49th International Arctic Workshop 2019

3-5 April | Stockholm University, Sweden
Program and Abstracts

49th ANNUAL
INTERNATIONAL
ARCTIC WORKSHOP

April 3rd-5th, 2019

Stockholm, Sweden

Stockholm University, Sweden

Organising Committee:
Karin Ebert
Sarah Greenwood
Stefan Wastegård
Frescati Campus and Geoscience buildings (Geohuset):
Introduction

Overview and history
The annual International Arctic Workshop has grown out of a series of informal annual meetings started by John T. Andrews and sponsored by the Institute of Arctic and Alpine Research (INSTAAR) of the University of Colorado, Boulder, US. The 49th Arctic Workshop is held 3-5 April, 2019, on the campus of Stockholm University, Stockholm, Sweden. The meeting is sponsored and hosted by the Bolin Centre for Climate Research and the Department of Geological Sciences, Stockholm University, Sweden.

Workshop website: https://aw19.geo.su.se/

Check-In / Collection of name badge
Please check in and collect your name badge on either Wednesday evening at the Icebreaker between 18.00 and 21.00, or on Thursday morning between 8.30 and 9.00, outside De Geer hall in the Geoscience building (Y-wing) on Stockholm University Campus. If you ordered a printed version of the program and abstracts book you will receive it when you collect your name badge. At registration, you will receive information on where to set up your poster.

Presentation files (Powerpoint/pdf)
Please load your oral presentation onto our computer during the Icebreaker on Wednesday evening or the Check-In on Thursday and Friday morning. Time during breaks is limited.

Wi-Fi: Eduroam wifi is available on campus. SU additionally has an ‘open’ wifi network with guest log-in and authorisation.

Venue
The conference will take place in the Geoscience building of the Frescati Campus of Stockholm University (subway and bus stops ‘Universitetet’ or ‘Universitetet Norra’).

Talks and poster sessions will be held in and opposite the De Geer hall, in the Y-wing of the Geoscience building.

Catering and social events will all be offered on campus: lunch will be provided at Lantis restaurant; the student pub will be in U1 (Geoscience building); and the conference dinner will be hosted by the Stockholm University Faculty Club.
# Arctic Workshop 2019

## Program summary

### Wednesday 3 April 2019

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<thead>
<tr>
<th>Time</th>
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<tr>
<td>18.00-21.00</td>
<td>Icebreaker. Check-in, name badge, presentation upload, poster set up.</td>
<td>Outside De Geer hall</td>
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### Thursday 4 April 2019

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<tr>
<td>08.30-09.00</td>
<td>Drop-in/presentation upload</td>
<td>De Geer hall</td>
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<tr>
<td>09.00-09.15</td>
<td>Introduction + welcome</td>
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<tr>
<td>09.15-10.30</td>
<td>Presentation session I</td>
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<td>10.30-11.00</td>
<td>Coffee</td>
<td>Outside De Geer hall</td>
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<td>11.00-12.30</td>
<td>Presentation session II</td>
<td>De Geer hall</td>
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<td>12.30-13.45</td>
<td>Lunch</td>
<td>Lantis restaurant (on campus)</td>
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<tr>
<td>13.45-14.15</td>
<td>Brief poster introductions</td>
<td>De Geer hall</td>
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<td>14.15-16.15</td>
<td>Poster session</td>
<td>Y22 and 23</td>
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<td>15.00-15.30</td>
<td>Coffee</td>
<td>Outside De Geer hall</td>
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<tr>
<td>16.15-17.30</td>
<td>Presentation session III</td>
<td>De Geer hall</td>
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<td>17.30</td>
<td>End of conference day</td>
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<tr>
<td>18.00-20.30</td>
<td>Student pub</td>
<td>U1 Geoscience building</td>
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# Program details

## Wednesday 3 April 2019

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<tr>
<td>18.00-21.00</td>
<td>Icebreaker. Check-in and collect your name badge. Mingle, load your presentation on the laptop, and/or set up your poster. We serve snacks and drinks, including wine.</td>
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## Thursday 4 April 2019

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| 09.00-09.15 | Welcome and introduction  
Karin Ebert, Sarah Greenwood, Stefan Wastegård, the organisation committee. Nina Kirchner, co-director of the Bolin Centre for Climate Research. |

## Presentation session I  
*Chair: Stefan Wastegård*

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| 09.15 | Greenland Ice Sheet Ocean Interactions: recent results, challenges and perspectives as seen from the Wet Side  
Inga Monika Koszalka |
| 09.30 | Sedimentological and Faunal Evidence of Ice Shelves during the Early Holocene Deglaciation of Nares Strait  
Anne E. Jennings; Brendan Reilly; John T. Andrews; Kelly Hogan; Maureen Walczak; Joseph Stoner; Alan Mix; Martin Jakobsson |
| 09.45 | A widespread Laurentide Ice Sheet response to the Younger Dryas in the western Canadian Arctic?  
Mark F.A. Furze |
| 10.00 | Evolution and past dynamics of the northwest Greenland Ice Sheet  
Paul C. Knutz; Andrew M.W. Newton ; Mads Huuse; John R. Hopper ; Karen Dybkjær; Ulrik Gregersen; Emma Sheldon |
| 10.15 | The Ryder 2019 Expedition to Northern Greenland  
Martin Jakobsson; Larry Mayer, Ryder Expedition Scientific Party |
| 10.30 – 11.00 | Coffee |

## Presentation session II  
*Chair: Martin Miles*

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| 11.00 | Warm summers and rich biotic communities during N-Hemisphere deglaciation  
Karin F. Helmens |
| 11.15 | Intact Polar brGDGTs at Lake Qaupat, Baffin Island: Implications for Sources of the Paleotemperature Proxy  
Jonathan H. Raberg; Sarah Crump; de Wet, Gregory; Dildar, Nadia; Miller, Gifford H.; Sepúlveda, Julio |
| 11.30 | Lipid biomarkers quantify Holocene temperature in Icelandic lakes and soils  
David J. Harning; Lorelei Curtin; Áslaug Geirsdóttir; Gifford H. Miller; William J. D’Andrea; Thor Thordarson; Sigurveig Gunnarsdóttir; Julio Sepúlveda |
11.45  Leaf wax hydrogen isotope reconstruction of Holocene precipitation seasonality in High Arctic Svalbard  
Sofia E. Kjellman; Anders Schomacker; Elizabeth K. Thomas; Lena Håkansson; Sandrine M. Duboscq; Allison Cluett; Wesley R. Farnsworth; Lis Allaart; Owen Cowling

12.00  Dissecting complex Holocene ice cover histories on Baffin Island  
Simon Pendleton; Gifford H. Miller; Nicolás Young

12.15  Timing of cryosphere expansion across Baffin Bay compared to a 2 ka CESM1 transient simulation: a data-model comparison  
Gifford H. Miller; Simon Pendleton; Scott Lehman; Alexandra Jahn; Yafang Zhong; Jason Briner; Avriel Schweinsberg

12.30 – 13.45  Lunch

Poster session:
13.45 - 14.15  Quick-fire poster introductions (1-2 minutes), De Geer hall.  
Chair: Sarah Greenwood
14.15 - 16.15  Poster exhibition (all posters), Y22 + Y23.
15.00 - 15.30  Coffee available

Quick-fire intros:

#42  High resolution hydroclimatic reconstruction from annually laminated Holocene proglacial lake sediments, Linnévatnet, Svalbard  
Michael Retelle; Francois Lapointe; Raymond Bradley

#44  A Multiproxy, Varve-Derived Chronology of a Svalbard Lacustrine Sediment Core  
Roman M. Ackley

#46  Population residing on permafrost in the circumpolar Arctic  
Justine Lucille Ramage; Leneisja Jungsberg; Eeva Turunen; Shinnan Wang; Timothy Heleniak

#48  High resolution mapping of Permafrost Landforms and soil properties at catchment scale, Beaufort coast (NW Canada)  
Julia Wagner; Gustaf Hugelius; Niek Speetjens; Andreas Richter; Victoria Sophie Martin; Rachele Lodi

#50  The impact of permafrost forecasting accuracy on predicting the influence of Arctic vegetation type and disturbance events on permafrost degradation  
Marion A. McKenzie; Vladimir E. Romanovsky; Alexander L. Kholodov

#53  The current state of landscape-geochemical systems of West Spitsbergen Island  
Tatiana Kuderina; Tertitski Grigory

#55  Occurrences of the Vedde Ash in meltwater-fed basins imply a late Younger Dryas maximum ice-sheet extent in the Trondheimsfjorden region, central Norway  
Simon A. Larsson; Stefan Wastegård; Fredrik Høgaas

#57  The Veiki moraines - A key to the glacial history of northern Scandinavia  
Mimmi Adina Lindqvist; Helena Alexandersson
#59 Developing new proxies for an under-utilized archive, glacial marine diamict: a pilot study from West Greenland
Andrew J. Christ; Paul Bierman; Lee B. Corbett; Paul C. Knutz; Julie C. Fosdick; Elizabeth K. Thomas

#61 Provenance of iceberg derived material during Greenland stadials and interstadials in Marine Isotope Stage (MIS) 3
Lisa Griem; Craig D. Storey; Trond M. Dokken; Eystein Jansen

#63 Amino acid racemization geochronology using foraminifera from the Yermak Plateau
Gabriel West; Matt O'Regan; Darrell Kaufman; Katherine Whitacre

#65 Paleoceanographic evolution of the Eastern Baffin Bay during the Mid to Late Holocene
Katrine Elnggaard Hansen; Jaques Giraudeau; Guillaume Massé; Arka Rudra; Hamed Sanei; Christof Pearce; Marit-Solveig Seidenkrantz

Presentation session III

16.15 Melttown: Side-effects of globalization in Longyearbyen, Svalbard
Zdenka Sokolickova

16.30 Arctic energy futures: decentralized renewable energy solutions in the Russian Arctic
Maria Morgunova; Dmitry Solovyev

16.45 Patrimonialization in South Greenland: farms, mine, and ruins.
Pia Bailleul

17.00 APECS - Association of Polar Early Career Scientists - Sweden
Julia Wagner; Julia Kukulies; Corinna Röver; Lina Rasmusson; Berta Morata; Samo Grasic; Camilla Winqvist; Linus Lundström; Daniel Emanuelsson; Martin Mohrmann

17.15 Opening the review of IPCC reports to Early Career Scientists
Paul Rosenbaum; Mathieu Casado; Gwenaelle Gremion; Jilda Alicia Caccavo; Kelsey Aho; Nicolas Champollion; Sarah Connors; Adrian Dahood; Alfonso Fernandez; Martine Lizotte; Katja Mintenbeck; Elvira Poloczanska; Gerlis Fugman

C. 17.45 – 20.30 Student pub!
Friday 5 April 2019

08.30-09.00  Load your presentation on the laptop and/or set up your poster.

09.00-09.15  Welcome and introduction
   The organisation committee - practical information
   Gifford Miller: next year’s 50th Arctic Workshop at INSTAAR

Presentation session I  Chair: Martin Jakobsson

09.15  Arctic Straits Volume Transports: Forcing and Response
   Agatha de Boer; Estanislaio Gavilan Pascual-Ahuir; David P. Stevens; Léon Chafik; David K. Hutchinson; Qiong Zhang; Louise C. Sime; Andrew J. Willmott

09.30  Sea-ice dynamics and biogeochemical cycling in the eastern Bering Sea over the last 30 ka
   Henrieka Detlef; Sindia M. Sosdian; Simon T. Belt; Lukas Smik; Caroline H. Lear; Ian R. Hall; Sev Kender; Christof Pearce; Melanie J. Leng

09.45  Persistent late Holocene multi-decadal variability in ocean-atmosphere dynamics in the Chukchi Sea, western Arctic Ocean
   Matt O’Regan; Francesco Muschitiello; Christian Stranne; Johan Nilsson; Agatha de Boer; Martin Jakobsson

10.00  Identifying and understanding the ecological preferences of the most abundant planktonic foraminifera in the Arctic Ocean: a combined approach
   Mattia Greco; Julia Jonkers; Julie Meilland; Kasia Zamelczyk; Michal Kucera

10.15  Investigation of the relationship between primary production and sea ice in the Barents and Kara Seas
   Stanislav D. Martyanov; A. Yu Dvornikov; V.A. Ryabchecnko; D.V. Sein; S.M. Gordeeva

10.30 – 11.00  Coffee

Presentation session II  Chair: Gifford Miller

11.00  Impacts of environmental temperature on the stability of terrestrial communities and food webs
   Sinikka I. Robinson; Órla B. McLaughlin; Bryndís Marteinsdóttir; Eoin J. O’Gorman

11.15  Understanding Changes in Hydroclimate-Dependent Outbreaks of Infectious Diseases in High-Latitude Regions
   Yan Ma; Arvid Bring; Zahra Kalantari; Georgia Destouni

11.30  Spatial modelling of soil organic carbon stocks in West Greenland
   Philipp Gries; Thorsten Behrens; Thomas Scholten; Peter Kühn; Karsten Schmidt

11.45  Distribution of carbon and nitrogen along hillslopes in three valleys on Herschel Island, Yukon Territory, Canada
   Justine L. Ramage; Daniel Fortier; Gustaf Hugelius; Hugues Lantuit; Anne Morgenstern

12.00  Waterborne transport in the active layer of permafrost environments
   Andrew Frampton; C. Schuh; P. Kuhry; A. Hodson; H. H. Christiansen
12.15 – 13.45  Lunch

**Poster session:**

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**Quick-fire intros**

#41  Greenlandic aeolian dust deposits dated using several luminescence techniques and radiocarbon
    L. Petter Hällberg; Thomas Stevens; Andrew S. Murray; Daniele Sechi; Mihály Molnár; Jan-Pieter Buylaert; Titanilla G. Kertész; Giulia Cossu; Stefano Andreucci; Vincenzo Pascucci

#43  Coarse-grained mineral dust deposition records in alpine lakes suggest more frequent tornadoes during warmer intervals of the late Holocene period in arid and semi-arid tracts of North America.
    Anne Bennett; Alejandra Pedrazza; Elora Werner; Tyler Vollmer; Atreyee Bhattacharya; Tom Marchitto; Elana Leithold; Aradhna Tripati

#45  Holocene landscape disturbances in the central highlands of Iceland as recorded in soil sediment archives
    Lori A. Berberian; Darren J. Larsen; Ian Van Dusen; Thorvaldur Thordarson; Ásleig Geirsdóttir; Gifford H. Miller

#47  The influence of frozen ground on the productivity of Rhododendron groenlandicum in the Alaskan boreal forest
    Barbara Bevacqua; Alexander Kholodov; Katie Spellman

#49  Primary succession process and changes of soil properties along foreland of Irenebreen (NW Svalbard)
    Paulina Wietrzyk-Pelka; Michał Węgrzyn; Wojciech Szymański

#51  The First Svalbard Holocene Assembly: Introducing the SVALHOLA Network
    Wesley R. Farnsworth; the SVALHOLA Network

#54  Water chemistry responses to different types of bedrock in Foxfonna and Linnédalen, Svalbard, Norway
    Elina Kuusma; Alexander Kholodov; Katie Spellman

#56  Using streamlined landforms to reconstruct and compare paleo-ice flow paths in Bárðardalur, north Iceland and northwestern Pennsylvania
    Marion A. McKenzie; Sarah M. Principato; Ívar Örn Benediktsson

#58  Reconstructing the central sector of the Cordilleran Ice Sheet through the last glacial period
    Helen Elizabeth Dulfer; Martin Margold; Zbyněk Engel

#60  Late Holocene IRD fluctuations in the fjord Ata Sund, West Greenland, record rapid glacier response to changes in water temperature
    Fanny Maria Ekkblom Johansson; David J. Wangner; Camilla S. Andresen; Jostein Bakke; Eivind Nagel Støren; Sabine Schmidt; Andreas Vieli
#62 New radiocarbon reservoir ages from coastal Greenland waters and the eastern Arctic Ocean
Christof Pearce; Ronja Cedergreen Forchhammer; Alexis Geels; Karen Søby Nielsen; Mériadec le Pabic; Jesper Olsen

#64 Timing and paleoceanographic impacts of the onset of Arctic-Baffin Bay throughflow during the Holocene
Anne E. Jennings; John T. Andrews; Lineke Woelders; Alexandra Jahn; Thomas Marchitto; Julio Sepúlveda; Benoit Lecavalier; Guillaume St. Onge

#66 Freshwater content in the Arctic Ocean and summer warmings
Anastasia Vyazilova; Genrikh Alekseev; Alexander Smirnov

Presentation session III
Chair: Anne Jennings

16.15 Land uplift in Fennoscandia - from the last ice age into 2100
Maaria Nordman; Havu Pellikka; Glenn Milne; Mirjam Bilker-Koivula

16.30 The Holocene glacial history of the Greenland Ice Sheet in Melville Bay based on 10Be exposure dating and 14C radiocarbon dating
Anne Sofie Søndergaard; Nicolaj Krog Larsen; Kurt H. Kjær

16.45 Wijdefjorden and Femmilsjøen - a fjord-lake study in northern Spitsbergen
Lis Allaart; Anders Schomacker; Matthias Forwick; Tom Arne Rydningen; Wesley R. Farnsworth; Juliane Müller; Michael Retelle; Lena Håkansson; Skafti Brynjólfsson; Sofia E. Kjellman

17.00 Glacigenic landforms and sediments in Store Koldewey Trough, NE Greenland - preliminary results
Ingrid Leirvik Olsen; Matthias Forwick; Jan Sverre Laberg; Tom Arne Rydningen; Katrine Husum

17.15 Early Holocene ice-dammed lakes in Arctic Sweden and the location of the last Scandinavian Ice Sheet remnants
Carl Regnéll

17.30 Mapping Arctic Lakes Using Small-size Autonomous Surface Vehicles
Elias Strandell Erstorp; Nina Kirchner; Jakob Kutenkeuler

17.45 Concluding words

18.30 – 21.00 Conference dinner
Greenland Ice Sheet Ocean Interactions: recent results, challenges and perspectives as seen from the Wet Side

Inga Monika Koszalka\textsuperscript{1,2}; ikoszalka@.geomar.de

1. Department of Meteorology, Stockholm University, Sweden
2. GEOMAR Helmholtz Centre for Ocean Research, Kiel, Germany

More than 25\% of global sea level rise is caused by mass loss from the Greenland Ice Sheet. A significant part of this loss is attributed to interactions between marine terminating glaciers and surrounding warm ocean waters. These interactions involve complex and regionally varying processes (subglacial discharge, tidal forcing, basal and frontal melt, buttressing, buoyancy-driven circulation, nonlocal ocean circulation) that are hard to observe in harsh polar conditions and are elusive to numerical representation. A reliable parameterization of ice sheet-ocean interactions in global climate models has been identified as the major challenges for future climate predictions and dedicated international working groups have been called upon to address it.

In this contribution, I will present results from a modeling study done in collaboration with the Johns Hopkins University about warm water advection toward the Helmheim and the Kangerdlugssuaq glaciers, as well as results from my recent German project about warm water pathways to the 79-North Glacier (East Greenland). These lead to a common conclusion that propagation of the observed warming signal in central ocean basins toward the Greenland glaciers involves multiple oceanic pathways, eddy mixing processes and a modulation by wind forcing, and is thus hard to monitor and predict. I will also highlight main findings from my German project partners about processes at the ice-ocean interface of the 79-North Glacier. Finally, I will give a broader context to these results in view of insights from the Workshop on Greenland Freshwater Fluxes organized by the GRISO working group and held at the last AGU Fall Meeting (December 2018).
Sedimentological and Faunal Evidence of Ice Shelves during the Early Holocene Deglaciation of Nares Strait

Anne E. Jennings¹; anne.jennings@colorado.edu
Brendan Reilly², John T. Andrews¹, Kelly Hogan³, Maureen Walczak², Joseph Stoner², Alan Mix², Martin Jakobsson⁴

1. INSTAAR University of Colorado USA
2. CEOAS, Oregon State University, USA
3. British Antarctic Survey, UK
4. Stockholm University, Sweden

During marine research expedition OD1507 with Swedish icebreaker Oden in summer 2015, a.k.a. Petermann 2015 Expedition, sediment cores and surface samples were collected from northern Nares Strait (Hall Basin and Robeson Channel) and from Petermann Fjord, including cores obtained beneath the modern ice tongue at sites 15 and 25 km from the grounding line; these cores and surface samples provide key information to identify a modern ice tongue/ice shelf facies and support interpretation of deglacial ice shelves in northern Nares Strait. We use CT (computed tomography) imaging, sediment grain size, and foraminiferal assemblages to assess sub ice-tongue sediment and faunal characteristics. Sediment mineralogy of the < 2 mm fraction provides insight into the varying importance of different glacial sources during the deglaciation. Under the modern ice tongue, sediments exposed to the grounding line are strongly laminated with no visible bioturbation and devoid of coarse clasts. The coarsest laminae comprise very fine sand and coarse to medium silt while the finer parts of the laminae are composed of very fine silt to clay. Multicore tops distributed in Petermann Fjord have abundant, diverse fauna beyond the ice tongue, dominated by Elphidium excavatum and Cassidulina neoteretis. The foraminifers in the upper 2 cm beneath the ice tongue are diverse, low abundance, mainly very small specimens and dominated by agglutinated taxa.

We use the information about the modern sub ice tongue environment to infer the past presence of ice shelves using four radiocarbon dated cores from several cruises (OD1507, HLY03, and 2001LSSL) that were studied in detail. Beneath a bioturbated mud unit covering much of the Holocene, all cores contain a thick, distinctly laminated silt and clay unit with rare coarse clasts and rare foraminifera. We hypothesize from comparison with the modern sub ice tongue facies and biostratigraphy in Petermann Fjord, that the widespread laminated clay unit was deposited beneath ice shelves extending from coalescent Humboldt and Petermann glaciers. The laminated clay unit documents intervals of ice-shelf instability/grounding line retreat with presence of IRD layers that coincide with shifts in sediment mineralogy and foraminiferal abundance peaks that were large enough to be radiocarbon dated. Over the time period represented by the laminated sediments of the four cores, four ice shelf disintegration/IRD events were identified. These are dated c.: 9.4-9.5; 9.0; 8.5 and 7.2 cal ka BP. We present grounding line position and ice shelf extent changes for Hall Basin, that lead by 8.5 cal ka BP to collapse of the Kennedy Channel ice stream and opening of the connection between the Arctic Ocean and Baffin Bay.

This research is funded by National Science Foundation PLR-ANS 1417784.
A widespread Laurentide Ice Sheet response to the Younger Dryas in the western Canadian Arctic?

Mark F.A. Furze¹; mark.furze@unis.no

1. Arctic Geology, The University Centre in Svalbard, Norway

In the eastern Canadian Arctic Archipelago (CAA), chronologically constrained records of end Pleistocene deglaciation and Holocene ice margin oscillations show little evidence for the Younger Dryas (YD) cold interval (12.9-11.7 ka BP - an event otherwise widely recognised from the circum-North Atlantic and beyond. Until recently, glacial behaviours coincident with, or in direct response to, the YD in the central and western CAA have been documented only from very limited and ambiguous terrestrial and marine records. This has made any assessment of the impact of the YD as a climate event (as opposed to a chronological interval) on the western and central Arctic margins of the Laurentide and Innuitian ice sheets difficult to determine. However, new work over the last five to ten years has now begun to outline what appears to be a record of re-advance along the northern-central and northwestern margins of the Laurentide Ice Sheet (LIS) coincident with and immediately following the end of the YD chronozone. This talk explores the latest evidence based on geomorphic, marine sediment core, and seismic data from the central and western regions to suggest that, not only did the Arctic sector of the Laurentide Ice sheet respond to the YD, but that this response was dramatic and expansive, marked by the rapid establishment and subsequent collapse of multiple extensive floating ice shelves. Further, that this behaviour had major dynamical implications for the stability of the LIS following the YD. Given the proximity of the western CAA to regions implicated in the initiation of the YD event, a linked response to YD forcing mechanisms can be entertained. And while much more work remains to be done to determine the detailed response of the Laurentide margin and to further constrain chronologies, a region-wide YD response is now emerging as a meaningful hypothesis.
Evolution and past dynamics of the northwest Greenland Ice Sheet

Paul C Knutz¹; pkn@geus.dk
Andrew M. W. Newton², Mads Huuse³, John R. Hopper¹, Karen Dybkjær⁴, Ulrik Gregersen¹, Emma Sheldon⁴

1. Geophysics Department, GEUS, Denmark
2. School of Natural and Built Environment, Queen’s University Belfast, UK
3. School of Earth and Environmental Sciences, University of Manchester, UK
4. Stratigraphic Department, GEUS, Denmark

The continental margins of Greenland are covered by extensive, thick sedimentary successions that represents an archive of as-yet unrealized potential for reconstructing the evolution of the Greenland Ice Sheet. In northeast Baffin Bay, the Melville Bugt and Upernavik trough-mouth fans (TMF) form prominent examples, deposited by ice streams that over millions of years have eroded the bedrock of northwest Greenland. Extensive coverage of high-quality 2D and 3D seismic data collected by industry provides outstanding imaging of glacial sediment progradation, grounding zone wedges, and pre-glacial marine deposits formed by along-slope currents. A complete seismic-stratigraphic mapping of the prograding units records eleven major phases of shelf-edge advance and associated lateral shifts in glacial depocentres. Based on seismic ties to available wells and boreholes a simple age model has been created that constrains the first phase of shelf-edge ice advance to the latest Pliocene, likely around 2.7 Ma. The results suggest that an abrupt change in ice flow conditions occurred during the Mid-Pleistocene Transition ~1 Ma. This is marked by a change from uniform ice advance across the shelf margin to focused ice streams contained within precursors of the present-day glacial troughs. Both tectonic and climatic changes may have influenced the long-term development of the glacial outlet system. We surmise, however, that the observed shifts in glacial depocentres could have been triggered by marine transgressions during prominent interglacials. To test this hypothesis and to unravel Greenland Ice Sheet dynamics during past warm climates, an IODP drilling proposal has been submitted (proposal 909-Full2). This presentation demonstrates the key results from seismic mapping and briefly outlines the plan for deep drilling along a transect in NE Baffin Bay.
The Ryder 2019 Expedition to Northern Greenland

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The Ryder 2019 Expedition with the Swedish icebreaker Oden targets the yet unexplored waters where the Ryder, Stensby, and C.H. Ostenfield glaciers drain the northwestern Greenland Ice Sheet into the ocean. The expedition is supported by the Swedish Polar Research Secretariat and is planned to take place between Aug 3 and Sept 8, Thule-Thule, northwest Greenland. Since no vessel has entered these fjords before, the expedition faces the major challenge of entering completely uncharted waters with the 108 m long and 8 m deep-drafting icebreaker Oden. In order to meet this challenge, an autonomous Echobot from Seafloor Systems Inc. will be used for the reconnaissance surveys ahead of the Oden. The Echobot is a small (1.7 x 0.8 m), light (30kg), autonomous vehicle equipped with a multibeam sonar integrated with a precise GPS positioning system. It can be operated either fully autonomously or remotely (through a remote control system) and telemeter data back over ranges up to 2 km with an endurance of 7 to 8 hours. The Echobot can be transported by helicopter and operated from shore or an ice flow to map nearby areas. In addition, a pre-study using satellite images of iceberg movements in the fjords have been carried out in order to identify areas where iceberg grounds. Seafloor mapping in one of the least mapped marine regions in the world will also contribute to a new endeavor, the Nippon Foundation – GEBCO - Seabed 2030 project, which has the vision of mapping 100 % of the World Ocean floor by 2030.

The Ryder 2019 Expedition is multidisciplinary with components involving the fields of biology, climatology, geology, geophysics, geochemistry, glaciology, oceanography, meteorology and paleoceanography. Here we present the components that together address scientific questions related to the history and stability of the marine cryosphere of northwestern Greenland and its role in global climate change and sea-level rise. This part of Ryder 2019 Expedition builds on the successful Petermann 2015 Expedition with Oden, which mapped and sampled the realm of Petermann Glacier, locater further south.
Warm summers and rich biotic communities during N-hemisphere deglaciation

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We explore an overlooked area in paleo-research, i.e. using fossil remains preserved in glacial lake sediments to make detailed paleo-environmental and -climate reconstructions during deglaciation. Glacial lake sediments were deposited over large parts of northern Europe and North America during repeated deglaciation of the Quaternary Eurasian and Laurentide Ice Sheets. In large parts of the N Hemisphere, the earliest evidence of the postglacial terrestrial and aquatic environments and climate are stored in these sediments. The study of glacial lake sediments and the fossils preserved in them is thus relevant for e.g. assessing the climate response and rates of ecosystem change during critical glacial-interglacial transitions.

We study three deglacial phases of the Fennoscandian Ice Sheet as a unique, repeated element in a long sediment record preserved at Sokli in northern Finland. We summarize extensive multi-proxy data (diatoms, chironomids, pollen, NPP's, macrofossils, biogeochemical data) obtained on glacial lake sediments dated to the early Holocene (10.5 kyr BP), early MIS 3 (ca. 50 kyr BP) and early MIS 5a (ca. 80 kyr BP). In contrast to the common view of an unproductive ice-marginal environment, our study reconstructs rich ecosystems both in the glacial lake and along the shores with forest on recently deglaciated land. Higher than present-day summer temperatures are reconstructed based on a large variety of aquatic taxa. Rich biota developed due to the insolation-induced postglacial warming and high nutrient levels. The latter resulted from erosion of fresh bedrock and sediment, leaching of surface soils, decay of plant material under shallow water conditions, and eutrophication caused by sudden decreases in lake volume. Aquatic communities responded quickly to deglaciation and warm summers and reflect boreal conditions, in contrast to the terrestrial ecosystem which responded with some delay probably due to time required for slow soil formation processes.

Our study shows that glacial lake sediments can provide valuable paleo-environmental data, that aquatic biota and terrestrial vegetation rapidly accommodated to new environmental conditions upon deglaciation, and that glacial lake ecosystems, and the carbon stored in their sediments, should be included in earth system modeling.
Intact Polar brGDGTs at Lake Qaupat, Baffin Island: Implications for Sources of the Paleotemperature Proxy

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The distribution of branched tetraether lipids (brGDGTs) has provided a valuable proxy for temperature reconstructions in Arctic lake sediments. One of the strengths of the brGDGT paleothermometer, however, is also one of its weaknesses: the lipids are seemingly ubiquitous. They have been found in soils, peats, sediments, and aquatic systems around the world. The brGDGTs in these different environments may record significantly different temperatures and biological sources, yet all end up in the lake sediment column, convoluting the interpretation of paleotemperature records. Investigations of brGDGT distributions have already yielded insights into their sources on the landscape, including production in anoxic waters. Importantly, these studies relied on measurements of only the recalcitrant “core” skeletons of the brGDGT lipids (c-brGDGTs). However, advances in chromatographic methods have allowed for the measurement of brGDGTs in their intact, polar form (i-brGDGTs), i.e. the lipids as they exist in living cells. These techniques expand the number of measurable brGDGTs from sixteen to over sixty, allowing for more subtle distinctions between brGDGT distributions of different samples to be measured. Here, we leverage the large and largely unexplored pool of i-brGDGTs present in a variety of physical settings within an Arctic lake catchment. We find that the distribution of i-brGDGTs in modern soils, lake water filtrates, and lake sediment enables differentiation between these potential sources in the lake catchment. Furthermore, we find a subset of i-brGDGTs in early Holocene lake sediments and in samples extracted at high temperature and pressure. These findings challenge the commonly held belief that i-brGDGTs are highly labile. They further raise the possibility of in situ brGDGT production in deeply buried sediments. Finally, we discuss the implications of our findings for temperature reconstructions in lake sediments archives.
Lipid biomarkers quantify Holocene temperature in Icelandic lakes and soils

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Iceland currently lacks reliable and continuous quantitative records of Holocene temperature, which are vital to better understand the Holocene climate history of Iceland. First, we report downcore paired branched glycerol dialkyl glycerol tetraethers (brGDGT) and alkenone records that quantify Holocene temperature change in Skorarvatn, a 25-m-deep lake in northwest Iceland. A combination of recent qualitative proxy-based climate reconstructions from Skorarvatn lake sediment and modeling experiments from the nearby Drangajökull ice cap provide a framework to evaluate the veracity of biomarker paleothermometers. Compared to previous records from Skorarvatn, relative changes in brGDGT-inferred MSAT closely track biogenic silica (BSi), a proxy for qualitative summer temperature in Iceland. Furthermore, brGDGTs and BSi both show synchronous cooling at ~2.4 ka, consistent with the first late Holocene appearance and subsequent growth of the temperature-sensitive Drangajökull ice cap. Alkenone-based temperatures exhibit less variability than brGDGT and qualitative climate proxies from Skorarvatn, and instead, closely track smoothly decreasing Northern Hemisphere June insolation. In addition to the lake-based proxies, we also examine brGDGT-based temperature reconstructions from stacked soil sequences that span the last 10,000 years in the central highlands. Due to the region’s proximity to the active volcanic zone, the soil sequences are separated by thick ash layers, which have diagnostic geochemical fingerprints that permit robust correlation to tephra of known age. Additionally, soil-derived records may circumvent complications associated with multiple brGDGT producers contributing to lake sediment. Using the global soil calibration, brGDGT-inferred temperatures from the soil sequence conform to regional qualitative lake sediment climate records and capture periods of documented abrupt climate change in Iceland. Modeling experiments for Drangajökull and Langjökull, an ice cap in central Iceland, both pin peak Holocene Thermal Maximum (+3 °C modern) and lowest late Holocene (-0.8 °C modern) temperature estimates near those inferred from lake sediment and soil brGDGTs, as well as alkenones. Hence, these new quantitative records will provide valuable constraints on the glacier and climate sensitivity of Iceland during the Holocene, and important insight into the warming expected over the current century.
Leaf wax hydrogen isotope reconstruction of Holocene precipitation seasonality in High Arctic Svalbard

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Arctic precipitation is predicted to increase the coming century, proposed to be caused by atmospheric circulation changes or reduction in sea ice and resulting enhanced local surface evaporation. We aim to determine the mechanisms behind Arctic precipitation isotope variation in the past. In this study, leaf wax biomarkers are used to reconstruct Holocene hydrological variability in Svalbard, Arctic Norway. Leaf waxes are lipids produced by plants as a protective coating, and record the hydrogen isotopic composition (δ²H) of the source water during photosynthesis: lake water for aquatic plants and soil water for terrestrial plants. Source water δ²H is controlled by moisture source, temperature, evaporative enrichment and lake water residence time. We present a Holocene record of the hydrogen isotopic composition (δ²Hwax) of leaf wax compounds (fatty acids; C22 from aquatic plants and C28 from terrestrial plants) in sediments from Austre Nevlingen, a lake with a 35-month residence time in the relatively arid central region of northern Spitsbergen. δ²H of C22 and C28 are interpreted to represent mean annual and summer precipitation δ²H, respectively, and may be modified by evaporative 2H-enrichment. C22 was relatively 2H-enriched prior to 10 ka and after 6 ka. From 10 to 6 ka, C22 was nearly 100‰ 2H-depleted compared to the beginning and end of the record. This strong 2H-depletion likely indicates more winter precipitation or more distal moisture transport during this interval, as mean annual temperatures would have to be more than 30°C cooler to explain the 100‰ depletion. In contrast, C28 varied by around 40‰ throughout the Holocene, and was relatively 2H-enriched from 9 to 5.5 ka and for a short period around 4 ka, suggesting proximal moisture sources or warmer summer temperatures and more evaporative enrichment during these intervals. We compare our new record to existing δ²Hwax records from Hakluytvatnet, a lake situated on Amsterdamøya, 100 km west of Austre Nevlingen. In contrast to Austre Nevlingen, Hakluytvatnet has a short residence time and a more maritime climate, allowing us to compare the Holocene climate pattern between lakes at similar latitude but different mean climate state and with contrasting residence times.
Dissecting complex Holocene ice cover histories on Baffin Island

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Warming over the past century is causing glaciers and ice caps on Baffin Island to retreat, revealing preserved landscapes complete with isotopic archives containing information about past ice-cover fluctuations on those landscapes. Radiocarbon ages from preserved plants situated on these recently exposed landscapes on Cumberland Peninsula, Baffin Island indicate that ice expanded over these landscapes, killing and preserving the plants in growth position (until the time of collection) between 0.4 – 3.7 ka. Complimentary inventories of in situ cosmogenic 14C measured in preserved rock surfaces adjacent to collected plants samples suggest 100s – 1000s of year of exposure prior the late Holocene burial indicated by the plant radiocarbon ages. It is unknown, however, if these landscapes experienced one period of exposure following regional deglaciation from the Last Glacial Maximum, or instead experienced more complex ice cover histories throughout the Holocene.

Using a simple cosmogenic 14C production simulation constrained by our new plant radiocarbon ages and cosmogenic 14C inventories, combined with previously published known ice cover fluctuations from the area, we show that these locations likely experienced at least two periods of exposure during the Holocene, separated by a period of ice cover beginning ~9ka. Our simulations suggest that most of the 10 locations presented here all subsequently became ice free ~6ka, indicating regional coherence in warming and ice margin retreat during the middle Holocene.

One possible explanation for the apparent coherence in timing of middle Holocene ice retreat and varying times of ice re-expansion during the late Holocene is that middle Holocene warming occurred uniformly and rapidly across the region, affecting ice caps and glaciers across a wide range of elevations (i.e. rapid rise in snowline), whereas later cooling was more spatially heterogenous, possibly complicated by local ice dynamics. A further complicating factor is that current warming and rapid ice margin retreat may only be revealing a partial picture of past ice fluctuations; continued sampling of these landscapes as ice margins continue to retreat will help provide a more complete picture of both past glacier fluctuations and climate trends throughout the Holocene.
Timing of cryosphere expansion across Baffin Bay compared to a 2 ka CESM1 transient simulation: a data-model comparison

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Changes in late Holocene ice-cap dimensions around Baffin Bay are dominantly set by changes in summer temperature allowing us to compare times of ice expansion with modeled summer temperatures. We reconstruct times of ice cap expansion from the radiocarbon ages of entombed tundra plants exposed as the cryosphere recedes under warming summers. Compositing the individual probability density functions of the calibrated ages defines periods of sustained summertime cooling. Our summaries are based on 232 ¹⁴C dates from the Eastern Canadian Arctic and 20 ¹⁴C dates from West Greenland that are <2 ka. Both regions show an expanding cryosphere between 100 and 500 CE, a lack of expansion between 500 and 700 CE, followed by cryosphere expansion between 700 and 950 CE. During Medieval times (1000-1250 CE) there is little evidence of an expanding cryosphere, but summer temperatures were not warm enough to cause ice recession behind first millennium margins. Renewed cryosphere expansion late in the 13th Century CE through the mid 15th Century CE, reaching peak dimensions between 1450 and 1900 CE, although most Greenland glaciers have receded behind their LIA expansion. We compare these results with a new 2 ka fully coupled climate transient using CESM1, with forcing data from PMIP4, including insolation, volcanic aerosols, land-cover, and GHG. The CESM results show a ~0.5°C reduction in summer temperature between 100 and 500 CE, consistent with widespread cryosphere expansion then. A second phase of persistent summer cooling in the model occurs between 800 and 950 CE, followed by slightly warmer summers between 950 and 1150 CE, although not as warm as early in the first millennium CE. Summers cool again in the model after 1150 CE, with stronger cooling after 1450 CE, reaching a minimum shortly after 1850 CE, ~1°C lower than at the start of the experiment. Orbitally driven declines in summer insolation appears to be the dominant forcing early in the first millennium CE, with volcanism and solar irradiance reductions increasingly important in the second millennium CE, but positive feedbacks from sea ice and the overturning circulation are necessary to explain the magnitude of peak LIA cooling.
Melttown: Side-effects of globalization in Longyearbyen, Svalbard

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The image of Longyearbyen as the northernmost community, a periphery "at the edge of the world", sells well. Yet if we look at the global trends that are changing the local economic, social and environmental outlook, Longyearbyen is situated just in the centre of globalization. One example for all: Svalbard is pivotal when it comes to climate change impacts. According to the Climate in Svalbard 2100 report, issued in January 2019, unprecedented deviations from today's status quo are to be expected. Alongside with the climate, other features are changing in front of our eyes. Several layers of the place’s identity clash. Norwegian, or international? Mining industry, or tourism? Pristine wilderness to be conserved, or accessible "disappearing destination"? The talk summarizes the most evident contradictions of global forces shaping local everyday life reality and presents the main research questions of a freshly started project of an intense and longitudinal study of globalization impacts on life in Longyearbyen. The project entitled boREALIFE: Overheating in the high Arctic is inspired by Thomas Hylland Eriksen's approach toward multiple effects of processes that cannot be stopped but might well be regulated. But who decides on that in case of Longyearbyen? The debate about the place’s present and near future is overheated, mines are closing down, tourists keep coming to consume – some of them "sustainably" – the pure Arctic nature, while in the fjord, sea ice is dark (meaning wet) even though it is wintertime.

The talk draws on fieldwork taking place from February 2019, using the method of participant observation and semi-structured interviews with residents and short-term visitors. At this point, no conclusions can be made for the fieldwork is meant to last for 2 years and the findings presented at AW 19 are only preliminary. A potentially controversial issue to be investigated is the very existence of a "local community". Who qualifies for membership? Is there just one and united, or are there several? What does "localiness" consist of? And how is it affected by global trends in force?
Arctic energy futures: decentralized renewable energy solutions in the Russian Arctic

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The main economic interests of the Arctic nations are still to a larger extent concentrated around the natural resources and new transit opportunities. For the Russian Arctic, this interest is being determined by high conventional and unconventional hydrocarbon potential of the region, as well as other natural resources and new transport and logistics routes as the Northern Sea Route. Nevertheless, the future region socio-economic development very much depends not only on the exploitation of natural resources but on the development of energy and transport infrastructure.

Currently, conventional energy resources transportation and delivery to the Arctic regions constitute a significant part of the total electricity generation costs and maintenance costs of existing infrastructure. The most promising way of providing reliable and affordable energy supply to the developing Arctic region is local and renewable energy sources. These energy supply solutions are possible for the Arctic region due to the availability of new technologies and materials, which significantly affect its efficiency and reliability.

The study is aiming to contribute to the sustainable development of energy infrastructure and supply in the Russian Arctic in line with climate and ecological challenges. The key focus is on broader deployment of decentralized energy generation solutions, based on combined use of conventional and local renewable energy resources. The specific focus of the study is on the Northern Sea Route infrastructure and similar remote decentralized energy consumers.

The study is inspired by an industrial dynamics theoretical framework, which provides instruments to analyse and understand the underlying processes of transformation of the energy system in the Arctic region. Being the part of a larger project, this particular piece focuses on a systematic analysis of available local and renewable resources, potential consumers in the Arctic and sustainable energy infrastructure development opportunities. Broader deployment of decentralized combined energy generation solutions will provide a basis for sustainable regional development.

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Patrimonialization in South Greenland: farms, mine, and ruins.

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Kujataa is a Southern Greenlandic area of 572,270 m² bringing together farming, tourism and mining industry, and historical sites. In July 2017, those sites have been inscribed on UNESCO's World Heritage List, thus questioning the safeguarding of archeological sites in land exploitation context, but also the meaning of the archeological data.

Eight Viking and Inuit farming ruins – respectively dating from the Middle Ages and the 19th century – spread on Kujataa’s landscape, intersection with operating farming grounds. The protection policy will be closely articulated with the tourism industry to highlight the ruins, hence displaying a specific historical perspective presented by touristic facilities. Those amenities are located near the soon to open Kvanefjeld mine, which new infrastructures greatly modify the landscape. Industrialisation shall be understood as an economical and spatial competition influencing conservation and tourism policy.

From an ethnographical fieldwork conducted in South Greenland from February to July 2018, I will present locals' and tourism policy makers' discourse concerning the UNESCO sites in order to discuss this patrimonialization process. This contribution will firstly try to determine if heritage is here either enhanced or constructed. Secondly, I will argue that patrimonialization is a key process for a better understanding of industrialization in South Greenland.
APECS - Association of Polar Early Career Scientists - Sweden

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The Association of Polar Early Career Scientists (APECS) is an international organization that brings together researchers interested in the Arctic, Antarctic and alpine regions. It welcomes everyone, from bachelor student to early faculty members, from humanities to theoretical physics. It aims to build a community for networking, outreach and transdisciplinary research.

APECS Sweden is one of APECS’ 24 national committees that hosts local events throughout the year in different cities in Sweden. APECS Sweden is the national committee for all polar researchers based in Sweden and Swedish polar researchers abroad. Our goal is to connect to the International Polar Research Community, promote research and collaboration, to reach out at the local level and to create platforms for exchange.

This presentation informs about the organisation APECS in general. Exemplary, the activities of APECS Sweden, as possibility to become involved in APECS, are presented.
Opening the review of IPCC reports to Early Career Scientists

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Early Career Scientists (ECS) represent a large part of the workforce in the natural sciences. While they typically have significant academic training, they have limited experience in how the scientific community self-evaluates and communicates, and they are rarely invited to engage in the peer-review process. We argue that such engagement would be beneficial to ECS - and to the scientific community as a whole. Our research presents a group review of the first order draft of the Intergovernmental Panel on Climate Change (IPCC) "Special Report on Ocean and Cryosphere and in a Changing Climate" (SROCC) supported by 75 ECS from 22 countries on behalf of the Association of Polar Early Career Scientists (APECS) during Spring 2018. We present our working process, results and lessons learned. Data from participant surveys and a comments catalog collectively illustrate that ECS are competent reviewers comparable to more experienced researchers. Furthermore, our study advances discussion about ECS as valuable reviewers of publications by the IPCC, other institutions and academic journals. We also note the particularly diverse expertise and geographic perspectives that APECS and its affiliates bring to the process. The IPCC has collaborated with APECS in the second order review of their SROCC in late 2018 and will continue collaboration with the AR6 Climate Change 2021: The Physical Science Basis, so we aim to enhance our conclusions with additional data from these - and future - group review processes.
Arctic Straits Volume Transports: Forcing and Response.

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Arctic heat and freshwater budgets are highly sensitive to volume transports through the Arctic-Subarctic straits. Here we study the forcing of the volume transport through four major Arctic straits and in particular, their response to perturbations in other straits. Specifically, we investigate the interconnectivity of the volume transports in three models; two coupled global climate models, one with a third-degree horizontal ocean resolution (HiGEM1.1) and one with a twelfth-degree horizontal ocean resolution (HadGEM3), and a tenth-degree ocean-only model with an idealized polar basin (NEMOv3.2). The two global climate models indicate that there is a strong anticorrelation between the Bering Strait throughflow and the transport through the Nordic Seas, a second strong anticorrelation between the transport through the Canadian Arctic Archipelago and the Nordic Seas transport, and a third strong anticorrelation is found between the Fram Strait and the Barents Sea throughflows. We find that part of the strait correlations is due to the strait transports being coincidentally driven by large-scale atmospheric forcing patterns. However, there is also a role for fast wave adjustments of some straits flows to perturbations in other straits since atmospheric forcing of individual strait flows alone cannot lead to near mass balance fortuitously every year. Idealized experiments with the ocean model to investigate such causal strait relations suggest that perturbations in the Bering Strait are compensated preferentially in the Fram Strait due to the narrowness of the western Arctic shelf and the deeper depth of the Fram Strait.
Sea-ice dynamics and biogeochemical cycling in the eastern Bering Sea over the last 30 ka

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The high latitude oceans are important for global biogeochemical cycling. Depending on the balance of the circulation and the biological pump carbon, oxygen, and nutrients are redistributed in these regions, both within the ocean and between the ocean and the atmosphere. This is particularly important on glacial/interglacial (G/IG) timescales, where large amounts of carbon are thought to be sequestered in the deep ocean during glacials and released again across the deglaciation.

In the Bering Sea sea ice plays a pivotal role for both primary productivity and regional circulation. Nutrient release and surface ocean stratification during spring sea-ice melting enhance primary productivity, while extended sea-ice cover leads to light limitation and reduced productivity in the surface ocean. Further, brine rejection during sea-ice freezing is important for intermediate water formation in the North Pacific. Results from previous studies suggest a better-ventilated, vertically expanded NPIW during the LGM and cold periods across the last deglaciation, which likely enhanced the efficiency of abyssal North Pacific carbon storage. However, the maximum depth of NPIW, the primary location of formation (Bering Sea versus Sea of Okhotsk), and the role of brine rejection versus thermohaline circulation, are still a subject of debate.

Here we use a multi-proxy approach to simultaneously investigate past changes in eastern Bering Sea sea-ice cover and changes in the biogeochemical cycling at International Ocean Discovery Program (IODP) Site U1343 (57°33.4′N, 176°49.0′W; 1953 m). Reconstructions are based on sea ice related biomarkers, foraminiferal geochemistry, and low oxygen tolerant benthic foraminiferal assemblages. Our results indicate two episodes of enhanced ventilation to depths of ~2000 m during the LGM and early Heinrich Stadial 1, coinciding with increased sea-ice extent in the eastern Bering Sea. This suggests that glacial NPIW likely formed locally in the Bering Sea via brine rejection affecting the regional ventilation, nutrient inventory, and carbon cycle.
Persistent late Holocene multi-decadal variability in ocean-atmosphere dynamics in the Chukchi Sea, western Arctic Ocean.

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Multi-decadal to centennial scale variability in the natural climate system is difficult to assess, but required to properly evaluate anthropogenic forcing. While a number of recent studies have identified multi-decadal variability in historical sea-ice records, complementary evidence over longer time scales from marine geological records is lacking. In 2014, the Swedish, Russian, US Arctic Ocean Investigation of Climate, Cryosphere, Carbon Interactions (SWERUS-C3) on icebreaker Oden recovered a remarkable sediment core (SWERUS-4PC1) from the Herald Canyon in the Chukchi Sea of the western Arctic Ocean. This record, obtained from a drift deposit located at the interface of Bering Sea waters and the Atlantic water layer, contains a persistent and strong, multi-decadal signal of bottom-water current speed over the past 3000-4000 years. Frequency spectra indicate a strong coherence with Holocene reconstructions of solar activity. Supporting this, we find increased westerly winds over the East Siberian Sea and the North Pacific, a stronger western Arctic Boundary Current, and a longer ice growth season in the Chukchi Sea during solar maxima winters in CMIP5 historical simulations with high-top chemistry-climate models. The 'top-down' propagation of solar signals in the lower atmosphere and ocean may explain the current velocity changes in Herald Canyon through a combination of mechanisms involving local upwelling of Atlantic waters and more efficient dense winter water formation/brine rejection in the Chukchi Sea.
Identifying and understanding the ecological preferences of the most abundant planktonic foraminifera in the Arctic Ocean: a combined approach

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Making more than 90% of the total assemblage, Neogloboquadrina pachyderma is the dominant species of planktonic foraminifera in the Arctic and the paleo-ecological signal contained in its shells has been widely used for reconstructing high latitude paleoeoenvironments. The right interpretation of this signal relies on a correct understanding of the ecological preferences of this species that shape its distribution in the water column.

Data from the polar regions have shown that N. pachyderma living depth ranges from the surface mixed layer to several hundreds of meters of water depth. The origin of this variability is still debated and different factors like temperature, stratification and food availability could be possible drivers of its distribution. Previous research also suggested that N. pachyderma avoids low salinities and preferentially occur deeper in the water column when the surface is fresh.

Here we use a coupled approach to better constrain the ecological space that defines the distribution of N. pachyderma. We combine field data of population density profiles from stratified plankton tow hauls collected in the Arctic and the North Atlantic Oceans and direct observations from a laboratory experiment. To this end, N. pachyderma specimens were collected off the northern coast of Norway, cultured individually at different salinity concentrations (35 PSU to 22 PSU) and their response monitored daily for 26 days.

Our field data show that the DH of N. pachyderma varies between 25 m and 280 m (average ~100 m) and that specimens reside closer to the surface when sea ice and/or surface chlorophyll concentrations are high. The DH also increases with time since sea-ice break-up indicating that the DH of N. pachyderma is controlled by multiple, interacting variables, likely connected in the temporal dimension.

In cultures, lower salinity concentrations lead to lower rhizopodial activity suggesting that N. pachyderma prefers water masses with salinity above 22 PSU.

Our results can be used to improve predictions of the response of the species to climate change and refine paleoclimatic reconstructions.
Investigation of the relationship between primary production and sea ice in the Barents and Kara Seas

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The work is focused on the further development of a regional coupled eco-thermohydrodynamic model of the Arctic seas with the aim of using it to better understand the interaction of dynamic and ecosystem processes in the ocean under a changing climate in the Arctic.

We used the MITgcm as a thermohydrodynamic block and an original 7-component ecosystem model which includes the carbon cycle as an ocean biogeochemistry block. The results of a model climatic run for a 40-year modern period for the Arctic shelf region (Kara, Barents and White Seas) are presented.

The estimates of the spatial distribution of the chlorophyll-a concentration in the surface layer have clarified the effect of sea ice on primary production in the Arctic seas, including under conditions of a changing climate that leads to a significant reduction of ice cover in the Arctic Ocean. The clear relationship between the area of the marginal ice zone and primary production has been obtained: the moments of their spring-summer peaks coincide completely and they are highly correlated (0.87), proving the importance of this zone in the functioning of the marine ecosystem. As expected, the interannual variability of the integrated primary production and the total sea ice area (both averaged over the hydrological year – from October to September) have demonstrated an antiphase oscillation which means that the reduced sea ice cover area in the previous winter is one of the main reasons for the increase in primary production in the current year.
Impacts of environmental temperature on the stability of terrestrial communities and food webs

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Understanding and quantifying impacts of warming across multiple levels of biological organisation is important for modelling the ecological and evolutionary dynamics of ecosystem change. We use a natural warming experiment in Iceland to investigate the impact of temperature on the stability of terrestrial communities and food webs. Sample collection over several time points within a season allows assessment of whether temperature alters temporal variability in terrestrial communities and compositional turnover. We construct food webs based on consumer-resource feeding links, exploring the topological structure of food webs along the temperature gradient and temperature effects on their stability. These data are used to test if with increasing soil temperature: (1) temporal variability in community composition increases; (2) species turnover through time increases; (3) food web complexity decreases; (4) temporal stability of food web properties decreases. Results remain forthcoming.
Understanding Changes in Hydroclimate-Dependent Outbreaks of Infectious Diseases in High-Latitude Regions

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Hydroclimatic changes, which may be particularly large in the sub-Arctic and Arctic region, can influence outbreak occurrences of infectious diseases, jeopardizing regional human and animal health. In this study, we consider tularemia as a model disease, observed at relatively high occurrence in high-latitude regions, and analyze a quantitative model of its past outbreaks to understand the model implications for possible future outbreak conditions under hydroclimatic change. Model results reveal high sensitivity in tularemia outbreak changes from one year to the next for certain threshold combinations of hydroclimatic variable values, shifted somewhat from current average conditions but still remaining within the range of past regional observations. In particular, water flow and temperature conditions that relate to relative mosquito abundance, as well as summer precipitation in the same year and summer temperature of the preceding year are all positively related to tularemia incidence and contribute to increased number of outbreaks relative to those of the preceding year. Relatively small variations and changes in these hydroclimatic variables are found to dramatically shift tularemia outbreaks to much greater numbers than seen in the past, under the model derived from past conditions and with variable values remaining within the past observation range. These results call for further research on how projected hydroclimatic change can be expected to affect infectious disease outbreaks in high-latitude regions, with particular focus on threshold variable combinations (tipping points), as well as on the generality and spatiotemporal transferability of statistical disease models, such as that for tularemia used in this study.
Spatial modelling of soil organic carbon stocks in West Greenland

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The soil organic carbon (SOC) pool of the Northern Hemisphere contains about half of the global SOC stored in soils. As the Arctic is exceptional sensitive to global warming, permafrost-affected soils thaw to greater depth and might contribute to increasing greenhouse gas emissions progressively. To assess their overall impact on global warming in permafrost-affected regions the spatial variability of SOC stocks is of upmost interest. However, sparse and unequally distributed soil data sets result in highly uncertain estimations of SOC stocks (SOCS) of the Northern Hemisphere and here particularly in Greenland.

This study focuses on the spatial modelling of SOCS using digital soil mapping (DSM) combined with machine learning techniques (e.g. random forests, RF) and the scale dependent approach of contextual soil mapping (CSM). The objectives are (i) identifying major environmental factors controlling spatial variation of SOCS and (ii) estimating SOCS of two study areas in West Greenland. The dataset comprises SOCS from 140 sampling locations at two study areas in West Greenland being located at the coast (Sisimiut, SISI) and the ice margin (Kangerlussuaq, KANG). Further, we use a set of environmental covariates such as terrain parameters at different scales and remote sensing data.

First results comprise area-wide calculation of SOC stocks and dominant covariates for both study areas using RF. At SISI, the quality of the RF model (R²/RMSE) is 0.28/7.46 and predicts an average SOCS of 7.91 kg m⁻² (± 1.33 kg m⁻²) for the depth increment 0-25 cm. At KANG, the RF model (0.59/2.51) predicts an average SOCS of 7.56 kg m⁻² (± 2.05 kg m⁻²) at 0-25 cm. Aspect and curvature at different scale levels are the most important covariates to explain the spatial variation of SOCS at both study areas. The curvature represents relevant issues of predominant geomorphologic features signature (e.g. moraine topography) to soil formation. The aspect stands for the influence of the local wind system and the solar radiation affecting biomass production.
Distribution of carbon and nitrogen along hillslopes in three valleys on Herschel Island, Yukon Territory, Canada

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Thermokarst results from the thawing of ice-rich permafrost and alters the biogeochemical cycling in the Arctic by reworking soil material and redistributing soil organic carbon (SOC) and total nitrogen (TN) along uplands, hillslopes, and lowlands. Understanding the impact of this redistribution is key to better estimating the storage of SOC in permafrost terrains. However, there are insufficient studies quantifying long-term impacts of thaw processes on the distribution of SOC and TN along hillslopes. We address this issue by providing estimates of SOC and TN stocks along the hillslopes of three valleys located on Herschel Island (Yukon, Canada), and by discussing the impact of hillslope thermokarst on the variability of SOC and TN stocks. We found that the average SOC and TN 0-100 cm stocks in the valleys were 26.4 ± 8.9 kg C m-2 and 2.1 ± 0.6 kg N m-2. We highlight the strong variability in the soils physical and geochemical properties within hillslope positions. High SOC stocks were found at the summits, essentially due to burial of organic matter by cryoturbation, and at the toeslopes due to impeded drainage which favored peat formation and SOC accumulation. The average carbon-to-nitrogen ratio in the valleys was 12.9, ranging from 9.7 to 18.9, and was significantly higher at the summits compared to the backslopes and footslopes (p<0.05), suggesting a degradation of SOC downhill. Carbon and nitrogen contents and stocks were significantly lower on 16% of the sites that have been previously affected by hillslope thermokarst (p<0.05). Our results showed that lateral redistribution of SOC and TN due to hillslope thermokarst has a strong impact on the SOC storage in ice-rich permafrost terrains.
Waterborne transport in the active layer of permafrost environments.

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The active layer constitutes an important subsystem of permafrost environments. Thermal and hydrological processes in the active layer determine local phenomena such as erosion, hydrological and ecosystem changes, and can have significant implications for the global carbon-hydrological-climate feedback. Permafrost degradation usually starts with a deepening of the active layer, followed by the formation of a talik and the subsequent thawing of the remaining permafrost. Increasing active layer depths are thus regarded as an early warning indicator of permafrost degradation. The importance of hydrology for active layer processes is generally well acknowledged on a conceptual level, but the typically non-linear physical interdependencies between soil moisture, subsurface water and heat fluxes and active layer behavior are not fully understood.

In this contribution, a modelling methodology for analysis of coupled thermal and hydrological and solute transport processes is presented and applied to a permafrost system with a dynamic active layer. Initial model results demonstrate that both soil water retention properties and inter-annual temperature variations strongly control both moisture and ground ice distribution in the active layer through cryosuction. This in turn impacts ground warming in the active layer differently, leading to different hydrological and solute mass transport regimes, and different active layer dynamics.
Land uplift in Fennoscandia – from the last ice age into 2100

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Fennoscandia and northern parts of North America are geodynamically active regions due to the relatively recent (20-8 kyr BP) demise of the large ice sheets that covered these regions at the last glacial maximum. The weight of the ice pressed the Earth’s crust down and now, in a process called glacial isostatic adjustment (GIA), the crust is slowly uplifting as the Earth relaxes to a state of isostatic equilibrium. Fennoscandia has the highest number of land uplift related observations in the world, and the phenomenon has also been studied for centuries. Here, we provide the latest numbers of land uplift for the Fennoscandian area, the modelling results for the past, the current rates from geodetic observations, and probabilistic scenarios for future relative sea level rise. The maximum land uplift rates in Fennoscandia are in the Bothnian Bay of the Baltic Sea, where the maximum values are currently on the order of 10 mm/year with respect to the geoid. During the last 100 years, the land has risen from the sea by approximately 80 cm in this area. Estimates of future relative sea-level change have considerable uncertainty, with values for the year 2100 ranging from 75 cm of sea-level fall (land emergence) to 30 cm of sea-level rise.
The Holocene glacial history of the Greenland Ice Sheet in Melville Bay based on 10Be exposure dating and 14C radiocarbon dating

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Knowledge about the glacial history of the Greenland Ice Sheet and its dynamic response to past climate variability is important to put the current changes into context. However, there are areas in Greenland where only little knowledge about past ice marginal fluctuations are available. One of these areas is Melville Bay where only a few minimum-limiting radiocarbon ages exist to illuminate the glacial history.

In this study, we add further age constraint to the Holocene glacial history in Melville Bay 72.7-75.6 N, using 10Be cosmogenic exposure dating of boulders and 14C radiocarbon dating of reworked marine molluscs. A total of 38 boulder samples from 11 different locations close to the ice margin and off the coast were retrieved during fieldwork in 2016 and 2018. Additionally, 40 marine mollusc samples from Little Ice Age moraines at 5 different locations were collected during fieldwork in 2018.

With the new ages, we expect to obtain a more thoroughly age constrain of the Holocene glacial history in one of the least explored parts of Greenland. We will discuss the new age constraints in relation to existing climate records from northwest Greenland as well as new bathymetry data from Melville Bay and put the new results into context.
Wijdefjorden and Femmilsjøen – a fjord-lake study in northern Spitsbergen

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Recent research in Svalbard has provided compelling evidence for early Holocene glacier advances during a time when marine bivalves indicate that the surrounding seas were warm. The overall aim of this project is to reconstruct the Holocene climate and glacial history of northeast Spitsbergen, using a holistic approach that includes collection and integration of marine, terrestrial and lacustrine data. The areas of interest are the lake Femmilsjøen and the adjacent fjord Wijdefjorden on northern Spitsbergen, Svalbard. The 8 km long, Femmilsjøen is one of the largest and deepest lakes in Svalbard. The active surge-type glacier Longstaffbreen terminates in the eastern end of the lake. Marine sediment cores, swath bathymetry data, as well as sub-bottom profile data were collected in the fjord just off Femmilsjøen in the summer of 2017. Lacustrine sediment cores, sub-bottom profiles and swath-bathymetry from the lake were collected in 2018. The surrounding area of Femmilsjøen, between the coast of Wijdefjorden and Longstaffbreen/Midtsundstadbreen, was mapped during the field campaign in 2018, and an end moraine ridge containing shell fragments was identified. The acoustic data reveal several transverse ridges across the lake floor, and acoustically stratified deposits that fill the depressions between the ridges. On-going analyses of the sediment cores from the two archives include lithostratigraphic logging, organo-geochemical analyses (TOC), biomarker (IP25, phytosterols), and granulometric analyses, as well as XRF core scanning. This multiproxy approach enables inter-archive comparison, as well as comparison with other lake and fjord systems on the Svalbard archipelago. In the talk, we present preliminary results from the data set and discuss their implications about the development of the environmental conditions on northern Svalbard during the Holocene.
Glacigenic landforms and sediments in Store Koldewey Trough, NE Greenland – preliminary results.

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The Last Glacial Maximum (c. 24-19 ka BP) extent of the NE Greenland Ice Sheet, as well as the timing and dynamics of the deglaciation remains poorly constrained. New studies suggest that the ice sheet was more dynamic than previously thought, extending all the way to the shelf edge during the last glacial.

One of the major ice streams draining the ice sheet was located in Store Koldewey Trough, a ~210 km long, 30-40 km wide and up to 400 m deep transverse trough dissecting the NE Greenland continental shelf at ~76ºN, offshore the modern termination of the Storstrømmen glacier. Based on swath bathymetry, high-resolution seismic data and marine sediment cores from the middle part of the trough, we reveal well-preserved glacigenic landforms and draping deposits, providing evidence of the presence and subsequent retreat of the Greenland Ice Sheet. Mega-scale glacial lineations oriented parallel to the trough axis are overlain by a complex pattern of transverse ridges and multi-keeled iceberg ploughmarks. The lineations are interpreted to be products of a fast-flowing ice stream draining eastwards towards the shelf break during full glaciation, whilst the transverse ridges are inferred to be formed subglacially as crevasse fills or at the grounded ice front during minor readvances (ice surges?) during deglaciation. Sediment cores contain a characteristic sequence of compact, clast-rich muddy diamicton, absent of bioturbation and shells. This is overlain by laminated mud and massive mud. Within the massive mud the abundance of coarser grains (IRD) in the cores increase towards the core top, probably reflecting increasing deposition from icebergs. The diamicton is suggested to be a basal deformable till corresponding to the top of the landforms, whereas the overlying draping deposits are interpreted to be of glaciomarine origin, changing from an ice-proximal to a more ice-distal environment dominated by deposition from meltwater plumes. New results on the timing of the deglaciation based on radiocarbon dating will also be presented.
Early Holocene ice-dammed lakes in Arctic Sweden and the location of the last Scandinavian Ice Sheet remnants

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This study presents geomorphological evidence of a larger system of early Holocene ice-dammed lakes in Arctic Sweden than previously thought. The distribution of the ice-dammed lakes indicates final deglaciation of the last Scandinavian Ice Sheet remnants east of the Scandinavian mountain range, northwestern Sweden, in contrast with the prevailing view of final deglaciation in the higher mountains of Sarek. The extent of the ice-dammed lakes is based on mapping of paleoshorelines from high resolution (LiDAR) terrain models. Using cross-cutting relations and the altitudes of bedrock thresholds the relative ages of the different lake-stages was obtained and used to trace the ice-sheet retreat in the area. Similar to the deglaciation further to the north and south, the distribution of the ice-dammed lake deposits in this area suggests an eastward retreating ice-sheet, damming up lakes towards the water divide in the mountains to the west.

In addition, geomorphological evidences are presented, in the form of mega deposits and extensive erosive features, of a catastrophic glacial lake outburst flood along the Pite River valley. These features, including erosive lines found up to 50 m above present day river level, can be traced continuously for some 130 km starting in the mountain range in the west and ending at the early Holocene Ancylus lake level in the east. Based on cross-cutting relations to early Holocene raised shorelines from the Ancylus lake we constrain the age of the flood to c. 10.3-9.8 cal. ka BP.
Mapping Arctic Lakes Using Small-size Autonomous Surface Vehicles

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In Arctic alpine regions, glacio-lacustrine environments respond sensitively to variations in climate conditions, impacting e.g. glacier extent and rendering former ice-contact lakes into ice distal lakes and vice versa. Lake floors may hold morphological records of past glacier extent, but remoteness and long periods of ice cover on such lakes make acquisition of high-resolution bathymetric datasets allowing for the detection and analysis of subaqueous landforms challenging.

Autonomous, unmanned Surface Vehicles (ASVs) provide a mobile and cost-efficient platform for acquisition of high-resolution bathymetric data from these remote and harsh environments, with satellite-based positioning accuracy.

Recently, two different concepts of ASVs have been developed at KTH Royal Institute of Technology. The first concept, ANKA, was built in 2015. The second concept, a fleet of ASV’s called Ducklings, was built in 2017. Both ANKA and the Ducklings are lightweight, robust, and manageable by 1-2 persons. They are equipped with single-beam echo sounders and GPS for collecting and georeferencing depth measurements up to 200 meters. Operating at a nominal speed of 1.0 m/s, and equipped with battery capacity to run continuously for 6-12 hours (depending on concept and configuration), they can efficiently map large, uncharted sea/lakefloors. The vehicles have been used to map two Arctic lakes, each very difficult to reach and map thoroughly using conventional, manned, methods: In 2016, Lake Tarfala in the Kebnekaise mountains of northern Sweden was mapped [1]. In 2018, two Ducklings were used to map Lake Isvatnet on Phippsøya in the Seven Island Archipelago north off Svalbard. The presentation will show the results from these two missions and illustrates the potential to use ASVs for the collection of high-resolution bathymetric data.

Greenlandic aeolian dust deposits dated using several luminescence techniques and radiocarbon

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Wind-blown dust deposits, ‘loess’, are abundant in the arid proglacial landscape of West Greenland. Loess reflects past dust activity and can be used as paleoenvironmental archives. However, these deposits are highly underutilized by researchers, in part due to the challenge of dating them reliably. Here, we explore several luminescence techniques and 14C to overcome this obstacle.

High resolution luminescence dating of sediment samples is attempted on two different mineral fractions and three particle size fractions. AMS radiocarbon dating is conducted as an independent age control.

Preliminary results show that feldspar Infra-Red Stimulated Luminescence (IRSL) dating of the fine silt (4-11 µm) fraction produces superior results compared to sand fractions and quartz minerals. Ten IRSL dated silt samples from a section sampled at ~9 cm intervals are all in stratigraphic order and show good agreement with radiocarbon ages. The two sand fractions (63-90 and 250-300 µm) are poorly bleached and provide some age over-estimations.

Our results show that Greenlandic loess deposits can be reliably dated using feldspar silt fraction IRSL and bulk radiocarbon. The deposits cover a large part of the Holocene and appear to not have been significantly cryoturbated, which highlights their considerable potential as paleoenvironmental archives for dust and proxy research.
High resolution hydroclimatic reconstruction from annually laminated Holocene proglacial lake sediments, Linnévatnet, Svalbard

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In Svalbard, periods of intense rainfall, associated with warm sea surface temperatures and declining sea ice cover, now occur during all seasons with the greatest increases seen in fall and winter. These changes have led to a shift in the hydrological regime with an increase in fall flooding when permafrost active layer is deepest and the potential transport of sediments is greatest.

Here, we present preliminary results analyzing annually laminated sediments from a proglacial lake in western Svalbard, targeting the sedimentary signal of recent changes in hydrology. Laminated sediments are used to reconstruct the long-term history of rainfall-related sedimentary events, to determine when similar autumn “shoulder season” conditions may have prevailed in the past. Monitoring watershed and climatological processes from 2003 to 2018 provides a direct interpretation of annual varve sedimentation in recent years. Over this period, intervalometer-calibrated sediment trap analysis indicated that from 2003 to 2010, peak river discharge occurred during the spring-summer nival flood, while in 6 of the past 8 years peak flow and sedimentation occurred during early and late fall rain storms.

About 1000 scanning electron microscope images (1024 X 768 µm) were taken from thin sections from a sediment core recovered in 2018 and processed to extract annual grain-size and varve thickness (VT) for the past ~900 years. Results show that thicknesses from the adjacent sediment traps collected over the past 14 years compare well with VT and D50 µm from the sediment core (R=0.70, p=0.005). The long-term coarse grain-size variability in Linnévatnet is coherent with that of VT from the sediment core (R=0.61, n=900, p<0.0001). Both parameters are strongly correlated to instrumental June to September (JJAS) temperature and also to the JJAS Atlantic Multidecadal Oscillation (AMO). Spectral analysis of the grain-size reveals a persistent 60-76 year-cycle over the past ~900 years that we hypothesize to be linked to the AMO. Finally, our record suggests that the temperature increased to unprecedented levels in the past two decades compared to the last 900 years.
Coarse-grained mineral dust deposition records in alpine lakes suggest more frequent tornadoes during warmer intervals of the late Holocene period in arid and semi-arid tracts of North America.

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Mineral dust accumulation is often causally associated with aridity, with higher dust deposition rates assumed to reflect higher magnitude of aridity. However, the relation between dust deposition and aridity is not straightforward; grain sizes play a crucial role in processes associated with mineral dust generation, transportation and deposition in sedimentary settings.

In this study, we apply grain-size analyses to six well-studied cores (spanning the late Holocene), previously collected from high-alpine lake sites distributed across the arid regions of west, southwest, and the Great Plains of North America. Previous work on these cores has demonstrated that sedimentary deposition in these lake sites was of detrital origin.

Particle size analyses reveals that the most commonly occurring grain sizes are a fine fraction (typically <4 microns, which is easily lofted and transported long distances) and a coarse fraction (typically >25 microns and in some cases with a distinct peak at 100 microns, both of which usually reflects short distance transportation). We used grain size separation techniques to separate the two size fractions and finally selected three sites (that represented the most youngest ages) to geochemically fingerprint the size fractions.

We find that an increase rate of deposition in the coarser coarser-grain sizes fractions to be associated with wetter intervals over the Holocene. Furthermore, we also find that the geochemistry of the coarse fractions indicate regional sourcing of the material (instead of local sourcing determined using a comparison with bed-rock geochemistry). Note that we do not find any clear relationship patterns between the fine fraction and aridity patterns and also the geochemistry does not reveal a clear source region.

We hypothesize that the increase in coarser fraction during wetter intervals is related either to intensification of land-use patterns associated with agriculture and/or to more frequent occurrence of intensely windy meteorological events (e.g. tornadoes); in fact warmer and wetter intervals in the areas under consideration have been associated with intensified cyclogenesis. Our study demonstrates the critical need to incorporate grain-size analysis as well as fingerprinting of the different size in interpreting mineral dust record.

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A Multiproxy, Varve-Derived Chronology of Kongressvatnet, a Svalbard lake

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Lake basin sediments contain proxies through which paleoenvironmental and paleoclimatic conditions can be estimated. However, in order to reconstruct climate variability with the highest degree of temporal accuracy, these climate signals may be calibrated to a near-annual, varve-derived chronology. This Svalbard lake core study observes local Late Holocene climate variability (using geochemical, geotechnical, and mineralogical proxies) through the lens of a varve-based, high-resolution timeline.
Holocene landscape disturbances in the central highlands of Iceland as recorded in soil sediment archives

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Ongoing and widespread soil erosion in the Icelandic Highlands threatens the sustainability of terrestrial environments in this ecologically sensitive region. The effects of land degradation and aeolian erosion are expressed on the landscape as blowouts, erosional spots, rofabards, and desertified surfaces. It remains unclear whether these features and ongoing erosional processes are a response to natural climatic variability or the arrival of Norse settlers ~1.2 ka and their introduction of grazing livestock. This study aims to differentiate between relative roles of climate change and human activity in driving vegetation loss and soil erosion in central Iceland through analyses of soil sediment sequences. Most soils in the Highlands are classified as Andosols (primarily composed of volcanic/minerogenic material), commonly containing a series of distinct tephra layers from Holocene volcanic eruptions of known ages. Where present, surface vegetation acts to stabilize underlying soils. Disrupted vegetation cover allows soil to become vulnerable to aeolian erosion. We have collected a suite of 19 soil sedimentary profiles, varying in length from 0.85m—4.3m, situated along a ~100 km latitudinal transect between Langjökull and Hofsjökull ice caps. Sedimentological parameters including: bulk density, organic content, grain size, and sediment accumulation rates were analyzed to determine the onset and signature of accelerated soil erosion during the late Holocene. Regional tephrostratigraphy is well established, providing accurate age control. Soil age models indicate that, where present, relict soils have persisted for at least the past ~8 ka. The data suggest regional soil erosion rates increased during the past two millennia AD and that accelerated erosion rates are unprecedented within the length of the records. Preliminary results suggest spatiotemporal variability in the onset of widespread erosion during the Late Holocene, commonly occurring between tephra layers corresponding to 1300 AD and 1721 AD. This event is characterized by diagnostic changes in sediment parameters recorded within soil profiles, recognized as a sharp transition to coarser grained, minerogenic sediment, low in organic content, from finer-grained relict soils that had accumulated gradually through the Holocene. Comparing data from this study with existing regional paleoclimate data will provide insight into landscape responses and Holocene landscape instabilities.
Population residing on permafrost in the circumpolar Arctic

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The global permafrost region occupies ca. 15% of the terrestrial Earth surface and 24% of the northern circumpolar region. The near-surface permafrost in the high Arctic has warmed by more than 0.5°C between 2007–2009 and 2017, triggering permafrost disturbances in the landscape. These changes have strong impacts on the Arctic ecosystems and on the life of the Arctic inhabitants who are dependent on this ecosystem in their daily activities. To assess the impacts of permafrost thaw on the population residing on permafrost it is crucial to combine demographic data with permafrost extent data. This study presents recent data on the structure of permafrost settlements in the northern circumpolar Arctic region and estimates the impacts of permafrost thaw on the population residing on permafrost. We used demographic data from 2017 at the settlement level from the national statistical institutes. We combined this data to a permafrost extent and thaw risk database to count the number of settlements and people living on permafrost and to estimate the type of risk that these settlements and inhabitants will be facing in the near future. Key findings show that 51.3% of Arctic settlements are located on permafrost giving residence to 34.3% of the Arctic population. In total 49.3% of the permafrost settlements are coastal, highly dependent on resources from the sea. Majority of the population residing in a permafrost settlement lives along the coast, except in Sakha and Khanty-Mansi (Russian Federation), the Yukon, and the Northwest Territories (Canada). By 2060, 46.7% of these settlements will not be underlay by permafrost any longer and 61.9% of the inhabitants who are currently living on permafrost will have to adapt to this change. This will have a strong impact on the infrastructure in these settlement as well as on the daily life of permafrost inhabitants.
The influence of frozen ground on the productivity of Rhododendron groenlandicum in the Alaskan boreal forest

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The presence or absence of permafrost is the most significant threshold in determining the composition of an ecosystem within the Boreal Forests of Interior Alaska. While the relationship of permafrost and vegetation is well understood on a broad ecosystem scale, little attention has been paid to individual species. The productivity of Labrador Tea (Rhododendron groenlandicum), a common medicinal plant found throughout the northern hemisphere, offers insight into how the thawing of permafrost in the coming decades may impact plant productivity. This study aims to decipher whether the presence of frozen ground throughout the growing season impacts the productivity of Labrador Tea by tracking the growth of 84 individual plants within four ecosystem types within the Boreal Forests near University of Alaska Fairbanks Campus throughout five weeks in the summer of 2018. Plants present in deciduous dry ecosystems were the most productive, whereas those in coniferous frozen ecosystems were the least productive. Soil moisture and ground temperature account for some of the variation in leaf productivity, whereas the rate of thaw positively correlates with the growth rate of leaves for plants in areas with frozen ground. These results support the notion that Labrador Tea is a relatively plastic plant, and has the potential to transition to a more productive life history strategy as frozen ground thaws in the future. This understory behavior could offset some of the carbon released by a warming arctic, however more research is required to assess whether this behavior is consistent with other understory species and to explain why thaw rate and leaf growth rate are related.
High resolution mapping of Permafrost Landforms and soil properties at catchment scale, Beaufort coast (NW Canada)

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Current research indicates that Arctic coastal systems are considered as highly vulnerable towards climate change. More than one third of the Earth's coastlines are comprised by Arctic permafrost coasts. Along the Yukon coast in Northwestern Canada, erosion rates of up to 25 m yr⁻¹ at specific locations and retreat rates of 0.5 m yr⁻¹ occur.

As part of the EU project Nunataryuk our goal is to map and characterise land cover and landforms of small arctic catchments using high spatial resolution data. The landforms in the investigated catchment are portrayed by high- and low-centered ice wedge polygons at different stages of degradation. To classify and distinguish these different types, we use Object-Based Image Analysis (OBIA). To estimate the spatial distribution of soil organic carbon and nitrogen stocks, we apply Machine Learning (ML) Digital Soil Mapping methods. Previous studies show that ML methods can gain promising results. Environmental variables derived from satellite data and digital elevation models are used for training and prediction. Our goal is to characterise small catchments at a high spatial resolution to link soils, soil properties and potential fluxes from land to the sea.
Primary succession process and changes of soil properties along foreland of Irenebreen (NW Svalbard)

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Soil development and vegetation succession are inseparably linked and influence each other. On the one hand the stage of soil development is one of the main factors responsible for local habitat diversity in the Arctic region and on the other transformation of vegetation in time greatly affects the soil properties itself. To study the relationships between soil chemical parameters and vegetation development, glacier foreland of Irenebreen (NW Svalbard) has been chosen. In the foreland, three parallel transects were designated from the current glacier forehead till the end of foreland. In every 50 m along each transect, species cover and overall vegetation cover were investigated in 1 m² plots, and soil samples were collected for later laboratory analyses. Changes in soil chemical parameters (i.e. content of total organic carbon, total nitrogen, total sulphur, soil pH) and vegetation cover were analysed in relation to distance from the current glacier forehead and time elapsed after glacier retreat. Analyses showed that both total organic carbon and total nitrogen contents are positively correlated with the distance from the glacier forehead as well as the time after the glacier retreat, and their contents change according to power and exponential functions, respectively. Concerning soil pH, it decreases linearly with increased time after glacier retreat. The wide variation in total sulphur contents prevent the determination of clear relationships. The study showed that vegetation cover and soil parameters are interrelated: with increasing vegetation cover the contents of total organic carbon, total nitrogen, and total sulphur in soil gradually increases whereas soil pH decreases. Vegetation cover seems to be the main factor effects on soil properties; however, chemical soil properties and distance from the glacier forehead affect species distribution and vegetation cover. The number and cover of cryptogam species colonising the foreland of Irenebreen considerably exceed the number and cover of vascular plant species. This indicates the need for comprehensive analyses on the relationship between cryptogams and initial soil development on the glacier forelands.
The impact of permafrost forecasting accuracy on predicting the influence of Arctic vegetation type and disturbance events on permafrost degradation

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The Arctic is covered in vastly different terrains and ecotypes that affect the properties of the soils beneath the vegetated surface. Vegetation in the Arctic region faces periodic disturbance events such as fires or human interference that change the basic soil composition in these areas. This project aims to quantify and analyze the extent to which ecotype and disturbance events affect active layer soil properties and consequently influence the rate of permafrost degradation. The properties of soil of two different Arctic ecotypes, the boreal forest and dry tundra, and a “disturbed soil” scenario were formulated using a combination of fieldwork and lab analyses. Temperature and precipitation data from 1929-2018 was used to assess the “past warming scenario,” and synthesized data for both a 4.6 and 8.5 Representative Concentration Pathway (RCP) warming scenario from 2019-2099 were used to create a “future warming scenario” for each ecotype analyzed. Additionally, the accuracy of the Geophysical Institute Permafrost Model (GIPL) was assessed by comparing previously forecasted permafrost temperatures with measured mean annual temperature values at the permafrost table (MAPST) from 2010-2017. This comparison was used to comment on the plausibility of both of the future warming scenarios presented. All permafrost table data was analyzed at a one-meter depth. The slope of the line of best fit for the measured data of permafrost temperature at a one-meter depth was 0.19 units higher than the slope of the line of best fit for the forecasted data at the same depth. This disparity was critically examined to determine the extent to which GIPL accounts for soil layer dynamics in its analyses.
The First Svalbard Holocene Assembly: Introducing the SVALHOLA Network

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Climate change is one of the most serious challenges facing society today. Hence, there is a pressing need to improve our knowledge of natural climate variations and establish long-term reference values. The climate on Svalbard during the Early and Mid Holocene resembles the current climate regime on Svalbard (i.e. warmer regional waters, increased precipitation and reduced land-based ice cover). Yet, unlike those earlier periods, solely natural driving forces cannot explain the current changes.

The first Svalbard Holocene Assembly was held the 1st-3rd of February 2019 at The University Centre in Svalbard (UNIS) in Longyearbyen, Norway, funded by the Research Council of Norway and the Svalbard Science Forum. The workshop gathered international researchers and institutions involved in studies of Holocene glacier and climate history on Svalbard in order to discuss recent research developments, identify priorities in research activities, and plan for future directions. The workshop united thirty-six early career and senior researchers as well as students with experience in marine, terrestrial, lacustrine and cryosphere fields in addition to ice-sheet modelers. One of the key objectives of the workshop was to discuss interdisciplinary collaboration and correlation between environments.

As a product of the Svalbard Holocene Assembly, the SVALHOLA Network was developed as an international working-group by the workshop participants. The network will strive to i) initiate collaborative projects between research groups, ii) promote holistic studies that synthesize evidence from sedimentary archives (terrestrial, marine, lacustrine and cryosphere) and iii) develop multi-disciplinary projects that combine field-data with climate proxy records and modeling studies. Organization, collaboration and a holistic approach are key ingredients for better understanding the Holocene glacial, landscape and climate history of Svalbard. This knowledge provides a critical perspective to assess the future of Svalbard’s landscapes, ecosystems, and human population in a changing Arctic.
The current state of landscape-geochemical systems of West Spitsbergen Island

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Current climate changes cause glacier retreat in polar and alpine landscapes. Due to thawing, vast areas get free of glaciers, where mechanical, physio-chemical and biogeochemical processes are intensified. Transformation of landscapes is particularly pronounced in the polar latitudes.

The study of the current state of landscape-geochemical systems was conducted on West Spitsbergen Island in the summer season of 2010 and 2013.

The Svalbard Archipelago is located in the high latitudes of the Arctic. Mountainous terrain determines the vertical zoning of landscapes. Under current climate changes, the following development stages of the landscape - geochemical systems of West Spitsbergen Island are formed:

- nival landscapes of the glaciation zone, in which primary organic matter is formed in cryoconites and on the surface of rocks;
- periglacial wastelands and polar deserts with pioneer vegetation;
- arctic tundra with a pronounced polygonal and tundra vegetation;
- unique ornithogenic landscapes - a special type of grassy or meadow tundra under sea-bird colonies, which are the “Center of Life” in Svalbard;
- intrazonal landscapes of the bottoms of valleys are characterized by intensive dynamics of the processes of formation of the modern geosystems.

The research results show that the processes of biogeochemical migration of chemical elements are actively going on Svalbard, leading to the formation of new types of geochemical landscapes. Primary mechanical weathering starts in nival landscapes, where occurs enrichment with lithogenic chemical elements and primary organic matter originated from blue-green algae. Typical tundra landscapes with low pH values accumulate heavy metals originated from weathered postglacial deposits on the oxygen, biogeochemical, and gley barriers. The maximum accumulation of almost all lithogenic elements is observed in ornithogenic landscapes due to the biotic development of the coastal zone by large colonies of gulls and supply of matter from the sea during the functioning of bird colonies. In this regard, there is an accumulation of chemical elements that are not typical for the terrestrial landscapes of Spitsbergen.

Thus, biogeochemical transformation of all components in Spitsbergen’s geosystems requires landscape-geochemical monitoring in West Spitsbergen.

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Water chemistry responses to different types of bedrock in Foxfonna and Linnédalen, Svalbard, Norway

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The study gives an overview of the bedrock geology of Linnédalen and Foxfonna glacier in Svalbard and points out the differences in glacial, karst system and rock glacier area in relation with water chemistry. The possible origin of streams is briefly discussed. The study is based on water samples from several streams in Linnédalen and Foxfonna, Svalbard, that were collected and measured for pH and electrical conductivity values in July and August 2018 and later compared to the bedrock of each study site.
Occurrences of the Vedde Ash in meltwater-fed basins imply a late Younger Dryas maximum ice-sheet extent in the Trondheimsfjorden region, central Norway

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The Scandinavian Ice Sheet responded to the Younger Dryas (YD) stadial in an apparent time-transgressive fashion with large regional variation (see e.g. Mangerud et al., 2016). In the Trondheimsfjorden area, central Norway, there are two prominent ice-marginal zones related to the YD: the Tautra Moraines and the Hoklingen Moraines, previously radiocarbon dated to c. 12.7 cal. ka BP (early YD) and 11.6 cal. ka BP (late YD), respectively (e.g. Rise et al., 2006; Olsen et al., 2015). The Tautra Moraines represent the maximum ice-sheet extent during the YD, and the glacial re-advance which formed it created the ice-dammed Leksvik glacial lake at c. 225 m a.s.l. on the Fosen peninsula, on the northern shore of Trondheimsfjorden (Selnes, 1982). The pro-glacial lake submerged the present-day Lake Lomtjønna basin and drained through a spillway that transported sediments into present-day Lake Rørtjønna.

New investigations of sediments from these basins, including identifications of tephra horizons, suggest that the ice-dammed lake existed in the late rather than the early YD—an interpretation based on the units of fine-grained glacial sediments corresponding to the ice-dammed lake stage found above visible layers of the Vedde Ash, dated to c. 12.1 cal. ka BP, in both lake basins. This implies that the glacial re-advance which formed the Tautra Moraines occurred much later than previously suggested, and is comparable to the late YD maximum ice-sheet extent reconstructed in southwest Norway (Lohne et al., 2012; Mangerud et al., 2016) and, recently, in southeast Norway (Romundset et al., 2019).

The ice sheet covered the area inland of the ice-marginal zone at this time, which is supported by a tephrochronological investigation at the site of Damåsmyran, northeast (inland) of the Tautra Moraines. Here the Vedde Ash is only found as a diffuse cryptotephra at the bottom of the sediment column, interpreted as a reworked, low-concentration occurrence in the meltwater sediments from the later retreating ice-sheet.

The results presented here call for a revision of the deglaciation in the region, and a challenge arises considering the contradiction to radiocarbon-dated ages of the Tautra and Hoklingen Moraines.
Using streamlined landforms to reconstruct and compare paleo-ice flow paths in Bárðardalur, north Iceland and northwestern Pennsylvania

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The properties of streamlined landforms and paleo-flow indicators in the valley of Bárðardalur, north Iceland and northwestern Pennsylvania (NWPA) were quantified using a combination of spatial analyses, fieldwork, and sediment analysis. The study region in Iceland is primarily composed of basaltic bedrock from the Pliocene and Pleistocene epochs, while the study region of Pennsylvania is sedimentary rock formed during the Devonian epoch. A combination of satellite imagery from Google Earth, the National Land Survey of Iceland Map Viewer, and a 5m mosaic of the Arctic Digital Elevation Model were used to identify drumlins and megascale glacial lineations (MSGL) in Iceland, while Pennsylvania Spatial Data Access Data and 7.5 minute topographic maps from the United States Geologic Survey were used to identify similar features in part of northwestern Pennsylvania. Quantitative analyses were conducted in ArcGIS using the manually traced data set. Landforms were classified as either drumlins or MSGL by elongation ratio, with drumlins having a ratio of < 10:1 and MSGL having a ratio of ≥ 10:1. In Iceland, at least 148 streamlined landforms were identified in Bárðardalur using Google Earth, with 69 drumlins and 79 MSGL. Average elongation ratio and parallel conformity of these landforms is 11.7:1 and 6.03 degrees, respectively. The modal orientation of these streamlined landform long axes is 317.8 degrees. The landforms present in Bárðardalur have an average density of 1.85 landforms per 1 km2 and average packing value of 0.14 landform surface area per km2. In northwestern Pennsylvania, at least 312 streamlined landforms were identified, with 304 drumlins and 8 MSGL. The distribution of the NWPA landform elongation ratios has an average of 4.38:1. Parallel conformity of the landforms in NW PA is 8.48 degrees, and the modal orientation of streamlined landform long axes is 150.6 degrees. The average packing of NWPA landforms is 0.14 landform surface area per km2 while average density is 1.38 landforms per km2. In comparing these two datasets, factors such as bedrock composition and geothermal heat gradient are being considered to analyze the extent to which they influence the presence of streamlined landforms in each of the study regions.
The Veiki moraines – A key to the glacial history of northern Scandinavia

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Northern Sweden is a key area when reconstructing Late Quaternary environmental changes and the history of the Scandinavian ice sheet. It is a core area of the former ice sheets and most of Sweden’s known pre-LGM interstadial sites are found here. Many of these sites are still lacking absolute age data or they have poor or only partial age constrains. Due to this, the ice-sheet dynamics and environmental variability during the Weichselian glacial period in the area are not fully understood.

The Veiki moraines in northern Sweden have attracted attention in the past and present. The moraines commonly display a hummocky terrain with a circular plateau surrounded by a rim ridge, but the morphology varies among individual moraines and areas of occurrence. In Fennoscandia the moraines are a distinct landform that covers an area mainly in the County of Norrbotten, northern Sweden, but have also been identified in other areas in Sweden and in northwestern Finland. Many hypotheses have been proposed regarding the origin of the moraines. The currently leading interpretation is that they are ice walled lake plains which have been overridden by an ice sheet and draped by a till. Their age is however, still debated and recent proposals range from Early Weichselian to Middle Weichselian; previous proposals of a Late Weichselian deglaciation age have been disproved. The lake sediments within the moraines thus contain palaeoenvironmental records of at least one Weichselian interstadial.

This study focusses on a Veiki moraine plateau at Kortejärvi, located nearby Junosuando, Norrbotten County in northern Sweden. The aim is to date the subsurface sediments and to reconstruct the environment during their deposition. This will contribute with information about the glacial history of northern Scandinavia. Sedimentological analyses have been carried out on a 5-m-long core and samples for optically stimulated luminescence and radiocarbon dating and pollen analysis have been collected. Ground-penetrating radar profiles from Kortejärvi have been examined to find the optimal coring site, and will further be used in the interpretations. Here we will present preliminary results of our investigations.
Reconstructing the central sector of the Cordilleran Ice Sheet through the last glacial period

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The Cordilleran Ice Sheet (CIS) repeatedly covered western Canada during the Pleistocene and attained a volume and area similar to that of the present-day Greenland Ice Sheet (GIS). The ice sheet had a western marine-terminating margin in the Pacific Ocean, and at maximum extent, an eastern margin that locally coalesced with the Laurentide Ice Sheet. The basal topography of the CIS, with a core central zone surrounded by high mountains, is similar to that of the present-day GIS and therefore, determining the response of the CIS to abrupt climate changes during the Pleistocene provides an analogue for the present and future behaviour of the GIS.

The subglacial mountainous terrain makes it challenging to reconstruct local glacial dynamics, impeding the reconstruction of ice sheet-wide glacial advance and retreat patterns and the central sector of the CIS that covered the mountain systems of northern British Columbia and southern Yukon Territory is one of the least understood areas of any ephemeral Pleistocene ice sheet. Here we present a preliminary glacial geomorphological map of the Cassiar Mountains, which hosted an ice dome at the centre of the CIS during the Last Glacial Maximum. The glacial landforms, including moraines, drumlins, eskers and meltwater channels, were mapped using high resolution remotely sensed data and their spatial distribution defines the evolving ice sheet configuration. This glacial geomorphological map will be used to understand the relationships and relative ages of different landforms across the Cassiar Mountains, and to identify sampling locations for quantitative chronological methods in order to determine the absolute chronology of ice advance and retreat.
Developing new proxies for an under-utilized archive, glacial marine diamict: a pilot study from West Greenland

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Observing past dynamics of the Greenland Ice Sheet is important for constraining future cryospheric responses predicted by coupled numerical ice, ocean, and atmosphere models. However, due to glacial erosion and transport, the terrestrial evidence of prior glaciations and interglaciations, and thus, much of the ice sheet’s history, is only preserved in marine archives. Deep water sediments provide continuous time series of past climate, but are located far from the glacial sources and therefore do not directly record the behavior of the Greenland Ice Sheet. Moreover, previous applications of detrital isotopic techniques to deep water sediments proved challenging due to the scarcity of sand-sized minerals. In ice-proximal shelf environments, sequences of glacial-marine diamict were deposited and occasionally preserved from subsequent erosion. These sediments are under-utilized for paleoclimatic and paleographic interpretations because they are challenging to recover, difficult to date, and lack an easy-to-interpret stratigraphy for commonly applied analyses.

Here, we show that glacial-marine sediments from the continental shelf contain abundant quartz for cosmogenic nuclides, detrital apatite for (U-Th)/He thermochronology, and leaf waxes from terrestrial and marine sources. These analytical techniques, when applied together, provide a unique opportunity and a novel approach to examining millions of years of glacial/interglacial exposure, erosion, and climate history.

We are currently analyzing ~1.8-2.0 Ma glacial diamict recovered from IODP Core 344S-U0110 collected from Melville Bugt on the western Greenland continental margin. We separated the diamict by grain size, shape, and mineralogic fraction for meteoric Be-10 and in situ Al-26/Be-10 measurements. In the 850-2000 mm fraction, 20\% of the quartz grains are well rounded and iron-stained, compared to other clear, angular grains. This suggests that the diamict may preserve both pre-glacial, fluvially rounded grains and sub-glacially abraded and eroded angular grains. These sediments contain well-preserved terrestrial and marine plant biomarkers, which we use to infer paleoenvironments. Detrital apatite (U-Th)/He analysis sheds light on the efficacy of both long-term and glacial erosion in sculpting Greenland’s present topography.

Based on these data, we demonstrate that the application of multiple, complementary analytical methods to glacial-marine diamict has previously unrealized potential for deciphering the Cenozoic glacial history of the high latitudes.
Late Holocene IRD fluctuations in the fjord Ata Sund, West Greenland, record rapid glacier response to changes in water temperature

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In order to quantify the Greenland ice sheet’s contribution to future sea level rise, it is important to understand the processes involved in glacier retreat. The processes that occur on the border between the ice sheet and the ocean influence outlet glaciers calving activity and the production of icebergs. This in turn, permits the study of fjords and their sedimentary archives as proxies for glacial activity and extent. Here we contribute a grain size analysis of two marine sediment cores to help elucidate the last 600 years of glacial history in the fjord Ata Sund. Ata Sund is located on western Greenland and is connected to the well-studied Disko Bay. We use Ice Rafted Debris (IRD) as a proxy for calving activity of the two marine terminating glaciers in the fjord, Eqip Sermia and Kangilerngata Sermia. To obtain the IRD proxy, we use and compare two methods, wet sieving and x-ray computed tomography (CT). Based on assemblage of foraminifera in the sediment record we also reconstruct bottom water temperatures in the fjord. The results show three distinct periods from the onset of the record in 1400 CE until today. High calving activity and stable bottom water temperatures characterise the first period lasting from 1400 to 1920 CE. The following period, lasting from 1810 to 1920 CE, evidences a distinct decrease in calving activity and bottom water temperatures. We suggest that colder arctic waters influence the fjord waters during this period that increased the sea ice production during the winter seasons. High amount of sea ice would hinder glacial calving and iceberg production. During the third period, lasting from 1920 to 2014 CE, the calving activity increased again, but did not reach previous values. The bottom water temperatures stabilize at a lower temperature compared to the first period, before starting to increase just at the end of the third period. The third period holds retreating and smaller glaciers consequently produce less icebergs and affords icebergs transport routs other than those crossing our core location.
Provenance of iceberg derived material during Greenland stadials and interstadials in Marine Isotope Stage (MIS) 3

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Provenance studies of ice rafted debris (IRD) are key to improve our knowledge of past and future iceberg transport and ice sheet variability. Especially, for MIS 3, the impact of cold Greenland stadials (GS) and warm Greenland interstadials (GI) on the mass balance of Northern hemisphere ice sheets is highly debated. Increased calving rates were proposed for both, GI and GS, whereby the Northern hemisphere ice sheet collapses occurred every fourth GS on average resulting in so called Heinrich (H) events. Altogether six of those collapses were discovered within the last 65 ka. They are evident from thick layers of IRD deposited between 55 and 40°N (Ruddiman belt) in the North Atlantic, mainly transported by icebergs from the Laurentide ice sheet. For H3 and H6 occurring during GS5.1 and GS18, respectively, icebergs from the European ice sheet seem to be the main source and were even proposed as the trigger for Laurentide ice sheet collapse. However, the role of the Greenland ice sheet is largely underestimated or unknown. Here, we present continuous records of IRD and petrologic tracers combined with Scanning Electron Microscopy (SEM) and Pb-isotope analyses in single K-feldspar grains from a marine sediment core (GS16-204-22CC, 58°02.83 N, 47°02.36 W) located south of Greenland, in the northeastern Labrador Sea, outside the main route of the Ruddiman belt. The combination of traditional and modern analytical techniques allows us to investigate differences and similarities of IRD sources during GS, GI as well as GS which are known for their huge ice sheet collapses. Our results confirm that the Laurentide ice sheet was the main contributor of icebergs during H4 but not during H3. In contrast to previous findings we hypothesize that only the IRD deposited during H6 is of European origin whereas the IRD coinciding with H3 mainly contains grains from Greenland. A question that needs to be further addressed is why the Pb-isotope signature as well as the SEM-data for GI14, a warm period with very little IRD input, and H4, a cold period with collapsing ice sheets are extremely similar.
New radiocarbon reservoir ages from coastal Greenland waters and the eastern Arctic Ocean

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Radiocarbon (14C) dating is the standard method for obtaining the age of marine sediments of Holocene and late Pleistocene age. For accurate calibrations, however, this tool relies on precise knowledge of the local radiocarbon reservoir age of the surface ocean, i.e. the regional difference (ΔR) from the average global marine calibration dataset. This parameter has become impossible to measure from modern mollusk samples because of 14C contamination from extensive testing of thermo-nuclear bombs in the second half of the twentieth century. The local reservoir age can thus only be calculated from the radiocarbon age of samples collected before AD 1950 or from sediment records containing absolute age markers, derived from e.g. tephrochronology or paleomagnetism.

Knowledge of the marine reservoir age around Greenland and in the Arctic Ocean is extremely sparse, and relies on work by only a few studies. No information exists for the Kara Sea, East Siberian Sea and the western Chukchi Sea, and the coastal seas around Greenland are represented by very few measurements, clustered in local patches. This study presents preliminary results of a series of new radiocarbon measurements on historical mollusk collections from Arctic Expeditions of the late 19th and early 20th Century. The new samples are from central east Greenland, the entire western Greenland coastline and the east Siberian Arctic extending into the northern Bering Sea.
Amino acid racemization geochronology using foraminifera from the Yermak Plateau

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Amino acid racemization (AAR) geochronology is a powerful tool for dating Quaternary marine sediments across the globe, yet its application to Arctic Ocean sediments has been somewhat limited. Anomalous rates of AAR in foraminifera from the central Arctic were reported in previously published studies, indicating that either the rate of racemization is higher in this area, or inaccurate age models were used to constrain the sediment ages. This study investigates racemization rates in foraminifera from three well-dated sediment cores taken from the Yermak Plateau during the 2015 TRANSSIZ Expedition. D and L isomers of the amino acids, aspartic acid (Asp) and glutamic acid (Glu), were separated in samples of the planktic foraminifera, Neogloboquadrina pachyderma and the benthic species, Cassidulina neoteretis to quantify the extent of racemization. In total, 241 subsamples were analyzed, extending back to MIS 7. Two previously published power functions, which relate the extent of racemization of Asp and Glu in foraminifera to sample age are revisited, and a comparison is made between the ages predicted by these calibrated age equations and independent geochronological constraints available for the cores. The analyses reveal an excellent match between ages predicted by a global compilation of racemization rates for N. pachyderma, and confirm that a proposed Arctic-specific calibration curve is not applicable at the Yermak Plateau. These results generally support the rates of AAR determined for other cold bottom water sites, and further highlight the purportedly high rate of racemization indicated by previous analyses of central Arctic sediments. Future work will focus on extending this study into the central Arctic Ocean, where independent chronologies for a number of cores are being constructed using OSL dating of quartz grains and calcareous nannofossil biostratigraphy.
Timing and paleoceanographic impacts of the onset of Arctic-Baffin Bay throughflow during the Holocene

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This poster presents initial data from a newly funded project that uses modeling and multi-proxy analyses of sediment cores from northern Baffin Bay to study the timing and consequences of the opening of the western gateway for Arctic freshwater to the Labrador Sea. Sediment cores at the head of Baffin Bay including cores from the southern outlets of Lancaster and Smith Sounds capture an expanded sediment record of the history of the western freshwater route through the Canadian Arctic Archipelago (CAA), owing both to the high sediment accumulation rates associated with ice sheet retreat and the high productivity in the North Water polynya (NOW). The project is applying both novel (nutrient tracers from ICPMS on planktic foraminifers; algal biomarkers) and traditional (quantitative X-ray diffraction mineralogy, benthic and planktic foraminiferal assemblages, stable isotopes on planktic foraminifers, Silica abundance) proxies on sediment cores as well as climate modeling with the Community Earth System Model (CESM) and Glacial Isostatic Adjustment modeling to test three hypotheses: 1. The opening of the western freshwater route of the Arctic-Atlantic throughflow changed the freshwater outflow to the North Atlantic with consequences for the AMOC; 2. Significant shallowing of the CAA channels by glacial isostatic uplift has changed the composition of the Arctic outflow with consequences for carbonate preservation and the AMOC; 3. The NOW formed in the middle to late Holocene as a consequence of increased Arctic sea-ice. Chronology development of the cores relies on radiocarbon dating and paleomagnetic secular variations from u-channels. The cores were selected to capture the time period prior to and following the opening of throughflow through Barrow and Nares Straits.

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Paleoceanographic evolution of the Eastern Baffin Bay during the Mid to Late Holocene

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The Baffin Bay is a semi-enclosed basin connected to the Arctic Ocean via several gateways in the Canadian Arctic Archipelago with Nares Strait being the deepest, whereas to the south, the Davis Strait Sill is linking the Baffin Bay to the North Atlantic Ocean. Thus, the Baffin Bay is as an important area for water interchange between the Arctic Ocean and the North Atlantic Ocean. The purpose of this study is to reconstruct the relative water mass exchange between the Arctic Ocean and North Atlantic Ocean, by reconstructing the fluctuations in entrainment of relatively warmer and saline Atlantic water via the West Greenland Current and the advection of colder southward flowing Arctic derived water masses. The study is based on a multiproxy investigation of a 738 cm long marine sediment core from the Eastern Baffin Bay near Upernavik (core AMD14-204C; 73°15.663’ N/57°53.987’ W; 987 m water depth). The results of 11 radiocarbon datings on foraminifera, benthic foraminiferal assemblage analyses, X-ray fluorescence data and organic pyrolysis data (Rock-Eval), reveal that several fluctuations in the incursion of Atlantic water have occurred in the Baffin Bay during the past 9.1 ka BP. The area was primarily influenced by deglacial conditions with substantial influx of meltwater from 9.1-8.0 ka BP, inferred by the general low species diversity in the benthic fauna and high values of terrestrial derived sediments. 8.0-7.1 ka BP and 6.5-5.8 ka BP mark two periods with strong incursion of Atlantic water masses, based on the high abundance of Atlantic water indicator species. These two periods coincide with decreasing abundancies of the benthic sea-ice indicator species, implying a reduction of the sea ice cover possibly related to increasing air temperatures. 3.2 ka BP marks a sudden transition towards a benthic fauna mainly comprised by agglutinated benthic species, indicative of enhanced carbonate dissolution, plausibly associated with influxes of cold corrosive Baffin Bay Deep Water and reduced inflow of warmer Atlantic waters. These cold subsurface water conditions persisted throughout the late Holocene, only interrupted by short-term subsurface ameliorations associated with increased advection of Atlantic water masses.
Freshwater content in the Arctic Ocean and summer warmings

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The results of the study of freshwater content in the Arctic Ocean and the subarctic zone of the North Atlantic are presented. It is shown that the increase in freshwater inflow and desalination of the subarctic Atlantic in the 1950s and early 1960s is associated with summer warming in the Arctic. The increase of freshwater content in the Baffin Sea, the Davis Strait and in the western part of the Fram Strait in the 1990–2000s is also caused by the strong summer warming in the Arctic. In the eastern part of the Fram Strait significant positive anomalies of temperature and salinity were observed due to the increase of inflow from the Atlantic to the Arctic Ocean. As a result, the upper boundary of the Atlantic water layer in the Eurasian basin rose and some of the desalinated water in the upper layer shifted to the Canadian basin.

The influx of sea ice and fresh water from the Arctic affects the formation of abnormal desalination in the subpolar Atlantic. The similarities in the distribution of salinity anomalies in the Fram Strait and in the Baffin Bay in the 1960s and 2000s can be considered as a harbinger of a new salinity anomaly in the North Atlantic due to increased water influx and sea ice from the Arctic. However, large-scale desalination across the North Atlantic, like in the 1970s, is not yet observed due to an increase of warm and saline waters flow from low latitudes. The increasing of air temperature and salinity of the surface layer persists in the considered region of the North Atlantic from 2000 to the present due to an increase of inflow from low latitudes. But in the last few years, the occurrence of negative temperature and salinity anomalies in the Labrador Sea and in the adjacent water area as a result of increased inflow of fresh water and sea ice from the Arctic has been noted.

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