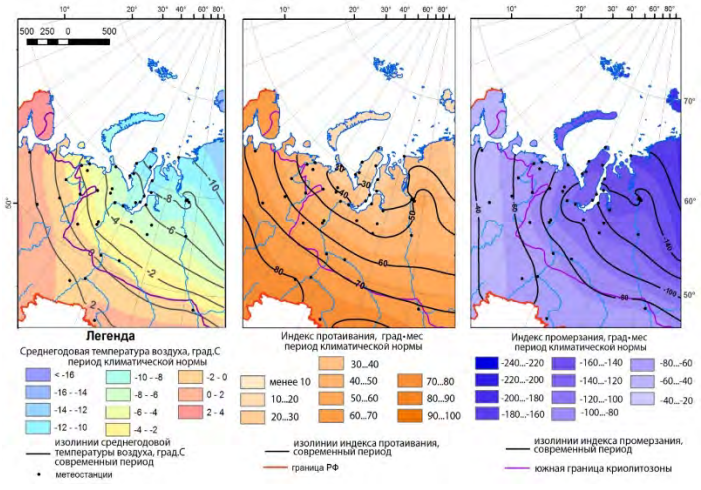


Map of the spatial temperature distribution of the southeast part of the Barents and Kara seas seabed

3. According to the study of frozen deposits in the territory south of the Taz Peninsula, geochemical processes are considered under the hydrocarbon migration from the lower productive complex. An analysis of the cryolithological structure of the frozen stratum was performed, and the composition of the gas and authigenic associations was studied. It was shown that the migration of gases is caused by shear deformations with the formation of cryogenic textures with the presence of gas-bearing ice crystallites on slip surfaces. It was found that the migration of hydrocarbons causes significant local changes in pH/Eh parameters in the frozen stratum and determines the micromosaic distribution of sulfate and iron reduction processes that lead to the formation (including microbiological processes) of various forms of iron: sulphides, carbonates and oxides.

References: *Kurchatova A. N., Rogov V.V., Slagoda E.A., Taratunina N.. Geochemical Anomalies of Frozen Ground due to HydrocarbonMigration inWest Siberian Cryolithozone //Geosciences 2018, 8, 430; doi:10.3390/geosciences8120430,// www.mdpi.com/journal/geosciences*

4. A group of scientists (Drozdov D.S., Malkova G.V.) developed maps of changes in average annual air temperature, thawing index and freezing index in the cryolithozone of the European North of Russia and Western Siberia. On the maps, the displacement of the isolines of the average annual air temperature occurs in the direction from South-West to North-East and reaches 100 ... 200 km (Fig.). Thawing index isolines moves North of about 100-150 km. Isolines of freezing index move due to climate warming in cold periods East, and East-North-East for a distance of 200 km (Fig.).

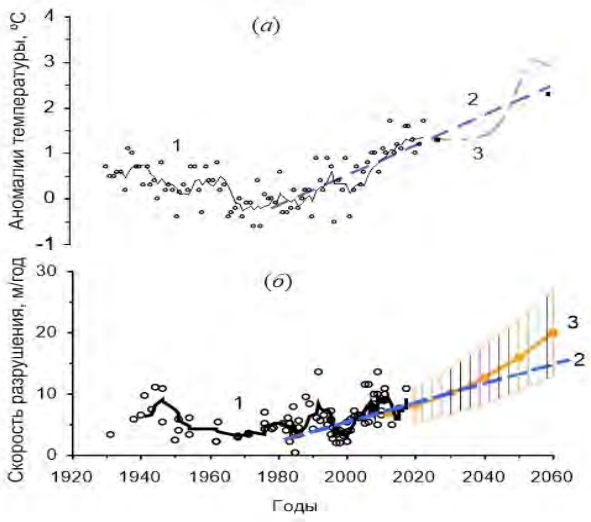


Changes in climatic parameters of permafrost zone of the European North of Russia and of the Western Siberia in the period of the climate standard (1960-1990) – colored fill; and in the 21st century (isolines)

Melnikov Permafrost Institute, Siberian Branch, Russian Academy of Science (MPI SB RAS, Yakutsk) http://mpi.ysn.ru/en/

Selected Research Results

1. A mathematical model was developed to predict the dynamics of coastal permafrost along the Laptev and East-Siberian Seas during the first half of the 21st century. The model results predict that erosion rates along the coasts with ice contents of 30-70% will vary from 4-12 m/yr in 2015-2020 to 8-26 m/yr in 2050 (S.O. Razumov, MPI Laboratory of General Geocryology).



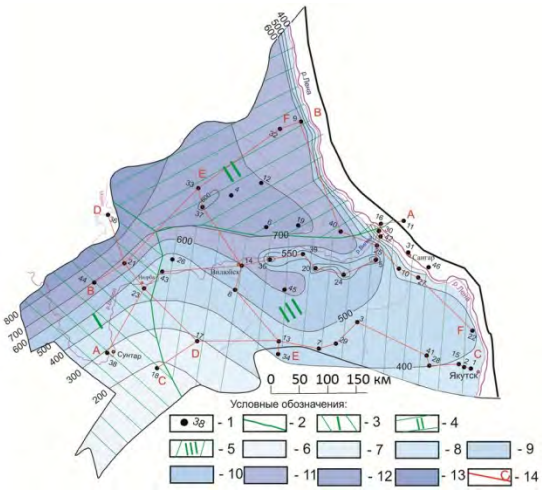
Changes in thaw-season (June-September) mean air temperature anomalies and ice-rich coastal erosion rates in the Laptev and East Siberian Seas. Cliff height 10-20 m, total ice content of coastal sediments 30-70%. (a) Temperature anomalies: (1) measured, (2) predicted for an inertial (linear trend) climate change scenario; (3) predicted for an extreme scenario. (b) Coastal erosion rates: (1) measured, (2) linear trend, (3) predicted average rates and spatial variations of thermal and mechanical erosion. The solid black line represent 5 point linear filtering.

Related Publications:

Razumov S.O. (2018). Peculiarities of reaction of coast in the east arctic seas of Russia on climatic changes. *Science and World* 9(61): 70-72.

Razumov S.O. Response of permafrost coasts in the Russia's eastern Arctic seas to extreme climatic changes in the first half of the 21st century. *In*: Georisk 2018: Analysis, Prediction and Management of Natural Risks Considering Global Climate Change, Proceedings of Int. Conf., 23-24 October 2018, Moscow.

2. Geothermal investigations were carried out to determine the distribution and thickness of disequilibrium permafrost in the Vilyui Basin. A map was compiled showing depths to the permafrost base in the region and thermal cross-sections were constructed for individual tectonic units, as well as for hydrocarbon and mineral deposits. The study results indicate that permafrost thicknesses vary over a wide range, from 45 to 820 m, generally decreasing from west to east. This is due to geothermal heat flow increasing in the same direction, as well as to paleoenvironmental conditions. Significant variations in the depth of the permafrost base, up to 200 m, occur even within small geostructural units or hydrocarbon and mineral deposits (V.P. Semenov, MPI Laboratory of Permafrost Geothermics).



Map showing depths of the permafrost base in the Vilyui Basin. (1) Exploration borehole area and its number; (2) permafrost boundaries; (3) permafrost region I; (4) permafrost region II; (5) permafrost region III; 6 to 13 – permafrost thicknesses: (6) <200 m; (7) 200 to 300 m; (8) 300 to 400 m; (9) 400 to 500 m; (10) 500 to 600 m; (11) 600 to 700 m; (12) 700 to 800 m; (13) > 800 m; (14) Thermal cross-sections.

Semenov V.P., Zheleznyak M.N., Kirillin A.R., Zhizhin V.I. (2018). Thermal conductivity of sedimentary rocks in the Leno-Viluy oil-and-gas bearing province. *Kriosfera Zemli,* 5(XXII): 30-38.

Semenov V.P. (2018). Subsurface Temperature Distribution and Permafrost in the Vilyui Basin. PhD Thesis Abstract. Yakutsk: MPI SB RAS, 22 pp.

3. The ground temperature control system designed at the Vilyui Station in Chernyshevsky led by S.A. Velikin was implemented in *International*, the first underground diamond mine in permafrost. The system incorporates 1650 temperature sensors installed in 56 drill holes and 84 blast holes to provide a field digital model of multi-directed thermal pressures (climatic and anthropogenic) and associated seepage processes on frozen foundations. In March 2018, a Pattern Approval Certificate RU.C.32.004.A no. 69246 was granted by the Russian Federal Agency for Technical Regulation and Metrology for the CKTK-02 permafrost temperature control measuring system.

International mine ***Control cabinet***

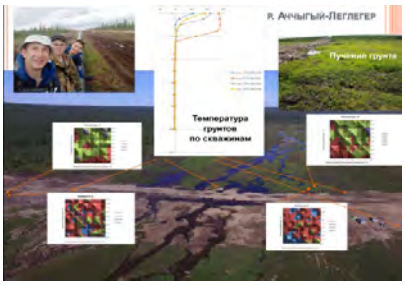
Temperature borehole ***Pattern Approval Certificate***

Velikin S.A. (2018). Application of 3D interpretation technologies to solving foundation monitoring problems at hydroprojects in permafrost. *In*: 5th European Conference on Permafrost regions, Book of Abstracts, pp. 914-915.

Expeditions

During 2018, MPI continued field studies in East Siberia, northern Tien Shan, Altai, and Verkhoyansk Mountains. The most important, large-scale field studies were conducted along the Power of Siberia Pipeline corridor in southern Yakutia as part of a 2018-2020 research project to study changes to permafrost conditions and assess the potential effects of related hazards on linear infrastructure under changing climatic conditions (Project PI: V.V. Samsonova). In July-August 2018, a reconnaissance survey was undertaken from the Chayanda field to Skovorodino to identify permafrost-related problems areas along the pipeline corridor.

Five field teams worked in the Chayanda, Skovorodino, Nimnyr, Aldan and Tynda areas focusing on permafrost terrain features, icings, and rock streams. In total, 410 sites were examined, of which 30 were identified as the greatest problem areas requiring further drilling and geophysical investigations in 2019-2020. In addition to icings and rockstreams, potential hazards along the pipeline were found to be subsurface erosion, thermokarst and gullying. 1:5,000-scale permafrost terrain maps and permafrost indicator tables were compiled. Hazard assessment of thermokarst, subsurface erosion, thermal suffosion, icing development and associated processes was made for the construction and operation stages of the Power of Siberia Pipeline.



Meetings

On 4-29 June 2018, MPI organized the Fifth Forum for Young Permafrost Scientists. The Forum commemorating the 90th anniversary of the birth of Professor, Dr. Maria K. Gavrilova included two events: a conference held from 4-8 June 2018 under the title "*Permafrost Response to Climate Change"* and a field trip from 9-20 June 2018.

The conference was attended by 56 undergraduates, graduate students, and early-career scientists from the Melnikov Permafrost Institute, North-Eastern Federal University (Yakutsk), Moscow State University, 3 HYDEC Hydrological and Geoenvironmental Co. (Moscow), Earth Cryosphere Institute (Tyumen), Tomsk Oil and Gas Research and Design Institute, Institute of the Earth's Crust (Irkutsk), St. Petersburg State University, Trofimuk Institute of Petroleum Geology and Geophysics (Novosibirsk), Novosibirsk State University, North-East Interdisciplinary Scientific Research Institute (Anadyr), as well as 10 colleagues from the State Key Laboratory of Frozen Soil Engineering (Lanzhou, China) and Heilongjiang University (Harbin, China). The conference covered a wide range of permafrost-related topics, including regional and historical geocryology, permafrost thermal studies, periglacial processes and forms, landscape dynamics in permafrost regions, permafrost geochemistry, permafrost hydrology and hydrogeology, climate change and permafrost evolution, greenhouse gases and gas hydrates, permafrost microbiology, remote sensing of permafrost, and stability of engineering structures on permafrost.

The post-conference field trip to Amga, central Yakutia, was designed to examine permafrost processes and landforms (thermokarst, frost heaving, mass wasting, icings, thermal suffosion, etc.); surface and subsurface thermal regimes in different landscapes; permafrost-related engineering problems and mitigation techniques; mitigation and restoration measures for degraded agricultural lands; and land suitability mapping and assessment for agriculture. Together with senior scientists from MPI, participants conducted field observations to assess the extent of permafrost

degradation in different landscape settings. They took part in the establishment and instrumentation of observation sites to monitor ground temperatures, permafrost processes, groundwater, and geochemistry.
The Forum was held with financial support from the Russian Foundation for Basic Research (Grant 18-35-10015) and the Republic of Sakha/Yakutia Young Researchers Foundation.


Presentation by Yuri Dvornikov, PhD, Earth Cryopshere Institute, Tyumen.


Field trip participants in the vicinity of Amga, central Yakutia.

In 2018, MPI researchers participated in 32 international conferences in Russia and abroad, including Germany, France, Japan, China, South Korea and the USA.

International Cooperation

An important event in international cooperation in 2018 was the "20 Years of Lena Expeditions" International Symposium which took place on 17–19 October 2018 in St. Petersburg. The meeting was organized by the Arctic and Antarctic Research Institute (AARI), St. Petersburg; Melnikov Permafrost Institute (MPI SB RAS), Yakutsk; Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research (AWI), Bremerhaven and Potsdam; University of Hamburg, Institute of Soil Science (UHH); and German House of Science and Innovation Moscow (DWIH).
During the last 20 years, Russian-German joint expeditions have been working in the poorly studied East Siberian region of the Arctic. Russian and German research teams, including geomorphologists, geologists, paleogeographers, permafrost scientists, geophysicists, hydrologists, zoologists, botanists, and soil scientists carry out research within the framework of the Laptev Sea System project. Implementation of this joint project promotes international scientific exchange and the advancement of Arctic research. The expedition has resulted in hundreds of articles and dozens of monographs which explain the current and historic state of the Earth's geosphere and climate change in the Arctic. The Lena Delta expedition's research and logistical base on Samoylov Island is among the best Arctic research stations in the world.
The symposium was attended by about 80 participants from the AARI, Melnikov Permafrost Institute, Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research, University of Hamburg, German House of Science and Innovation Moscow, German Research Centre for Geosciences, St. Petersburg State University, Max Planck Institute, Forestry Institute, and Institute of Petroleum Geology and Geophysics.
The speakers presented the main results of the Russian-German Lena expeditions over the past 20 years in the following areas: hydrology, geomorphology, geological reconstructions, permafrost monitoring, carbon and greenhouse gas cycles, geophysics, modeling, biology, coastal zone research, and others.
A commemorative volume, "20 Years of Terrestrial Research in the Siberian Arctic. The History of the Lena Expeditions", published in Russian, English and German was published to mark the anniversary and presented to all Symposium participants.


Participants of the 20 Years of Lena Expeditions Symposium, 17–19 October 2018, St. Petersburg.

Mikhail Grigoriev, MPI Vice Director, talks about the beginning of terrestrial research in the Lena Delta and Laptev coastal zone and the history of the Samoylov station.

A poster is presented by Lyudmila Lebedeva, a junior scientist from MPI.

Publications

Theoretical, experimental and field investigations carried out by MPI researchers resulted in about 300 publications, including three monographs and 82 articles in journals listed in Russian Ministry of Education and Science's VAK and Web of Science. Four papers published in *Earth's Cryosphere* were chosen by the journal's editorial board as best in 2018 and included in the Russia's report to the International Permafrost Association.

A 211-page monograph titled "*Cryoecosystems of the Alazeya River Basin*" by S.P. Gotovtsev, L.I. Kopyrina, A.P. Efimova et al. published in Novosibirsk by Geo Academic Publishers summarizes the results of multi-disciplinary investigations conducted in 2008-2009 in the Alazeya River basin, Kolyma Lowland. It presents data on permafrost conditions, river hydrological regime, surface water chemistry and biology, soil texture and structure, and flora and fauna diversity. The authors conclude that repeated catastrophic floods have resulted in significant degradation of the northern ecosystems and permafrost environment in the Alazeya basin.

Completed Degrees

In 2018, three MPI researchers successfully defended PhD dissertations: Valery Semenov (Subsurface temperature distribution and permafrost in the Vilyui Basin), Pavel Zabolotnik (Ground temperature regime at large heat power generation facilities on permafrost: Yakutsk CPP Plant), and Lyudmila Lebedeva (Streamflow generation in the East Siberian permafrost zone).

Cryolithology and Glaciology Department, Geographical Faculty, Lomonosov Moscow State University

The studies of 2018 were conducted in several areas, traditionally distinguished in the scientific research of the Department of Cryolitology and Glaciology.

Yu.B. Badu prepared and published a monograph “Cryogenic strata of gas-bearing structures of the Yamal Peninsula. About an influence of gas accumulations on cryogenic strata forming and development” (Badu, 2018). In this book, the author expounds the concept of his cryolithololo gic paradigm developed at the result of the multi-year study of cryogenic gas-bearing strata forming conditions in the North of Western Siberia. It has been shown that in terms of structural geology, composition and conditions of rocks, the “cryogenic strata in a gas-bearing structure” is a special cryolithololo gic system, which evolved during the Pleistocene-Holocene with the sedimentation conditions marked by sediment cooling and freezing, governed by heat fl ux and gas emission from gas deposits. It has been established that in the context of either modern or ancient accumulation, cryolithogenesis is manifest in the continued gas saturation of both deposited and accumulating marine sediment, while the specifi c cryolithololo gical features develop as sediment accumulation proceeds in the respective facies environment, until laida deposits crop out on the surface, with the subaqueous processes having ceased, and all of its phenomena are reported in the cryogenic structure of permafrost.

N.A. Shpolyanskaya released a revised and updated reissue of the textbook “Geocryology. Evolution of the cryolithozone and global climate change” (Shpolyanskaya, 2018).

I.D. Streletskaya continued the study of traces of paleopermafrost. Ground wedge structures were found in the sections of Srednyaya Akhtuba, Leninsk, Bataevka, Cherniy Yar and Kosika (Lower Volga). The ground wedge structures in Quaternary deposits were interpreted as evidence of the

existence of permafrost and conditions of deep seasonal freezing earlier. The aim of the research was to analyze new data and to reconstruct the paleo-geographic situation of ground wedge structures. The position of the soil wedges in the section, their shape and size allow to conclude cryoarid conditions alternated with periods of warming in the Lower Volga region during the Pleistocene. Some of the vein wedges s thawed subaquately, indicating a changing sea level in the Pleistocene. The most severe conditions are reconstructed in the atelier time (MIS 4) (Streletskaya, Taratunina, Belayev, Kurbanov, 2018).

New unique data on the content and genesis of methane in ground ice, frozen Quaternary sediments and seasonally thawed layer at the Marre-Sale area (Western Yamal) was presented. Methane concentration in dominant landscapes of typical tundra of Western Yamal has been measured. The highest methane content in the active layer was measured in tundra bogs, wet gully bottoms, and polygonal tundra. A large content of methane (up to 10 ml/kg) is noted in the massive ice of the research area. Data on the determination of methane content in seasonally thawed layer for various types of landscapes are also presented. The layout of the map-scheme "Spatial distribution of methane content in the seasonal thawing layer in the Marre-Sale area" is constructed. Within typical tundra of Western Yamal, only 30 to 40% of the area may be considered to be a significant source of methane emission to the atmosphere. Methane fluxes measured in typical tundra of Western Yamal are approximately 2 times lower than those measured in Alaska (Streletskaya, Vasiliev, Oblogov, Semenov, Vanshtein, Rivkina, 2018).

New study proves that permafrost degradation of coastal and marine sediments of the Arctic Seas can result in large amount of methane emitted to the atmosphere. The value of methane emissions in the destruction of frozen sea shore with underground ice is high enough and comparable to the emission of methane from wetland ecosystems. The quantitative assessments of such emissions were analyzed data on methane content in permafrost sediments and ground ice. Gas was present in pores of sediments and in bubbles within the ice and the methane content is characterized by high variability (Streletskaya, Vasiliev, Oblogov, 2018).

V.I. Grebenets with colleagues on the basis of field observations, research of stock sources and analysis of satellite images for the first time evaluated the effect of storage of solid waste on the state of permafrost (Grebenets et al., 2018). The analysis was carried out for 5 types: 1) solid household waste, including the accumulation of barrels, 2) frozen moving dumps of rock; 3) accumulators of sludge, slags, ash dumps, tailing dumps, 4) construction waste, including in deformed abandoned settlements in the permafrost, 5) wood waste. It has been established that due to thermal and physicochemical processes, permafrost degradation occurs, erected after engineering training in these territories, buildings and structures are quickly deformed, and storage sites for industrial waste and displacement zones of frozen dumps (man-made rock-glaciers) become completely unsuitable for further usage. For 6 types of linear systems in Russia V.I.Grebenets with colleagues analyzed the negative impact of dangerous cryogenic processes, including the fact that about 70% of underground utilities in the largest Arctic cities of Russia are in poor condition, 30-40% of main pipelines in discontinuous permafrost zones become deformed after 5-10 years of operation.

In July 2018, in the lower reaches of the Ob and in the south of the Yamal Peninsula, a comprehensive training practice in cryolithology was conducted (heads - V.I.Grebenets and V.A.Tolmanov). It was collected a large amount of data on transformation of landscape-frozen conditions under climate warming, as well as carried out several hundred thermometric measurements to assess the thermal effect of various plant-soil tundra covers on the depth of seasonal thawing and thermo-conditions of permafrost soils.

A.I.Kizyakov with colleagues from the Earth Cryosphere Institute TSC of the Siberian Branch of the Russian Academy of Sciences performed studies on the assessment of the relief-forming role of gas emission craters (GEC) (Kizyakov et al., 2018). The role of GEC in relief changes is local, incomparable in terms of the movement of rocks with other destructive cryogenic processes.

However, the relief-forming role of GECs is not limited to the appearance of the crater itself, but also results in positive and negative microforms as well. Negative microforms are rounded hollows, surrounded by piles of ejected or extruded deposits. Hypotheses related to the origin of these forms are put forward and supported by an analysis of multi-temporal satellite images, field observations and photographs of GECs. Remote sensing data specifically was used for interpretation of landform origin, measuring distances and density of material scattering, identifying scattered material through analysis of repeated imagery. Remote-sensing and field data reliably substantiate an impact nature of the hollows around GECs. Hollows formation is associated with the impact of large blocks of frozen deposits and ice ejected from the crater during its formation. It is found that scattering of frozen blocks at a distance of up to 293 m from a GEC is capable of creating an impact hollow. This study aims at the prediction of risk zones.

In July 2018, A.I.Kyzyakov took part in the Russian-German expedition “Lena-2018” as part of a field team led by S.Wetterich (AWI). This team

study exposures of ice-wedges and frozen deposits of the ice complex, on Sobo-Sise Island in the Lena delta, as well as measurements of the of seasonal thawing depth were performed.

Complex glacio-meteo-hydrological monitoring was carried out by V.V.Popovnin at the Djankuat Glacier, a representative object for the Central Caucasus. A 2017/18 balance year turned out to reveal a number of anomalies and peculiarities. For instance, a tremendous sand influx from Sahara Desert was detected in the springtime; it resulted in unusual concentration of transported impurities in the deposited snowpack that led to distorted albedo values which consequently caused the increased ablation (about 3370 mm w.e.). However, It could not compensate for rather high winter snow accumulation that equaled ca. 3810 mm w.e. – mainly at the expense of extraordinarily high snow density (up to 0.60 and 0.65 g•cm3 on the snow and in the firn basin, correspondingly, by the date of seasonal accumulation maximum). Thus, a moderate positive mass balance value of +440 mm was preliminarily derived for 2017/18 – the first positive value throughout the last 14 years.

Two methodical innovations were introduced into the traditional monitoring observational programme at the Djankuat Glacier. First, snow accumulation survey was partly made by means of radar sounding that revealed good compatibility with the direct measurements even in the firn basin. Second, in the end of the balance year some ablation stake readings within inaccessible areas of the glacier were made with the help of drone; the drone was also successfully applied for snow coverage surveys and concomitant geodetic tasks.

Mass balance monitoring of 3 reference glaciers (Karabatkak, Sary-tor and Bordu) in the Inner Tien Shan, Kyrgyzstan, was continued. In 2017/18 balance year all of them revealed a strong mass loss (-810, -540 and -870 mm w.e., correspondingly), though this year was a bit better than average for the state of the Karabatkak and the Bordu Glaciers and the best for the Sary-tor Glacier since the resumption of mass balance programme here.

Another object of long-term monitoring, Glaciar de los Tres in Patagonia, Argentina, was surveyed as well. It was the 7th field season since the start of direct terrestrial observations in 1995/96 by Russian glaciologists. The continuous ongoing glacier terminus recession was corroborated by laser ranger. Its total retreat of 223 m during 1995-2018 was estimated, while application of earlier remote sensing data reveals the value of 321 m for the longer 1963-2018 period. The overall mean retreat rate comes to 5.8 m/yr for the entire 55-year-long time span whereas evident signs of its acceleration can be derived when analyzing results of front positioning inside this time interval. The adjacent lake Laguna Ira has lost its proglacial status 3 years ago. Today its aquatory is estimated as 2.060 ha that is approximately 3.3 times larger than in 1995/96. Frontal recession rate along the rocky slope seems to decelerate in comparison with its dynamics at the floating stage. Glacier area, which is currently as small as 0.753 sq.km in orthogonal projection, reduced by 17 per cent since 1998 and by 21 per cent since 1963. The obtained values witness for acceleration of deglaciation trends in the Patagonian Andes over the last decades.

Using a variety of techniques including tacheometry, airborne and terrestrial close-range photogrammetry, high-resolution satellite DEMs D.A.Petrakov and N.V.Kovalenko with colleagues reported on fast regeneration of the Kolka glacier (Caucasus) after Kolka-Karmadon glacial disaster in 2002 (Petrakov et al., 2018). Since the disaster volume of the glacier has been increased up to 50 mln. m^3 which is about half of precatastrophic volume. Rapid growth of the Kolka contradicts completely to dramatic downwasting of the representative Caucasian glaciers, Djankuat and Garabashi.

N.V. Kovalenko analyzed the photographic material from the tracking camera, which removes the accumulation basin of the Kolka glacier at intervals of 3 hours starting in August 2017. The data of the ground radar survey of the largest Caucasus glacier, Bezengi, undertaken by first time, was processed and analyzed. The data obtained revealed the largest ice thickness in the Caucasus - up to 425 m and 197 as an average. The ice volume of the explored part of the Bezengi glacier reaches 1.4 km^3.

References:

Badu Yu.B. Cryogenic strata of gas-bearing structures of the Yamal Peninsula. About an influence of gas accumulations on cryogenic strata forming and development. Moscow, Scientific World, 2018. 232 p. [In Russian].

Grebenets V.I., Tolmanov V.A., Khayredinova A.G., Yurov F.D. The problem of storage of solid waste in the cryolithozone // In coll. Sergeyev readings: vol.20: Waste management: tasks of geo-ecology and engineering geology. Materials of the annual Scientific Council of the RAS on the problems of geoecology, engineering geology and hydrogeology. Moscow: PFUR, 2018. P.227-234. [In Russian].

Petrakov D.A., Aristov K.A., Aleynikov A.A., Boyko E.S., Drobyshev V.N., Kovalenko N.V., Tutubalina O.V., Chernomorets S.S. Rapid regeneration of kolka glacier (caucasus) after the 2002 glacial disaster. Earth's Cryosphere, 22(1):58–71, 2018. DOI: 10.21782/KZ1560-7496-2018-1(58-71)

Streletskaya I.D., Taratunina N.A., Belayev V.R., Kurbanov R.N. SOIL WEDGES AS A PROXY OF RELICT PERMAFROST IN LOWER VOLGA RIVER REGION. Abstracts of the International conference “Loessfest2018: Diversity of loess: properties, stratigraphy, origin and regional features”. Moscow-

Volgograd, September 23-29, 2018, Volgograd State University Volgograd, p. 111-112
Streletskaya I.D., Vasiliev A.A., Oblogov G.E., Semenov P.B., Vanshtein B.G., Rivkina E.M. Methane in ground ice and frozen sediments in thecoastal zone and on the shelf of Kara Sea. Led i Sneg. Ice and Snow. 2018. 58 (1): 65–77. [In Russian].
Shpolyanskaya N.A. Geocryology. Cryolithozone evolution and global climate change. Moscow: KDU, Dobrosvet, 2018. 188 p. [In Russian].
Streletskaya I.D., Vasiliev A.A., Oblogov G.E. Coastal retreat and methane emission in The Western Yamal // Proceedings of Abstracts 11th International Conference on Air Quality – Science and Application, место издания Published by the Air Quality Conference College Lane Hatfield AL10 9AB United Kingdom, 2018. c. 208
Kovalenko N., Petrakov D., Alexandrin M., Lavrentiev I., Kutuzov S. New data on glacier thickness in Central Caucasus from recent radar surveys – Presentation on Practical Geography and XXI Century Challenges. International Geographical Union Thematic Conference dedicated to the Centennial of the Institute of Geography of the Russian Academy of Sciences, Moscow, Russia, 4-6 June 2018

Geocryology Department, Geology Faculty, Lomonosov Moscow State University

International projects:

Russian-Norwegian Research-based education in Cold Regions Engineering (RuNoCORE) project. CPRU-2017/10015
https://www.siu.no/eng/content/view/full/81242
Participants: NTNU- Norwegian University of Science and Technology (NO-NTNU) Department of Civil and Environmental Engineering; Lomonosov Moscow State University (MGU) (RU-MGU) Department of geocryology, Geology Faculty.
The northern part of Europe is becoming increasingly important from an economic point of view. However, for the sustainable development of this region, engineers need to improve their understanding of the mechanisms associated with the freezing and thawing of soils.
Moscow State University and NTNU have a long history of scientific cooperation in the field of the Arctic and cold regions, which can provide a better education for students of both universities. Through this collaboration, we better understand the culture and traditions that should be distributed to students. The project manager received a Ph.D. in geology engineer at Moscow State University and has worked in Norway for six years at SINTEF and NTNU.
The main activity of the project is to invite Norwegian students for field work in the northern part of Russia and to organize an intensive course in both countries for students from Russia and Norway. The courses will provide a very good basis for work as an engineer in the arctic climate. A significant part of the project is devoted to the financing of student scholarships and travel expenses. Project leaders rely on a solid foundation of research and make it available to more students from Norway and Russia. To facilitate student mobility, the administrative staff of both universities is involved, which should contribute to an understanding of the principles of operation of these two systems and allow for promptly solving administrative problems.
The subject of this project is a priority both in the participating universities and in partner governments.
This project will be important for creating a good platform for student mobility, making it easier for students to find funding for future mobility and cooperation.
Areas of education and training:
1. Construction equipment, architecture
2. Ecological technologies
3. Other engineering and technology
4. Earth Sciences

Sergeev Institute of Environmental Geoscience RAS (Moscow)

http://geoenv.ru/index.php/ru/

The Institute of Environmental Geoscience of the Russian Academy of Sciences (RAS), together with the Institute of Atmospheric Physics of RAS, the Institute of Earth Cryosphere of the Siberian Branch of RAS, the Institute of Petroleum Geology and Geophysics of the Siberian Branch of RAS and the Institute of Applied Mechanics RAS launched a large-scale project to develop principles and technological approaches to the adaptation of the Gazprom Corporation to climate change and geocryological conditions in the permafrost territory of Russian Federation.

Specialists continued the natural condition permafrost monitoring in the Northern Transbaikalia to provide the temperature data to GTN-P database. The fieldworks at the geocryological observatory in the vicinity of Vorkuta was continued – together with the Geological Faculty of Moscow State University. This observatory was founded in the 50s with the participation of V.A.Kudryavtsev.

Institute of Physicochemical and Biological Problems in Soil Science, RAS (Soil Cryology Laboratory)(Pushchino, Russia)

http://www.issp.psn.ru/

1. It has been shown, that Cenozoic permafrost is a unique ecosystem not impacted by anthropogenic factors. The genes and metabolic products of viable

microbial cells have persisted over geological time. Microbiological and molecular biological studies of paleobiological objects in permafrost extend our knowledge of the biosphere's spatial and temporal boundaries and set a new direction in Quaternary geology, geocryology, bacterial paleontology and exobiology. Furthermore, the ability of viable microorganisms in permafrost to carry out metabolic reactions at subzero temperatures and produce cold-active enzymes makes the Earth's permafrost one of only a few natural models for exobiology.

2. It has been obtained the first data demonstrating the capability of multicellular organisms for long- term cryobiosis in permafrost deposits of the Arctic. The viable soil nematodes *Panagrolaimus* aff. *detritophagus* (Rhabditida) and *Plectus* aff. *parvus* (Plectida) were isolated from the samples of Pleistocene permafrost deposits of the Kolyma River Lowland. The duration of natural cryopreservation of the nematodes corre- sponds to the age of the deposits, 30 000–40 000 years.

3. Samples Ant1 and Ant2, collected in Antarctic Miers Valley from permafrost sediments, with and without biogenic methane, respectively, were evaluated for methanogenic activity and presence of methanogens. After a one-year incubation of both samples under anaerobic conditions, methane production was observed only at room temperature in microcosm Ant1 with CO2/H2 (20/80) as carbon and energy sources and was monitored during the subsequent 10 years. The concentration of methane in the headspace of microcosm Ant1 changed from 0.8% to a maximum of 45%. Archaeal 16S rRNA genes from microcosm Ant1 were related to psychrotolerant *Methanosarcina lacustris*. Repeated efforts at achieving a pure culture of this organism were unsuccessful. Metagenomic reads obtained for the methane-producing microcosm Ant1 were assembled and resulted in a 99.84% complete genome affiliated with the genus Methanosarcina. The metagenome assembled genome contained cold-adapted enzymes and pathways suggesting that the novel uncultured Methanosarcina sp. Ant1 is adapted to sub-freezing conditions in permafrost. This is the first methanogen genome reported from the 15 000 years old permafrost of the Antarctic Dry Valleys.

4. Soil profile temperatures in Northern Yakutia depend on their location in tundra or taiga zones and subzones, water content (drainage conditions), ice content in the underlying permafrost, vegetation cover, as well as soil particle size (texture) and thickness of organic horizons. The studied soils differ mainly in winter temperatures. The mean coldest month temperatures of loam soils measured at 20 cm below the surface are 10 °C higher in northern taiga than in southern tundra. However, the mean annual temperatures at this depth vary from –4.3 to –9.7 °C in tundra and from –1.2 to –4.9 °C in taiga. This discrepancy is primarily due to the effect of the snow cover which is thicker, less dense, and more stable in the forest landscapes. Sandy podburs have larger thawing degree-day sums and deeper 0 °C, 5 °C, and 10 °C isotherms than the loamy soils of tundra or taiga zones. Xeromorphic soils of steppe ecosystems in the northern taiga subzone have the warmest summer temperatures and are most responsive to temperature change.

5. In the profiles of cryozems (Oxyaquic Turbic Cryosols) developing in tundra of northern Yakutia under conditions of shallow active layer, suprapermafrost horizons of the accumulation of raw organic matter are formed. Taking into account their genesis, stable and regular position in the soil profile, paragenetic links with the overlying horizons and neighboring soil profiles, and a set of diagnostic features and properties, these horizons can be separated as a new type of genetic soil horizons—the organomineral accumulative suprapermafrost horizon (CRO). Its qualitative composition (the ratio of organic and mineral matter in the material) can be reflected at a lower level. In relation to the separation of the new genetic horizon within the framework of the new Russian soil classification system, a new genetic types of soils—cryozem with suprapermafrost accumulation of raw organic matter (suprapermafrost organo-accumulative cryozem)—can be established. Its diagnostic profile has the following horizonation: (O, AO, T)–CR–CRO–$_{T}$C.

V.B. Sochava Institute of Geography SB RAS (Irkutsk) http://www.irigs.irk.ru/

A database of soil temperatures has been created from monitoring data of the climatic characteristics of landscapes at the Tunkinskaya depression ((south-west part of the Baikal Rift Zone in the South Siberia). The study area is located at the junction of the Tunkinskiy Goltsy and Khamar-Daban ridges, belongs to the island distribution zone of permafrost and is characterized by a sharp continental climate, a variety of landforms, soil-forming rocks, landscape conditions (from steppe to mountain-taiga and bald mountains in the height range of 700-3500 m a.s.l.). The data of year-round observations of the soil temperature and moisture (from the underlying

surface to 10 m) were collected. Since October 2011, observations are carried out automatically in 1 hour at 21 sites. Observation sites are located on plots with seasonally thawing soils (wetland) and seasonally freezing soils (sandy massifs, taiga and forest-steppe areas). For monitoring, the atmospheric-soil measuring complex developed and manufactured at IMCES SB RAS is used. Soil sampling at pits and boreholes on various underlying rocks were made to assess the influence of the physicochemical properties of soils on the features of the hydrothermal regime. More than 200 soil samples were collected. The moisture content, particle size, texture, bulk weight (density), the content of organic matter, etc. were analyzed. Fluctuations in average daily air temperatures at the sites are synchronous during the year. However, due to differences in vegetation cover, microclimatic differences in daily air temperatures reach 4-5 oC. The differences between average daily temperatures are slightly higher (7–9°C) on the soil surface.

Spain

Activities of the IPA-Spain group

In line with previous years, the different Spanish research groups working on permafrost and periglacial processes have conducted research activities on a wide range of different topics in several Iberian mountain ranges (Pyrenees, Cantabrian Mountains, Sierra Nevada, Iberian Range, Central Iberian Range), as well as in Antarctica and in the Arctic. As usual, there has been an intense collaboration between different teams. Researchers from the universities of Barcelona, Valladolid, Complutense and Autonoma of Madrid, Alcalá, Oviedo, Extremadura and the Pyrenean Institute of Ecology collaborate in different projects, along with other international centres.

Participation at permafrost and polar meetings

Over the last year, Spanish researchers participated in the 5th European Conference on Permafrost (Chamonix, France, 23rd June - 1st July 2018) presenting and exposing their recent results. In addition, several researchers also presented their last findings at the POLAR2018 (Davos, Switzerland, 15-26th June 2018). Remarkably, Spanish permafrost researchers organized several sessions in both conferences, being also involved in several committees and initiatives.

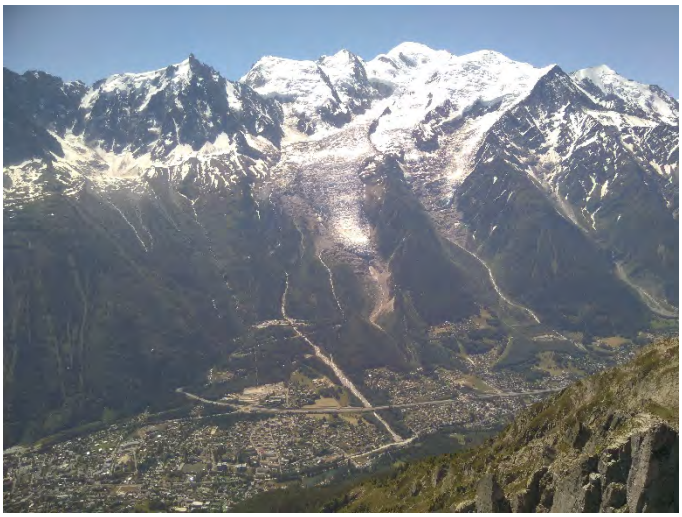


Fig. 1. The Chamonix, with the impressive Mont-Blanc, massif 5th EUCOP conference.

Proposal to host the next European Conference on Permafrost

The Spanish permafrost community made an official proposal to organise the next European Conference on Permafrost in Puigcerdà, in the heart of the eastern Pyrenees, from June 20 to 23th, 2022. This conference would be hosted by the University of Barcelona and would count on the support of several other Spanish universities and research centres.

Permafrost research in Spain has significantly increased over the last several decades, both in terms of quality and the number of scientists conducting research in permafrost environments. Since the International Polar Year 2007-08, the Spanish permafrost community has made a step forward on the internationalization and the development of a new generation of permafrost scientists. Currently, there are several groups in Spain studying permafrost in both polar regions and mountain environments, namely at the University of Barcelona, the Complutense University of Madrid, the University of Alcalá, the University of Valladolid, the University of Oviedo, the University of Extremadura, the University of Santiago de Compostela and also at the Spanish National Research Council (CSIC).

The Spanish permafrost community would be honoured to host the European Conference on Permafrost in 2022 in the Catalan Pyrenees. It would be also a unique occasion to show evidence of the importance of permafrost research in a country where most people have never heard of permafrost. It would therefore be a great opportunity to disseminate our research activities as well as to sustain funding and reinforce permafrost science in the Iberian Peninsula.

This event promoted by the IPA-Spain is celebrated every four years with the main objective of providing interdisciplinary collaboration and joint initiatives between the different research groups working on periglacial and permafrost subjects. Within the next few months, we will know if our proposal has been chosen to host the next EUCOP conference in June 2022.

Fig. 2. The village of Puigcerdà, in the valley floor of the Cerdanya district, has been proposted to host the next EUCOP conference.

Research by Spanish groups

Researchers from the Department of Geography of the University of Barcelona (Marc Oliva, Ferran Salvador, Antonio Gómez-Ortiz) have conducted research activities both in Polar Regions (Antarctic, Greenland and Iceland) and high mountain environments (Pyrenees, Sierra Nevada).

They have continued with the research activities that have been carried out in Sierra Nevada since the late 1990s, together with researchers from the Complutense University of Madrid and the University of Extremadura. Monitoring activities consist of the control ground temperatures in several sites across the massif as well as on the monitoring of rock glacier dynamics in the Veleta in order to control the degradation of the frozen masses existing in this cirque glaciated during the Little Ice Age. Ferran Salvador also continued with his long-term monitoring of soil and air temperatures in high mountain environments in the Eastern Pyrenees, namely in Cerdanya area. Marc Oliva replaced the loggers that are monitoring soil temperatures in the rock glacier of Beciberri, Central Pyrenees.

Marc Oliva, with Jesús Ruiz, Cristina García and Augusto Pérez-Alberti spent a month and a half in Antarctica carrying out research activities in different sites of the Antarctic Peninsula in order to reconstruct the calendar of glacial retreat and the development of permafrost-related features.

Fig. 3. Lichenometric measurements near the Spanish Juan Carlos I research station, Antarctica.

Marc Oliva, together with David Palacios and Jesús Ruiz and collaborators from other international research centres spent a month in NE Greenland to reconstruct the timing of glacier retreat and the development of certain periglacial features. After that, they also conducted some research in Iceland with the same purpose.

Fig. 4. Collecting samples for CRE dating in NE Greenland.

The Valladolid group (PANGEA-UVa) and Extremadura group (NEXUS) continues with the works focused on the monitoring periglacial processes and mountain permafrost in the Pyrenees and the Cantabrian Mountains (Picos de Europa and Alto Campoo). During 2018 the works have focused on monitoring of (i) Ice caves in Picos de Europa (including cave mountain permafrost), and (ii) mass movements above the timberland belt, completing nine years of continuous surveys using GPS-RTK and TLS.

These studies have been complemented with the monitoring of ground temperatures and geomorphological mapping in the Picos de Europa and Campoo. Continuous fieldworks between June and November have allowed us to replace the instrumentation and complete the systematic measures on ice caves (temperature, moisture and ice changes), complemented by the collaboration with studies on extremophilic microorganisms colonization (by Sanda Iepure, UPV) and gases into the caves (by Carlos Sainz, UC). This research has allowed identifying the difference between the importance of the ice volumes in the ice caves, and the moderate contribution of the ice in the ground and the absence of seasonally frozen ground at the same altitudes.

Fig. 5. Researchers at the Renclusa hut (Central Pyrenees) and TLS measurements in the Maladet massif

In the Pyrenees, the works have focused on the monitoring of rock glaciers by photogrammetry, GPS-RTK and TLS measurements in Maladeta and La Paul rock glaciers, and the active rock glacier inventory task in the Pyrenees. Two field seasons have allowed completing the studies carried out in the Maladeta and La Paúl glaciers with the objective of applying new geomatic techniques in the field (photogrammetry and TLS) to monitor horizontal and vertical deformations that provide higher data accuracy. These research group goals go forward in agreement with the start of a PhD thesis by Adrián Martínez Fernandez, co-directed from UVa and University of Extremadura.

Fig. 6. The VIII IWIC Group in the El Soplao cave (above), the group visiting the Altais ice cave, at 70 m depth (below).

Regarding the ice caves, the PANGEA-UVa research group of the University of Valladolid organized the VIII International Workshop on Ice Caves (IWIC-VIII), promoted by the Commission on Glaciers and Ice Caves of the International Union of Spelology (UIS). The workshop was held in Potes, Picos de Europa National Park (Cantabria and Asturias) between the 11 and 16th June. Up to 40 European and American researchers attended the meeting, together with members of three Spanish groups working on ice caves (IPE-CSIC, CIEMAT and UVa). Works on ice caves were presented from different perspectives, with a total of 33 communications about ice caves in the Alps (Italy, Austria, Switzerland, Germany, and Slovenia), Romania, the United States, the Pyrenees, Russia and Picos de Europa. The meeting was an opportunity to show our frozen subterranean heritage and to share our scientific advances in the investigation of ice caves through oral communications, panels and field trips. Although the visit to the ice cave of Castil could not be done due to the thick snowpack, the last day we visited the Altaiz ice cave. The meeting was held in the old Church of San Vicente, courtesy of the Estudios Lebaniegos Institute of the Government of Cantabria.

The research of the High Mountain Physical Geography Group (GFAM) of the Complutense University of Madrid focused on the chronological analysis of the fossil rock glaciers existing in the Iberian Peninsula and their paleoclimatic significance. The team is conducting various studies on the moment of formation and stabilization of rock glaciers located in the Central Range, Pyrenees, Cantabrian Mountains and Sierra Nevada by means of cosmogenic dating. These stages reveal cold or warm periods occurred throughout the last deglaciation favourable for the formation of permafrost-related features. On the other hand, another line of research focuses on the study of active rock glaciers in the Tröllaskagi Peninsula, in northern Iceland. The group is studying the origin and its current dynamics as well as its relationship with recent climate changes. In addition, they are developing a new method for geomorphological mapping of rock glaciers that includes issues related to their dynamics.

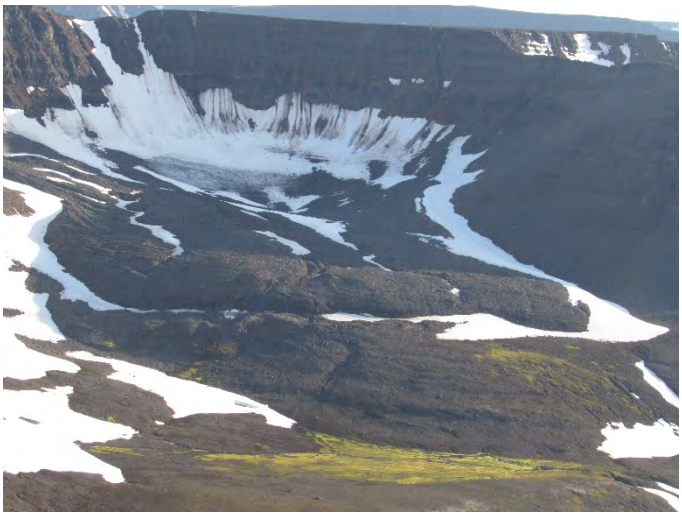


Fig. 7. Júllogil rock glacier in Hofsdalur valley, close to Hólar village, Tröllaskagi peninsula, northern Iceland. It is one of the rock glacier studied by the group using cosmogenic, lacustrine and lichenometric dating. The group also measures present-day boulder displacements.

Their work in the Andes is focused on the monitoring of permafrost in active volcanoes, obtaining successful results in Nevado Coropuna (6,425 m 15 ° 31'13 "S 72 ° 39'26" W), Southern Peru.

The permafrost team of the Alcalá University continues its research activities in Polar and Planetary permafrost, in close collaboration with the Portuguese Polar program, namely with the Centre for Geographical Studies (CEG-IGOT) of the University of Lisbon and the Department of Geography of the Masaryk University Czech Republic. Members of the Alcalá University team participated in the Spanish Antarctic expedition 2017-18, focusing on the study of the thermal regime of the permafrost by means of the CALM-S sites and the boreholes drilled in several sites across the Antarctic Peninsula. This was done in the framework of the PERMASNOW and PERMANTAR projects, funded by both the Spanish and Portuguese governments.

With regards to planetary permafrost studies, the Alcalá University has had an intensive collaboration with the Spanish Astrolobiological Center (CAB-INTA-CSIC) focusing on its participation to be used in the next NASA mission Mars-2020. The development of a singular instrumentation like a net radiation sensor (TIRS) to be used in the Mars surface will allow an accurate characterization of the energy balance in the soil surface of Mars, which will be useful to correlate it with the thermal wave propagation in the Martian permafrost. This new instrumentation belongs to a set of sensors named MEDA. Also, the TIRS sensor has been installed in the ongoing Antarctic mission of the wind sled program (2018-2019 Antarctica unexplored Dome Fuji) in order to test its functioning in the rush conditions prevailing in the interior of this continent.

Fig. 8. Set of instruments close to the Bulgarian Antarctic Station St. Kliment Ohridski, Livingston Island (Antarctica).

The Department of Geography of the Autonomous University of Madrid (UAM), led by Dra. Teresa Bullón-Mata focused on the climatic reconstruction during the Little Ice Age from documentary sources. The aim of this project is to obtain information about the meteorological events that occurred between the end of 18th and the beginning of the 19th centuries in order to know more about the Little Ice Age in the mountainous area of Central Spain. It is basically concentrated in the environmental, hydrological and periglacial consequences of this climatic crisis.

The research method consists on obtain and process information about meteorological events through documentary sources that refer to places located around the Sierra de Guadarrama. Acquired data are arranged in databases, valued, and converted in numerical indexes to get statistical analysis, graphs and tables. Temperatures and precipitations associated to these events are reconstructed using the meteorological information published in different journals and comparing it with recent and current climatic series.

Report prepared by Marc Oliva

Switzerland

Swiss Permafrost monitoring

The Swiss Permafrost Monitoring Network PERMOS (www.permos.ch) maintains a network of 28 high alpine sites in order to document the state and changes of permafrost in Switzerland based on three main observation elements (ground temperatures, changes in subsurface ice and water content, and permafrost creep velocities). PERMOS is funded by the Federal Office for the Environment (FOEN), the Swiss GCOS Office at MeteoSwiss, and the Swiss Academy of Sciences (SCNAT). The PERMOS Office (J. Noetzli, C. Pellet) coordinates observation and reporting activities undertaken by the six partner institutions ETH Zurich (ETHZ, D. Farinotti, L. Pruessner), the Universities of Fribourg (UNIFR, R. Delaloye, C. Hauck, C. Hilbich, M. Hoelzle, C. Pellet), Lausanne (UNIL, C. Lambiel), Zurich (UZH, I. Gärtner-Roer, A. Vieli), the WSL Institute for Snow and Avalanche Research (SLF, M. Phillips, J. Noetzli) and the University of Applied Sciences and Arts of Southern Switzerland (SUPSI, C. Scapozza).

In 2017 and 2018, PERMOS supported the re-drilling of two boreholes at Tsaté (3050m asl. VS) and Schilthorn (2970m asl., BE, Fig. 1), respectively to ensure the long term monitoring of the permafrost temperatures. An overlapping measuring period is planned to assess the consistency of the new and old time series.

The automatisation and standardization of the PERMOS network continues and an online data browser for borehole temperature as well as ground surface temperature has been setup. PERMOS is currently in the process of adding kinematic and geophysical (ERT) data to this browser.

Figure 1: Re-drilling of the Schilthorn borehole on September 24 2018 (C. Pellet, Univ. Fribourg).

News from research projects and activities

The Alpine Cryosphere and Geomorphology research group at the **University of Fribourg**, Department of Geosciences has pursued its activities on a range of topics related to permafrost occurrences and processes like rock glacier dynamics, sediment transfer, geomorphology, geophysics, subsurface modelling and remote sensing.

Various projects are currently conducted in the field of permafrost geophysics, both, regarding new field and processing techniques as well as field surveys for ground ice detection and monitoring. Coline Mollaret continued her PhD thesis on permafrost monitoring with electric and seismic techniques with a special focus on a new petrophysical joint inversion scheme of electrical resistivity and seismic traveltime data. The joint inversion approach is part of a collaboration with Florian Wagner (University of Bonn, Germany) with the objective to quantify ground ice and water contents and to estimate porosity at the same time within a joint inversion approach.

In a joint project with the TU Vienna/Austria and the University of Bonn/Germany, Theresa Maierhofer started a new PhD thesis on the application of spectral induced polarization to different permafrost environments. First test measurements were conducted at more than 10 field sites in the Swiss Alps, including rock glaciers, talus slopes and bedrock.

In a collaboration with Lukas Arenson, BGC Engineering/Canada, regular geophysical field campaigns are conducted in different regions of the high Andes (Chile/Argentina), with the aim to map and quantify volumetric ground ice occurrences to add observation-based evidences to the debate about the relevance of permafrost for future water availability in the dry Andes (Christin Hilbich). By the end of 2018, the data base consists of about 38 electrical resistivity profiles and 22 refractions seismic profiles, collected in 4 different permafrost catchments between 3800 and 5200 m asl. Further extensive geophysical surveys were conducted in the Berner Oberland as part of a regional monitoring network of the Canton of Bern.

In the field of permafrost modelling, Jonas Wicky continued his PhD project on the numerical modelling of air convection within the active layer of Alpine rock glaciers and talus slopes by an explicit 2-dimensional model approach including convective and conductive processes. These simulations are driven by observed long-term surface temperature measurements and validated with borehole temperatures from the PERMOS network.

The Alpine Cryosphere and Geomorphology research group is also taking part of the ESA (European Space Agency) Permafrost CCI (Climate Change Initiative) project, promoting the integration

of mountain permafrost in worldwide overviews of permafrost state and evolution (C. Barboux, C. Pellet, R. Delaloye). A 2-year IPA Action Group on rock glacier inventories and kinematics has been launched in 2018 aiming to establish commonly accepted guidelines for inventorying rock glaciers and integrating quantified information about their activity rate (R. Delaloye, C. Barboux). M. Kummert got his PhD grade with a thesis dealing with sediment transfer and connectivity at the front of active rock glaciers.

Fig. 2: ERT surveys at the top of Mont Fort (3330 m. asl.)(C. Lambiel, Univ. Lausanne)

Beside usual activities related to permafrost monitoring, the **University of Lausanne** carried out various projects related to mountain permafrost during this last period under the lead of Christophe Lambiel. Nicola Deluigi finished his PhD Thesis entitled *Data-driven Analysis and Mapping of the Potential Distribution of Mountain Permafrost*. Elisa Giaccone continued her Thesis on the influence of geomorphological variables, among them permafrost, on vegetation development in the alpine periglacial belt. Sebastian Vivero continued his PhD Thesis on rock glacier dynamics, with the objective of studying rock glacier velocity variations at different time scales, coupling rock glacier dating methods and both archival and SfM photogrammetry. Within this project, drone surveys were made on several rock glaciers in order to study rock glacier motion at very high resolution. During this last period, we started also to investigate permafrost in steep bedrock around the top of Mont Fort (3300 m. asl.) with ERT surveys and rock temperature monitoring. ERT surveys were also carried out on the frozen moraine at Col des Gentianes 9 years after the first measurements in order to quantify the changes in permafrost.

In parallel to its long-term monitoring of borehole temperatures in cooperation with PERMOS and GTN-P (J. Noetzli), the **WSL Institute for Snow and Avalanche Research SLF** continues to investigate permafrost slope deformation and the processes controlling them (R. Kenner). The role of permafrost in rock slope failures is investigated at selected sites in collaboration with geologists (F. Amann, A. Kos, Y. Bonanomi). Several near-surface rock slope failures and debris flows (Fig. 3) were recorded by the SLF in mountain permafrost regions during the summer 2018 heat wave. Mountain infrastructure stability and temperatures around structures are monitored (M. Phillips) with various engineering companies. Non-conductive processes in ice-rock mixtures and within the active layer are modelled using SNOWPACK and GERM (L. Pruessner, D. Farinotti, M. Huss, M. Hoelzle). A pilot project using relative gravimetry to determine water contents and hydrostatic pressure in fractured rock masses has been launched (R. Scandroglio, M. Krautblatter). Rock surface temperature data from Gemsstock and Gotthard Pass has contributed to paleo temperature reconstructions using cosmogenic ^{3}He (B. Guralnik et al.).

Fig. 3: Debris flow with a volume of approx. 10 000 m^3 triggered from the Ritigraben rock glacier (canton Valais) during a thunderstorm with intense rainfall and hail, June 2018 (M. Phillips, SLF).

The department of geography at the **University of Zürich** and the **ETH Zürich** (A. Vieli, I. Gärtner-Roer, J. Beutel, J. Faillettaz, A. Cicoira S. Weber) continue to investigate rockglacier dynamics and permafrost temperature in steep rock wall.

The PermaSense project has completed a unique ten+ year data record obtained from in-situ measurements in steep bedrock permafrost in an Alpine environment on the Matterhorn Hörnligrat, Zermatt, Switzerland at 3500 m asl. during the period 2008-2018. This data set constitutes the one of the longest, densest and most diverse data record in the history of mountain permafrost research worldwide with 17 different sensor types used at 29 distinct sensor locations consisting of over 114.5 million data

points captured over the past decade. By documenting and sharing this data in this form we contribute to making our past research reproducible and facilitate future research based on this data e.g. in the area of analysis methodology, comparative studies, assessment of change in the environment, natural hazard warning and the development of process models. A full paper describing this data set has been submitted to ESSD (will be in discussions shortly).

In June 2018, a large boulder block (5000 ton) was removed in the top of the Grabengufer, Randa (VS) rock glacier as an active safety measure. A three-four week preparation phase for the blasting was undertaken by GFZ Sprengtechnik St. Niklaus. The village was partially evacuated. This is one of the very few cases where there has been actual interventions on permafrost ground concerning natural hazard mitigation and not on the valley floor below (Fig. 4).

In 2018, Samuel Weber (UZH) successfully completed his PhD thesis entitled *Rock slope dynamics in bedrock permafrost: Insights across scales* on the topic of acoustic emission and microseismic measurement on the Matterhorn.

Fig. 4: Preparation for the blasting of a large boulder at the front of the Grabengufer rock glacier (Randa, VS) in June 2018 (J. Beutel, ETHZ).

United Kingdom

Rock fracture

Vikram Maji (University of Sussex) successfully defended his PhD thesis on *An experimental investigation of micro- and macrocracking mechanisms in rocks by freeze–thaw cycling*. This work involved monitoring of rock fracture by micro-computed tomography scanning (μ-CT) and acoustic emissions in the Sussex Permafrost Laboratory, coupled with statistical modelling of microcrack development using probability functions. Proof-of-concept was demonstrated by μ -CT for visualising in three dimensions the progressive growth and coalescence of microcracks and their transition to macrocracks. A novel approach was developed to define and quantify zones of microcracking during freeze–thaw cycling of anisotropic rock. This work elucidates the threshold behavior and order-of-magnitude increase in fracture rate and scale observed during early stages of fracture in certain limestone. The results from this work are now being prepared for publication.

United States of America

US Permafrost Association (https://www.uspermafrost.org/)

The Annual Meeting of the US Permafrost Association (USPA) and the Board of Directors meeting were held on December 11 at the 2018 Fall Meeting of the American Geophysical Union (AGU) in Washington DC. The Annual Meeting convened at the Fadó Irish Pub and was attended by approximately 135 members and their guests. Results of the BOD election were announced: New members are: John Zarling, Vice President; Susan Wilson, Secretary, Cathy Wilson, Board Member-at-Large. Continuing Board Members are Dmitry Streletskiy, Gerald Frost, Thomas Douglas, John Thornley, Frederick Nelson, Thomas Krzewinski. Matthew Whitley is the new PYRN Representative. Retiring Board members were Anna Liljedahl, Molly McGraw, Mark Demitroff, and Dan Vecellio. USPA paid membership has increased to approximately 100 including several non-US members: 68 regular members, 26 student/PRYN members, 5 corporate/institutional members, and include 7 lifetime members. The USPA Annual Report, prepared by Anna Liljedahl is available at https://www.uspermafrost.org/

The USPA, led by Tom Douglas, proposed to convene an IPA Regional Conference on Permafrost 11-16 July 2021 on the campus of the University of Colorado in Boulder. The proposed theme is "Permafrost Dynamics in Polar and Alpine Environments" and will include engineering themes. The International Permafrost Association has approved the invitation and national and international planning will commence in 2019.

The Association awarded 10 travel grants in 2018: Recipients of AGU travel grants were Mia Arvizu, Oregon State University; Stephanie James, US Geological Survey (USGS); Raven Mitchell and Kelsey Nyland, Michigan State University; Brianna Rick, Colorado State University; and Bianca Rodriguez-Cardona, University of New Hampshire, and the 2018 Andrew Slater Memorial Awardee was Risa Madoff, University of North Dakota (see photograph). The summer EUCOP travel awardees were Clayton Queen, Michigan State University; Rebecca Frei, Brigham Young University; and Matvey Debolskiy, University of Alaska Fairbanks.

Kristina Levine and Kate Hobart, students at Texas A&M University and supported by GW Scientific, prepared a compilation of all abstracts related to permafrost. The more than 340 abstracts in 138 paper and poster sessions were presented chronologically and were searchable in real time during the Fall Meeting on the USPA website.

The USPA and the American Geosciences Institute (AGI) jointly provide a monthly catalog of the world-wide, permafrost literature. The Permafrost Monthly Alert (PMA) program, initiated in 2012, produces professionally reviewed reference material on a monthly schedule and results are made available in multiple locations including the USPA web site. The seven-year collection contains 5,800 citations. The monthly accessions are uploaded by AGI to the Bibliography of Cold Regions Science and Technology (COLD), a searchable database that includes more than 29,000 permafrost references. For 2018, PMA content inquiries (views by individual readers) was the highest on record and exceeded 12,800 inquiries and over 59,500 inquiries since 2012. An AGU poster presentation provided details of the PMA program. During 2018, Arctic Foundations and GW Scientific supplemented USPA financial support. Michael Lilly, GW Scientific, Sharon Tahirkheli, American Geosciences Institute, and Jerry Brown are principal participants.
https://www.uspermafrost.org/monthly-alerts.shtml

Figure 1: Photograph of AGU travel grantees with Anna Liljedahl, USPA President (extreme right)

American Society of Civil Engineers

The ASCE Cold Regions Engineering Division (CRED) has five technical committees that assess and report on effects of cold regions environments upon engineering design, construction, and operations. The Publication Committee of CRED is responsible for editing the peer-reviewed *Journal of Cold Regions Engineering* (Jon Zufelt, editor) that publishes 25 to 30 refereed papers per year on topics related to permafrost and seasonal frost, ice engineering, construction, environmental quality, snow and ice control, and cold regions materials. The Environmental and Public Health Engineering Committee of CRED is currently updating the Cold Regions Utilities Monograph that's widely used as a reference by engineers working in permafrost regions. It is scheduled to be published in 2019.

ASCE co-sponsored the 2018 Arctic Technology Conference in Houston, TX on November 5-7 to discuss the latest technologies, responsibilities, and practices for responsible exploration and production in the Arctic where permafrost can be a major challenge.

This year, Ralph J. Hodek (Michigan Technological University) received the Harold R. Peyton Award for Cold Regions Engineering and Kenneth R. Johnson (Canadian consulting engineer and historian) received the Can-Am Civil Engineering Amity Award.

ASCE's Committee on Adaptation to a Changing Climate published a Manual of Practice entitled *Climate-Resilient Infrastructure: Adaptive Design and Risk Management* to provide guidance for developing or enhancing methods for infrastructure analysis and design in a world with a changing climate. Although permafrost is not directly addressed, the methodology for performing design of infrastructure projects can be extended to permafrost environments. Report submitted by Ed Yarmak and Tom Krzewinski.

U.S. Army Cold Regions Research and Engineering Laboratory (CRREL)

CRREL reports on a variety of active research and engineering projects. Extensive excavation was conducted at the Permafrost Tunnel near Fairbanks. The North Tunnel (old Tunnel) was connected to the South Tunnel with an 83m cross-cut and the South Tunnel was advanced forward by 12m. Planning progresses for Phase IV excavation to be conducted in winter 2019-20 with the ultimate goal to create a three dimensional test bed for geophysical and remotely sensed measurements of massive ice features. A variety of projects focused on geophysics, remote sensing, and vegetation continue at a variety of field sites across Alaska. Engineering design and infrastructure siting support continues at Thule, Greenland, including remediation design for thaw-affected structures. Site investigations on permafrost terrain were conducted to support the Eielson Air Force Base F-35A Beddown and expanded sensor development at the Chena Dam near Fairbanks. CRREL collaborated with the University of Alaska Fairbanks to conduct an analysis of permafrost thaw risk for 187 Alaska villages for the Denali Commission. CRREL organized a workshop with academics, industry, and government permafrost engineers to ascertain the State-of-the-Practice, determine knowledge gaps, and propose topics for future research. A multi-year project focused on remediation at sites near Barrow (Utqiaġvik) continues. Report submitted by Kevin Bjella and Tom Douglas.

U.S. Geological Survey (USGS)

The USGS, in collaboration with university, federal and independent partners, conducts fundamental research on hydrology, geology, soils, chemistry, and biology of permafrost and permafrost-affected environments to provide science for decision support to conserve land and water. The USGS has ongoing research throughout Arctic and boreal ecosystems of the northern circumpolar, where a suite of geophysical techniques and ecosystem surveys are judiciously used to monitor permafrost properties, conditions and landscape dynamics that exert strong controls on socioenvironmental systems.

USGS scientists continue to evaluate the effects of disturbance and climate on permafrost, soil physical, and hydrological conditions, and model surface and subsurface water distribution, flow, and water availability. Carbon cycling studies (both aquatic and terrestrial) are being conducted at lakes within the Yukon Flats National Wildlife Refuge, Kenai NWR, watersheds along the Dalton Highway, the Brooks Range, the Arctic Coastal Plain and at the Bonanza Creek LTER. Year-round studies are being conducted to characterize permafrost distribution and vulnerability from thermal characteristics using boreholes, water characteristics including groundwater, carbon sources and sinks in permafrost-impacted systems, including methane, nitrous oxide and dissolved organic carbon, and mapping of vegetation, active layer depths, and coastal erosion. Permafrost degradation and landscape change in Alaska are quantified through analyses of remote sensing data, geophysical data, wetland macrofossil analysis, field observations, and modeling. The group continued studies linking warming and permafrost thaw to biological responses, including beaver, waterfowl, and soil microbial communities. Detailed permafrost DNA and chemical analyses of pan-Arctic permafrost soils are being conducted as a reference for paleoecology, astrobiology, and biogeochemistry.

USGS research has been extended to the larger research community and land managers through synthesis activities with the Permafrost Carbon Network, the USPA, the NCA4, the SOCCR report, and NASA ABoVE. USGS researchers have presented their findings in a series of journal articles

and data releases, and national and international meetings including ASLO, EUCOP, and AGU. Report submitted by Mark Waldrop.

University of Alaska Fairbanks

Geophysical Institute Permafrost Laboratory

The main 2018 activity in the program "Thermal State of Permafrost" was focused on maintaining observations on the existing network that currently includes approximately 300 near-surface and deeper boreholes in Alaska, Canada, Greenland, and Russia. A limited number of new sites were instrumented. In Alaska, six shallow sites were instrumented by Vladimir Romanovsky and Alexander Kholodov as a part of the project "Alaska Reburn". Kholodov instrumented two more shallow sites to extend the existing observation transect at the Smith Lake area near Fairbanks. In Russia, Heather Alexander (Mississippi State University), in collaboration with Valentin Spektor (Melnikov Permafrost Institute) drilled and instrumented two 15-meters deep boreholes in the town of Chersky. Under the US National Science Foundation-funded project "Vegetation Impact on Permafrost" Kholodov instrumented eight shallow sites in the Pleistocene Park to assess the possible effects of grazing animals on the thermal balance of the ground surface. See the Permafrost Laboratory website for additional activities: permafrost.gi.alaska.edu/

Water and Environmental Research Center, Institute of Northern Engineering

The NSF announced funding for three new projects in 2018 that focus on ice-rich permafrost landscapes and their dynamics across the Arctic. These studies include catastrophic thermokarst lake drainage (Arp, Jones, Kanevskiy), ice wedge mapping and dynamics (Liljedahl, Shur, Kanevskiy), and the transition zone of the upper permafrost (Shur, Kanevskiy). Additional support for coastal permafrost research is being provided by Sandia National Laboratory (Jones) and by NSF for a coastal permafrost research coordination network (Jones). NASA EPSCoR also provided funding for a remote sensing project focused on historic and potential future thermokarst lake drainage in northern Alaska (Jones). WERC researchers contributed more than 30 journal publications and more than 50 scientific presentations on permafrost in 2018. Report submitted by Ben Jones.

George Washington University, Northern Michigan University, Michigan State University

The NSF recently announced funding for another five-year phase of the Circumpolar Active Layer Monitoring (CALM) program in Alaska and Russia. Nikolay Shiklomanov will continue to serve as lead PI, with Dmitry Streletskiy, Frederick Nelson, Grant Gunn, and Anna Klene as senior personnel. With this most recent award the project will have been funded by NSF for 25 consecutive years.

The CALM program is a network of active layer observatories located throughout both polar regions and select mid-latitude mountain ranges. The program is focused on assessing the long-term response of the active layer and near-surface permafrost to climate change. CALM recently marked its 25th anniversary, with continuous operation of observatories in North America, Europe, and Asia since the early 1990s (more information available at www.gwu.edu/~calm/).

The CALM V phase of the project will focus on several interrelated objectives: (1) maintain established programs of long-term active layer, near-surface permafrost, landscape, and geomorphologic observations in existing regional networks; (2) expand CALM networks to representative cold-region sites with strategic emphasis on currently unrepresented regions and on co-location with sites in the Thermal State of Permafrost (TSP) borehole network: (3) expand the range of environmental parameters measured at CALM sites; (4) continue development and refinement of data management and archiving activities and strategies and provide data management and archiving support; and (5) expand present CALM educational activities and outreach for the program.

Next-Generation Ecosystem Experiments (NGEE Arctic)

The Department of Energy, Office of Science Next-Generation Ecosystem Experiments (NGEE Arctic) project launched its eighth year in 2018 by continuing to build strong relationships with the broader permafrost community. NGEE scientists partnered with academics from across the US and around the world to chair seven sessions at the AGU annual meeting. Scientists on the NGEE Arctic project are engaged in a number of new and ongoing synthesis activities within the Permafrost Carbon Network. NGEE Arctic co-PI, Cathy Wilson from Los Alamos National Laboratory, serves on the SEARCH Permafrost Action Team and is a newly elected member of the USPA Board. In that role Cathy will work toward growing the diversity of USPA's membership and the development of closer relationships between the USPA and permafrost research organizations. Report submitted by Stan Wullschleger and Cathy Wilson.

Permafrost Carbon Network

The Permafrost Carbon Network (PCN) (www.permafrostcarbon.org) hosted two workshops in 2018 on 'Reconciling Historical and Contemporary Trends in Terrestrial Carbon Exchange of the Northern Permafrost-Zone' at the Arctic Data Center and National Center for Ecological Synthesis and Analysis in Santa Barbara, California. These two workshops brought together international experts on ecosystem dynamics to synthesize an observational time series of ecosystem-atmosphere carbon exchange from the 1990s to the present day.

The PCN also hosted its 8th Annual Meeting prior to AGU in Washington, DC. The latest on permafrost carbon science was presented in 18 science speed-talks to an audience of 120 scientists. Many of these brief presentations laid the foundation for nine breakouts in the afternoon during which details for data collection, spatial data representation, analysis procedures, people to involve, and timelines were discussed. Current synthesis activities of the PCN focus on 1) reducing uncertainty in carbon pools in permafrost and upscaling carbon stocks in Arctic river deltas, 2) building a decadal-scale time series of ecosystem-atmosphere arctic/boreal carbon exchange through synthesis, 3) identifying thaw-induced changes to the permafrost microbiome, and 4) improving visibility and outreach opportunities on permafrost carbon to the public and decision makers.

Multiple science syntheses were spearheaded by the PCN. A model intercomparison project for permafrost-enabled models simulates changes in permafrost and carbon storage in the northern permafrost regions from 2010-2299. The results show that controlling greenhouse gas emissions in the coming decades could substantially reduce the consequences of carbon release from thawing permafrost during the next 300 years.

Several synthesis papers were published: McGuire AD et al. The dependence of the evolution of carbon dynamics in the Northern Permafrost Region on the trajectory of climate change, *Proceedings of the National Academy of Sciences,* 115, (15), 3882-3887 and Loranty MM et al. Reviews and syntheses: Changing ecosystem influences on soil thermal regimes in northern high-latitude permafrost regions, *Biogeosciences* 15 5287–313.

Related activities of the Permafrost Action Team resulted in three published 'Arctic Answers' focused on 1) Climate change and the permafrost carbon feedback, 2) How is permafrost degradation affecting ecosystem services? 3) How is permafrost degradation affecting infrastructure. Arctic Answers provide scientific information in a format that can be used by scientists, stakeholders, policy- and decision-makers, as well as students and journalists. https://www.searcharcticscience.org/arctic-answers. The Permafrost Collaboration Team of the Interagency Arctic Research Policy Committee (led by Miriam Jones, USGS; Christina Schaedel, Northern Arizona University; Benjamin Jones, University of Alaska Fairbanks) hosted a number of webinars focused on Modeling of Permafrost, the Well-being of Arctic Residents, and Regional Security. Report submitted by Christina Schädel and Ted Schuur, Northern Arizona University

Permafrost Young Researchers Network (PYRN)

In late 2017 several young permafrost researchers created a North American chapter of PYRN (PYRN-NA) which successfully links young permafrost researchers in North America to information about upcoming conferences, workshops, funding opportunities, and recent publications. More information can be found at pyrnna.wordpress.com

At the AGU Fall Meeting, PYRN-NA teamed up with the US Association of Polar Early Career Scientists (USAPECS) to host a panel on Diversity and Inclusivity in the Polar Sciences. The panel included Emilie Sinkler (UAF), Kaare Erickson (Ukpeaġvik Iñupiat Corporation--Science), Allison Mattheis (CSULA), and Marilyn Raphael (UCLA) who all provided unique perspectives on: (1) the current challenges facing minority groups and women in the polar sciences, such as barriers to entry for underrepresented groups, sexual harassment at work and in the field, and representation of indigenous knowledge in the polar sciences; (2) what we as individuals can do to bring these issues to the forefront of conversations in scientific organizations and universities; and (3) strategies to promote diversity and inclusion of underrepresented perspectives in the polar sciences. The successful panel resulted in a larger turnout than the room could comfortably hold! Report submitted by Matthew Whitley.

Individual Member Activities

Mark Demitroff, Stockton University, is working on past permafrost and Pleistocene wind action across the mid-Atlantic region; coauthored a book chapter on a Clovis mastodon kill site in New York; co-led a PALSEA/QUIGS (PAGES-INQUA) joint-meeting field trip on Quaternary periglacial dynamics; and has a book due in 2019 on the paleoperiglacial legacy of the Pinelands National Reserve.

Matthew Whitley, newly appointed USPA PYRN representative, published his thesis work at the University of Alaska Fairbanks, based on research with the US ABoVE group: Assessment of LiDAR and Spectral Techniques for High-Resolution Mapping of Sporadic Permafrost on the Yukon-Kuskokwim Delta, Alaska.

Reginald Muskett, Research Associate, Geophysical Institute, University of Alaska Fairbanks, continues research on geodesy, geophysics and remote sensing and included: "To Measure the Changing Relief of Arctic Rivers: A Synthetic Aperture RADAR Experiment in Alaska," and a presentation (Pol-SAR) at the 2018 Annual Meeting of the Geological Society of America.

In Memoriam:
Florence Rooney, Anchorage, Alaska
Michael Walegur, Moorpark, CA

Complied and edited by: Susan Wilson (Secretary), Molly McGraw, and Jerry Brown, US Permafrost Association