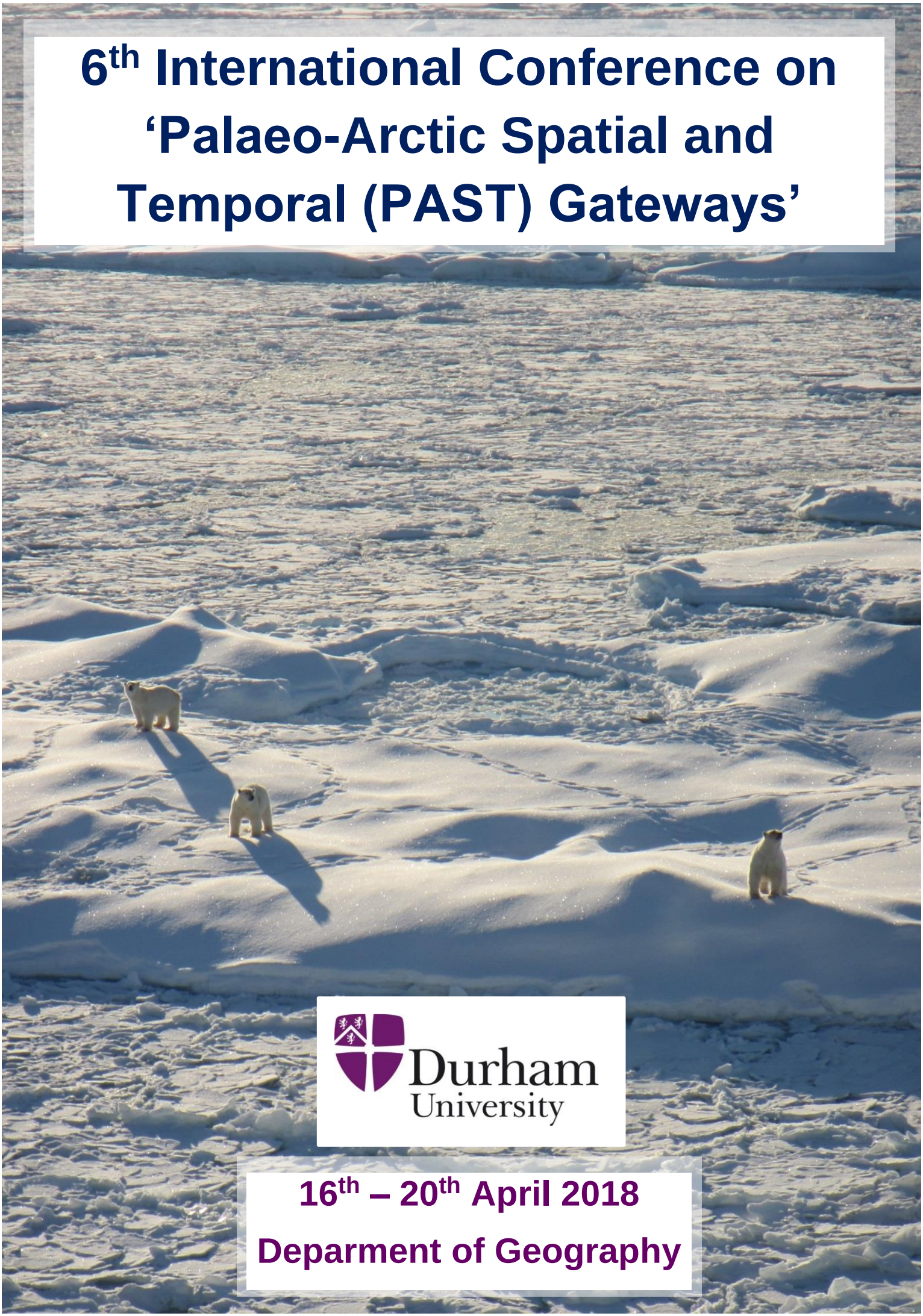
6th International Conference on 'Palaeo-Arctic Spatial and Temporal (PAST) Gateways'



Durham University

16th – 20th April 2018

Deparment of Geography

Conference Programme

Contents:

***Cover photograph**: Polar bears enjoying the sunshine in front of 79N Glacier, north-east Greenland (photograph: Jerry Lloyd, Durham University)*

Welcome and Introduction

On behalf of the Department of Geography at Durham University, it is our pleasure to welcome you to Durham for the 6th International Conference on 'Palaeo-Arctic Spatial and Temporal (PAST) Gateways'. We are delighted that we have over 70 delegates registered for the meeting, with around 40 oral presentations and around 30 posters spanning a range of exciting topics. It promises to be a very stimulating academic programme and we are pleased to be able to host our ice-breaker in the magnificent surroundings of Durham Castle, together with our Conference Dinner in Hatfield College, which is the second oldest University College. Indeed, we hope you get a chance to experience the splendour of Durham City during your time here, including the Norman Cathedral, which Bill Bryson referred to as "*the best cathedral on planet Earth*".

We wish you a successful, productive and enjoyable meeting and look forward to welcoming you back in the future.

The Local Organising Committee

Colm Ó Cofaigh (Chair), Chris Stokes, Louise Callard, Dave Roberts, Sarah Woodroffe and Jerry Lloyd.

Conference Venue, Department of Geography (West Building), Durham University

History of Durham University

After the Dark Ages in Europe, the 7th Century saw a flowering of thought and culture in the North East of England. Bede - poet, scientist, historian and the greatest European scholar of the 7th century - is buried in Durham, as is St Cuthbert, who established 'English' Christianity from its Celtic and Roman roots. The Lindisfarne Gospels, 'one of the great landmarks of human cultural achievement', were produced nearby and resided in Durham with the body of St Cuthbert until the 16th century when they were removed to London. The 'Cuthbert Community' became one of the richest in Europe, with lands extending from the Tyne to the Tees and beyond. This scholarly, monastic community was a precursor of the modern University tradition which spread across Europe and around the world. Durham's 11th century Norman Cathedral was built between 1096 and 1130 and is one of the world's truly great buildings. Durham Castle, now part of the University, dates from 1072 and was the seat of the all-powerful Prince-Bishops who wielded secular and religious power over much of the North of England, with their own armies, system of taxation and coinage. Until the end of the Prince-Bishopric in 1832 Durham was effectively a state within a state.

Durham Cathedral from the River Wear

Durham became one of England's leading centres of medieval scholarship, along with Oxford and Cambridge. Indeed, three Colleges - now part of Oxford University - were founded from Durham (University College and Balliol College, and in 1286 Durham College was run from Durham to train scholars for Durham for 300 years until it became incorporated into the University of Oxford as Trinity College). Henry VIII and Oliver Cromwell's attempts to formally establish a University for the North in Durham were subsumed by politics and North-South

rivalries, and it was not until 1832, that Durham was finally endowed with the Castle and lands and granted degree awarding powers by the king as England's third University.

With a medieval World Heritage Site at our heart, our new buildings continue the tradition of important and innovative architecture. Durham was one of the first universities to admit women on an equal footing to men (1890), to establish medical training (1834) and the first to award Civil and Mining Engineering degrees to meet regional and national needs during the industrial revolution (1838). Durham led in the development of science and established one of the earliest observatories in England. Durham University was based in two cities for over 100 years, its medical school at King's College and other Colleges in Newcastle becoming the new and independent University of Newcastle in 1963. In 1992 the University established a significant presence at our Queen's Campus in the heart of Tees Valley, reinitiating medical teaching and breaking disciplinary boundaries to enhance public health and social well-being.

Venue for the Conference Ice-Breaker on Monday 16th April, Durham Castle / University College

History of Arctic and Quaternary Environmental Change Research at Durham

The Department of Geography was founded in 1928 under Gordon Manley, the noted climatologist who had visited East Greenland on an expedition in 1926. He subsequently published on snowfall, snow cover and the snowline in Britain, and on the last glaciers in Cumbria, although he is perhaps best-known for assembling the Central England temperature record, the longest instrumental temperature record in the world. Brian John was appointed in 1966 and taught Physical Geography and Polar Geomorphology, publishing especially on Iceland, Wales and Antarctica (South Shetlands). John Glacier in the Pensacola Mountains is named after him. Arthur Rundle had worked on the Ross Ice Shelf with Charles Swithinbank and John Heap and, supervised by Brian John, he produced one of the first Ph.D. theses on glaciology from the Department - on an ice piedmont in the Antarctic Peninsula. Rundle Peaks, above the Byrd Glacier, are named after him.

In terms of the undergraduate curriculum, Brian John dealt with Wales, Greenland and Antarctica, and Peter Beaumont (who had written a well-cited Ph.D. on the glacial deposits of east Durham) focussed on NE England. Brian John, of course, co-authored with David Sugden the book *'Glaciers and Landscape'* (1976), which was widely used and remained in print for c. 25 years. John was joined by Ian Evans in 1970 and, when John retired to his Pembrokeshire meltwater channel in 1977, Evans taught 'Glacial and Periglacial Geomorphology' with fieldwork on cirques and moraines in Cumbria and the French Alps, and personal research on British Columbia and glacier distribution. Evans' Ph.D. students included Jasbir S. Gill (1975-78) and Richard Hindmarsh (1977-80).

The 1980s and 1990s saw an increased emphasis on Quaternary environmental change and a particular focus on sea-level change, amongst other research areas. Sea-level change research in Durham started in the 1970s (Michael Tooley and Ian Shennan) and led to the establishment of the Sea-Level Research Unit in 1987. The sea level group continued to grow through the early 1990s (Antony Long, Jerry Lloyd) and 2000s (Mike Bentley, Dave Roberts, Sarah Woodroffe) and saw an expansion in research in higher latitude regions and glacial environments. Recent sea-level research has also extended to GIA modelling (Mike Bentley, Pippa Whitehouse).

During the 2000s, the Quaternary Environmental Change research group continued to grow and several 'glaciology/palaeoglaciology' academic staff (Dave Evans, Colm Ó Cofaigh, Chris Stokes, and Stewart Jamieson) were appointed to complement existing strengths in sea level research and oceanography (Erin McClymont). This saw the Quaternary Environmental Change research group change its name to the 'Ice Sheets and Sea Level' cluster, which is now one of three physical geography clusters (the other two being 'Catchments and Rivers' and 'Hazards and Surface Change').

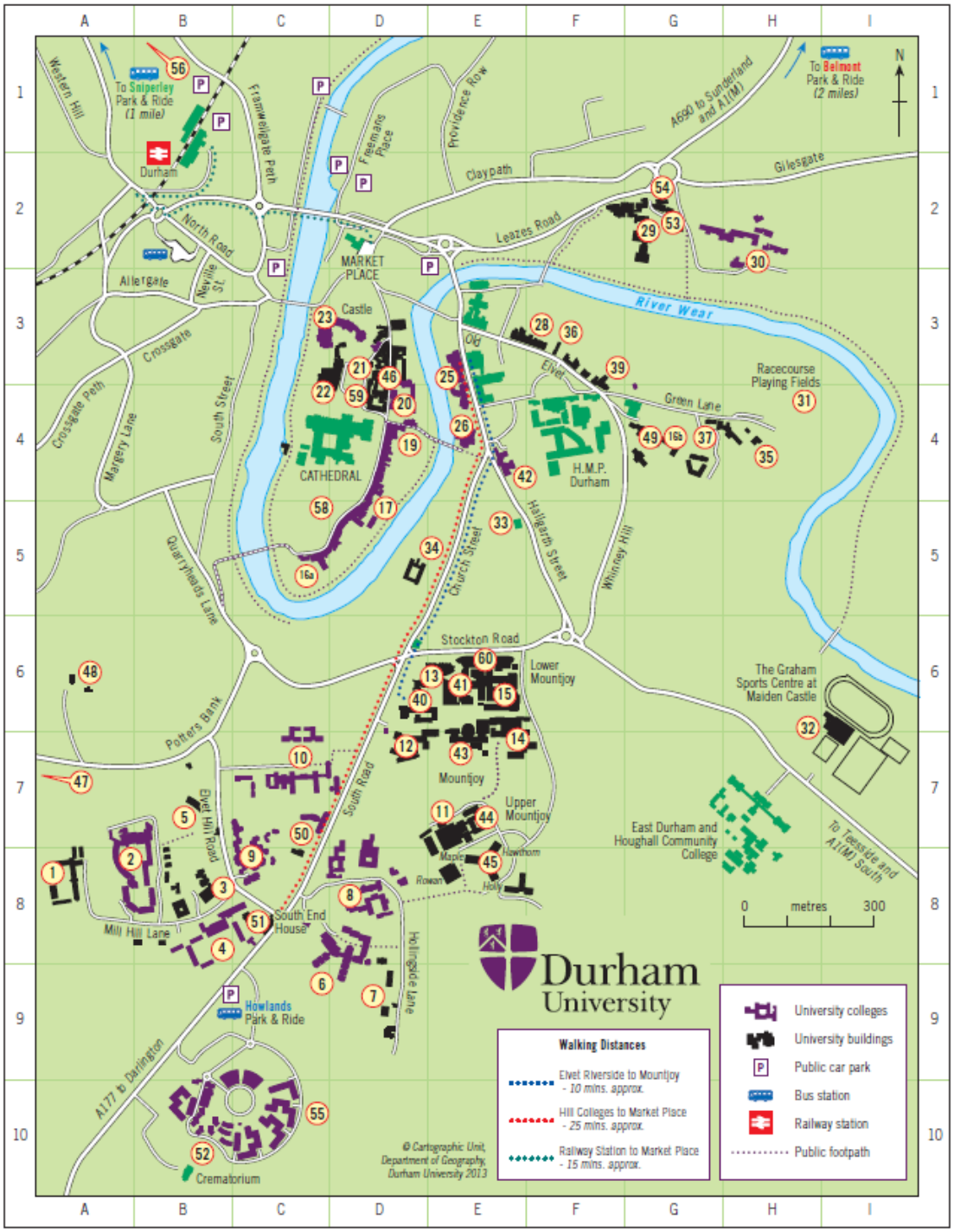
In terms of our current research, an over-arching theme of the 'Ice Sheets and Sea Level' cluster is to explain and quantify the dynamic response of ice sheets to external and internal forcing and their contribution to sea-level rise. A particular focus is on integrating our strengths in field and remote sensing with new expertise in numerical modelling to: (1) understand the decadal to millennial trajectory of the polar ice sheets to constrain how they respond to climatic and oceanic forcing; (2) advance understanding of how subglacial processes affect ice sheet dynamics, exploiting expertise in process-form relationships at the ice-bed interface; (3) develop understanding of sea-level change, especially during past transitions and interglacials, as an analogue for how sea level and ice sheets may interact and affect society in the future. This research feeds into our curriculum, with several modules covering various glacial topics across our three- (B.Sc.) and four-year (M.Sci.) degree programmes and with glacial topics taught on field-trips to the Isle of Skye, Iceland, northern Norway and Switzerland.

At the time of writing, the 'Ice Sheets and Sea Level' research cluster comprises 14 permanent academic staff along with a large body of post-doctoral researchers (Brader, Callard, Cook, Garrett, Jones, Nield, Miles, Small, Spencer-Jones), Ph.D. students, and Masters by Research students. More information, including current funded projects, publications, and staff profiles are available on the cluster website:

https://www.dur.ac.uk/geography/icesheetsandsealevel/

Location and Venues

The conference is being held in the Department of Geography at Durham University, also known as the West Building. This is located on the University's Mountjoy Campus, which is a 10 minute walk from the city centre (25-30 minute walk from the railway station, 5-10 minutes by taxi). The Department of Geography is labelled #40 on the Campus Map (below) and can be approached from either Stockton Road or South Road entrances. Accommodation is in Grey College, labelled #8. The icebreaker is in Durham Castle (#23) and the Conference Dinner in Hatfield College (#20).



Oral Presentations

Oral presentations will take place in the Department of Geography's Applebey Lecture Theatre (Room W103). Speakers are allocated 15 minutes (12 minute presentation with 3 minutes for questions). Talks will be run from a desktop PC and presenters should ensure that their talk is uploaded (and works!) before their session starts. A power-point presentation on a USB stick is preferable.

Poster Presentations

Two poster sessions will take place in the Department's Gordon Manley Room from **1600-1800 on Tuesday 17th April** and from **1600-1730 on Thursday 18th April**. Posters can be up to A0 size (841 x 1189 mm) and the poster boards are best-suited to a landscape format. We anticipate that posters can be put up on the morning of Tuesday 17th April and should be removed after lunch on Friday 20th April.

Conference Dinner

The conference dinner will take place at 1930 on **Thursday 19th April** in Hatfield College, labelled #20 on the enclosed map. Founded in 1846, Hatfield College is the second oldest College in Durham University. It is located between the World Heritage site of the Norman Cathedral and the banks of the River Wear, on one of the oldest streets in Durham. Unfortunately, only those who have pre- booked for the conference dinner can attend. Those with special dietary requirements should make themselves known to the servers before the meal.

Venue for the Conference Dinner, Hatfield College, Durham University (www.durham.ac.uk)

Conference Field-Trip

The conference fieldtrip will take place take place on **Wednesday 18th April** and coaches will depart from outside the Geography Department at 0900. A packed-lunch will be provided. The trip will cover the glacial and Quaternary geomorphology of the northern Pennines and a visit to Hadrian's Wall. We expect to return to Durham at 1800.

PAST Gateways 2018
Conference Schedule

Monday 16th April 2018		
1800-2100	**Registration and Icebreaker**	Durham Castle (number #23 in Durham City map, above)
2100-late	**Drinks (optional)**	Undercroft Bar, Durham Castle

Tuesday 17th April, 2018		
0800-0900	**Registration**	Foyer, Department of Geography
0850-0900	**Welcome (Colm O'Cofaigh)**	Applebey Lecture Theatre (W103), Department of Geography
Session 1: *Chair - Dave Roberts*		
0900-0930	Julian Dowdeswell	**Keynote:** The marine-geophysical signature of past ice sheets
0930-0945	Henry Patton	Reconstructing the evolution and proglacial legacy of the last Eurasian ice sheet complex
0945-1000	Anna Hughes	Evolution of the last Eurasian ice sheets: progress towards DATED-2
1000-1015	Monica Winsborrow	Glacial deposits of the north-eastern Barents Sea and implications for regional deglaciation patterns
1015-1030	Chris Stokes	Ice stream activity scaled to ice sheet volume during Laurentide Ice Sheet deglaciation
1030-1045	Michele Petrini	Ice stream sensitivity to ocean basal melting in the simulated retreat of the Barents Sea Ice Sheet during the last deglaciation
1045-1100	Ívar Benediktsson	Did palaeo-ice streams exist in NE-Iceland? A preliminary view of the terrestrial geomorphic record
1100-1130	***Refreshments break***	
Session 2: *Chair – Henning Bauch*		
1130-1145	Thorbjörg Sigfúsdóttir*	Active retreat of a marine-terminating glacier: Evidence from Late Weichselian sediments and glaciotectonics in western Iceland

1145-1200	David Evans	The multiple glaciations of Banks Island, Arctic Canada: a re-evaluation of a complex terrestrial record of Quaternary climate change
1200-1215	Per Möller	Glacial history and palaeo-environmental change of southern Tiamyr Peninsula, Arctic Russia, during the Middle and Late Pleistocene
1215-1230	Evgeny Gusev	New data on the boundaries of the Novaya Zemlya glaciations according to seismoacoustic data
1230-1245	Astrid Lyså	The last glaciation in the volcanic island of Jan Mayen
1245-1300	Eiliv Larsen	Volcanic induced river damming causing landlocking of Arctic Char in a Jan Mayen lake
1300-1400	***Lunch break***	*Gordon Manley Room, Department of Geography*
Session 3: *Chair – Anna Hughes*		
1400-1430	Anne Jennings	**Keynote:** New insights into deglacial and Holocene ice-shelf and ice tongue history in NW Greenland
1430-1445	Dave Roberts	The onshore imprint of the Northeast Greenland ice stream and 79N ice shelf
1445-1500	Colm O'Cofaigh	Extent and timing of retreat of the Northeast Greenland Ice Stream on the continental shelf offshore of Greenland during the last glacial cycle
1500-1515	Louise Callard	Late Quaternary and Holocene ice shelf sediment records from NE Greenland
1515-1530	Jerry Lloyd	Late Holocene interaction between ocean circulation and the Northeast Greenland Ice Stream
1530-1600	***Refreshments break***	
1600-1800	**Poster Session**	Gordon Manley Room, Department of Geography

Wednesday 18th April 2018		
0900-1800	Coach to depart from outside the Department of Geography at 0900	**Fieldtrip – Glacial and Quaternary geomorphology of the Pennines and visit to Hadrian's Wall**
	Packed lunch provided	

Thursday 19th April, 2018		
Session 4: *Chair – Louise Callard*		
0900-0930	Dorthe Dahl-Jensen	**Keynote:** Greenland ice cores tell tales on past sea level changes

0930-0945	Svend Funder	The case of the missing Younger Dryas
0945-1000	Jason Briner	Were there LGM nunataks in Greenland? New in situ 14C data suggest not
1000-1015	Sarah Woodroffe	Saltmarsh record of post Little Ice Age mass balance changes in southeast Greenland
1015-1030	Lilja Bjarnadóttir	Glacier surging into open-marine waters: submarine landform assemblages, eastern Svalbard
1030-1045	Nina Kirchner	Recent retreat of Kronebreen, western Svalbard: To which extent is calving activity related to glacier proximal water temperatures in Kongsfjorden?
1045-1100	Riko Noormets	Ice face morphology of Kronebreen, Svalbard: Observations and implications for the calving dynamics, meltwater drainage and sedimentary processes at tidewater calving glacier margins
1100-1130	***Refreshments break***	
Session 5: *Chair – Frank Niessen*		
1130-1145	Tom Cronin	Arctic paleoceanography of Marine Isotope Stage 11 ~400 ka based on ostracodes and foraminifera
1145-1200	Leonid Polyak	Implications of strontium-isotope stratigraphy for Plio-Pleistocene Arctic paleoceanography
1200-1215	Ruediger Stein	Reconstruction of Arctic sea ice cover: New insights and questions from biomarker and microfossil proxy records
1215-1230	Allyson Tessin	Iron input from Svalbard to the Yermak Plateau since MIS 6
1230-1245	Matt O'Regan	A 3500-year record of sea ice production in the Chukchi Sea and its possible links to multi-decadal climate variability.
1245-1300	Jochen Knies	Glacial Polynyas: A preconditioner for life in an Arctic desert
1300-1400	***Lunch break***	*Gordon Manley Room, Department of Geography*
Session 6: *Chair – Anne Jennings*		
1400-1415	Robert Spielhagen	Variable pathways of Atlantic Water flow in the Arctic Ocean during Late Quaternary warm periods
1415-1430	Erna Arnardóttir*	Ice rafted debris in the Iceland-Norwegian seas during the Weichselian
1430-1445	Renata Lucchi	Laminated sediments on the NW Barents Sea continental margin: new palaeoclimate insights
1445-1500	Lauren Gregoire	Holocene lowering of the Laurentide ice sheet affects North Atlantic gyre circulation and climate
1500-1515	Henning Bauch	Last Postglacial Sea-Level Rise in the Arctic - A Revisit to the Laptev Sea

1515-1530	Hreggviður Norðdahl	Was Late Weichselian glacio-isostatic recovery of Northwest Iceland controlled by local or distant centre of uplift?
1530-1600	***Refreshments break***	
1600-1730	**Poster Session**	Gordon Manley Room, Department of Geography

1930-	**Conference Dinner**	**Hatfield College** (#20 on Durham City Map, above)

Friday 20th April, 2018		
Session 7: *Chair – Sarah Woodroffe*		
0930-0945	Jan Mangerud	A 24,000 years long, high resolution lake record from the Polar Ural Mountains, Arctic Russia
0945-1000	Andrej Andreev	Paleolimnological transect (PLOT) project: preliminary results on the preglacial to postglacial history of the Russian Arctic
1000-1015	Grigory Fedorov	Initial results of a seismic survey and lithological, geochemical and palynological investigation of sediment cores from Lake Imandra, Kola Peninsula, Russia
1015-10.30	Ekaterina Garankina	Past and present debris flow and slush flow activity in western Lovozerskiye Tundry, Kola Peninsula, NW Russia
1030-1045	Wesley Farnsworth*	Svalbard Holocene Review
1045-1100	Witold Szczuciński	Quantification of carbon supply and burial in Arctic fjord sediments in response to post-Little Ice Age glaciers retreat, Hornsund, Svalbard
1100-1130	***Refreshments break***	
1130-1200	Colm O'Cofaigh	Closing remarks and introduction of new programme Steering Committee (follow-up to PAST Gateways)
Session 8: ***New programme***		
1200-1300	New Steering Committee report to main group	
1300-1400	***Lunch***	*Gordon Manley Room, Department of Geography*

*indicates presenting author is an undergraduate or postgraduate student

Poster Titles (*indicates presenting author is an undergraduate or postgraduate student)

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Oral Presentation Abstracts

Alphabetical by surname

Paleolimnological Transect (PLOT) project: preliminary results on the preglacial to postglacial history of the Russian Arctic

Andrej Andreev[1], Marlene Baumer[1], Grigory Fedorov[2], Raphael Gromig[1], Sebastian Krastel[3], Elodie Lebas[3], Larisa Savelieva[2], Ludmila Shumilovskikh[4], Bernd Wagner[1], Volker Wennrich[1] Martin Melles[1]

[1]*University of Cologne, Institute of Geology and Mineralogy, Cologne, Germany*

[2]*St.Petersburg State University, Institute of Earth Sciences, St. Petersburg, Russia*

[3]*Institute of Geosciences, University of Kiel, Ludwig-Meyn-Str. 10, 24118 Kiel, Germany*

[4]*Georg-August University, Department of Palynology and Climate Dynamics, Göttingen, Germany*

The joint Russian-German project ´PLOT - Paleolimnological Transect´ aims to investigate the Late Quaternary climatic and environmental history along a >6000 km-long longitudinal transect across the Eurasian Arctic. For this purpose, seismic surveys and sediment coring were conducted on five lakes, which are located along the transect and have the potential to host preglacial sediments. The data and samples are investigated with state-of-the-art analytical techniques, supplemented by numerical modelling. Following a pilot expedition on Lake Ladoga close to St. Petersburg in summer 2013, the full PLOT project commenced in Nov. 2015, supported for three years by the German and Russian Research Ministries. Since then, sediment coring was conducted at Lake Bolshoye Shuchye (Polar Urals) in summer 2016, followed by a seismic survey and a coring campaign on Lakes Levinson-Lessing and Taymyr (both Taymyr Peninsula) in summer 2016 and spring 2017, respectively. A joint seismic and coring campaign was also achieved on Lake Emanda (Verkhoyansk Range) in summer 2017. Here, we provide an overview about the completed fieldwork for the PLOT project and highlight some of the initial interpretations made on the basis of the seismic and sediment core data.

The investigated Lake Ladoga is the largest lake in Europe. Although the postglacial history of the lake was studied over the last decades, the preglacial history remained unknown. It is assumed that during the Last Interglacial Lake Ladoga was part of a precursor of the Baltic Sea, which had a connection via Ladoga and Onega Lakes to the White Sea. Sediment coring at two sites in western Ladoga Lake has revealed sediment succession subdivided into 5 main lithological units. The sediments studied in a 22.7 m lake core were also palynologically investigated. Pollen assemblages indicate that the lowermost sediments with pollen of *Betula*, *Alnus*, *Pinus, Carpinus*, *Quercus*, *Corylus*, *Ulmus*, *Tilia*, remains of fresh-water *Pediastrum* and *Botryococcus* colonies as well as cysts of marine dinoflagellates) were accumulated during the interval with climate more favorable than in the Holocene. The OSL-dated samples show the late Eemian and post Eemian ages.

The sediment thickness of the Lake Bol'shoe Shuch'e (Polar Urals) is 54 m. Preliminary studies show that the uppermost 9 m of the sediments were accumulated during the Holocene, between 11 and 9 m - in Younger Dryas, between 11 and 9 m - in Allerod, between 11 and 25 m - in LGM, between 25 and 54 m - in the MIS 2 and probably at the end of MIS 3.

The sediment thickness of the Lake Levinson-Lessing (Taymyr) is 46 m. Preliminary studies show that the lowermost sediments were accumulated during MIS 3. We expect that new cores will provide the most continuous and detailed records from the whole region which can be used to reconstruct the environmental changes.

Ice rafted debris in the Iceland-Norwegian seas during the Weichselian

Arnardóttir, E.Ó.[1], Guðmundsdóttir, E.R.[1], Eiríksson, J.[1], Benediktsson, Í.Ö.[1], Liu, Y.[2]

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[2] First Institute of Oceanography (FIO), State Oceanic Administration, Qingdao, China

The aim of the project presented here is to study ice rafted debris (IRD) in the Iceland-Norwegian seas during the Weichselian. The goal is to trace the source of IRD and reconstruct changes in IRD flux with the purpose of gathering information about sea ice coverage in the region and increase our understanding of oceanographic and climatic changes.

The north Atlantic sea ice coverage is an important Arctic climate system indicator. The cold southward flowing East Greenland current and a branch of the warmer north-westward flowing Norwegian current highly affect the study area, creating a complex zone of temperate and cold waters.

The material used for the study are two marine sediment cores, IS-1C and IS-4C. The cores were retreived from 821 m water depth and 1598 m water depth, respectively, from the north and east of Iceland, in the Iceland-Norwegian seas. Core IS-4C has been investigated with regard to source and quantity of ice rafted debris (IRD), planktonic foraminifera abundances and species distributions and tephra layers. Preliminary results of radiocarbon dating indicate that the upper 251 cm of this core represent the last 42000 years, with pending results of more detailed radiocarbon dating.

IRD has been counted and categorized to three main components: crystals, rock fragments and ash/tephra. Concomitantly, planktonic foraminifera were counted and identified to species level. These proxies display high amplitude variations throughout the core indicating variable sea ice flux.

Thus far, almost 40 potential tephra layers have been identified in core IS-4C. Tephrochronology and oxygen isotope records from IS-4C will be correlated with reccords from Greenland ice cores and additional sediment cores from the North Atlantic, proximal to Iceland. The investigation is ongoing.

Last Postglacial Sea-Level Rise in the Arctic - A Revisit to the Laptev Sea

Henning A. Bauch

Alfred Wegener Institute Bremerhaven c/on GEOMAR, Kiel Germany

Paleoclimate records from the polar North show a very strong tie to changes in insolation in general and, on a regional scale, to the particular post-glacial environmental development. The most drastic change to the Arctic environment occurred after the last glaciation when global sea level rose by about 120 m causing a gradual flooding of the shallow circum-arctic landmasses. This inundation process in fact lead to a significant expansion of the Arctic Ocean's area and its winter sea-ice cover, especially on the expense of the vast Beringian landmass adjacent to Siberia. Well-dated sediment cores from the Siberian side now clearly indicate that the regional sea level in the Arctic came to its Holocene highstand about 6 ka ago, leading to a general stabilization of the sedimentary regimes as well as water mass configurations in these shelf seas Bauch etc al. 2001. It is further noted from the subarctic Nordic Seas and Fram Strait, of which the latter controls the in- and outflow of water masses and export of sea-ice, that the present-day ocean circulation started to evolve also during the mid-Holocene.

This paper now is based on a revisit to the Laptev Sea sea level reconstruction. Using a number of cores from the western sector a clear relation is seen in a multitude of proxy records, among them various micropaleontological assemblages, O/C isotopes, and a number of sedimentlogical approaches, altogether allowing a reevaluation of the previously made time constrains of the last post glacial sea level rise in the Arctic.

Did palaeo-ice streams exist in NE-Iceland? A preliminary view of the terrestrial geomorphic record

Ívar Örn Benediktsson[1], Ólafur Ingólfsson[1]

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Current understanding of the configuration, geomorphological imprint, dynamics and recessional history of palaeo-ice streams in Iceland is limited. A new project aims to advance our understanding of palaeo-ice streams in NE Iceland by investigating glacial landform associations and sedimentary records in the Vopnafjörður, Bakkaflói, Þistilfjörður and Jökuldalsheiði areas, using multiple glacial geological, geomorphological, remote sensing, geophysical/geotechnical and chronological methods. The project is designed to elucidate the relative timing and spatial distribution of fast ice flow, the absolute timing of ice-stream/ice-sheet recession and thinning, and the mechanisms contributing to fast flow and the genesis of streamlined subglacial bedforms.

Preliminary mapping of elongate subglacial bedforms suggests that the flow sets of apparently cross-cutting former ice streams are preserved in the glacial landform record. This includes convergent onset zones with elongate bedforms, reticulated ridges and hummocky topography, and trunk-flow zones with elongate bedforms, rhombohedral ridge-networks and regularly-spaced transverse ridges. Detailed offshore data on the seafloor morphology in this part of Iceland is very limited but we hypothesize that the trunk flow and terminal zones of ice streaming occurred offshore and that the onshore record rather reflects the onset zones (and possibly upper trunk zones) of ice streaming. Reconnaissance fieldwork in 2017 indicates that elongate sedimentary bedforms consist of deformation till and sorted sediments, and that rhombohedral and transverse ridges are mainly composed of till. Future excavations and GPR surveys aim at revealing the internal structure of these landforms.

An important benefit of this project will be the value of its results for constraining numerical models aimed at illuminating subglacial landform development and the evolution of the Iceland ice sheet during the last deglaciation. Furthermore, the project may provide insight into marine-ice sheet instability and the vulnerability of marine-terminating ice streams to sea-level rise, and further our understanding of ice sheet deglaciation dynamics.

Glacier surging into open-marine waters: submarine landform assemblages, eastern Svalbard

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A large number of glaciers in Svalbard are so-called surge-type glaciers, undergoing cycles of relatively brief and rapid advances, followed by decades of stagnation and retreat. Distinct landform assemblages are associated with glacier surges, providing valuable insights into the glacier dynamics and surge history. Detailed bathymetry data (10 m grid) provided by the Norwegian Hydrographic Service reveal the detailed seafloor morphology in front of several outlet glaciers terminating in relatively open-marine settings in eastern Svalbard. The seafloor morphology beyond present glacier termini is very well preserved, recording a suite of glacial landforms related to the last surge cycle of these glaciers. Geomorphological maps of the seafloor in front of the glaciers and relative chronology of the landforms will be presented, together with a simple model of a full surge cycle for glaciers in this type of setting.

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Were there LGM nunataks in Greenland? New in situ ^{14}C data suggest not

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During the Last Glacial Maximum (LGM), the Greenland Ice Sheet terminated on the continental shelf around Greenland. Despite ongoing progress, the exact location of the ice margin – at the shelf break or somewhere on the middle or inner shelf – has been debated and even today is not confidently known in some regions. There is equal uncertainty regarding the vertical dimension of the ice sheet during the LGM. Was it thick enough to smother high, distal massifs? Based on bedrock weathering characteristics, some authors have suggested that distal summits in West Greenland escaped glaciation and existed as nunataks (Kelly, 1985). Cosmogenic nuclide inventories in bedrock surfaces, and in erratic boulders found in these areas, support the existence of nunataks at face value; inventories are higher than can be explained by post-deglaciation exposure (e.g., Rinterknecht et al., 2009; Roberts et al., 2009). Yet the possibility of non-erosive ice leaves the door open for past ice cover (Winsor et al., 2015). Burial dating using cosmogenic nuclides with different half-lives can add to the story. However, the nuclides employed thus far, ^{10}Be and ^{26}Al, do not have the sensitivity to detect burial of durations less than ~100 kyr. We measured in situ ^{14}C, in addition to ^{10}Be and ^{26}Al, from uplands in the central Uummannaq Fjord system, West Greenland. The relatively short half life of ^{14}C can be used to detect LGM burial. Previous work has shown that this region hosts bedrock surfaces with some of the highest ^{10}Be and ^{26}Al inventories yet recorded from Greenland, and with negligible detectable burial (Roberts et al., 2013; Lane et al., 2014; Beel et al., 2016). This is a surprising finding when compared with other high latitude sites with equally high ^{10}Be and ^{26}Al inventories, which almost always exhibit isotopic disequilibrium (Gjermundsen et al., 2015). Despite the cosmogenic nuclide data thus far pointing to the possibility of Uummannaq uplands existing as LGM nunataks (Beel et al., 2016), in situ ^{14}C concentrations in the same bedrock samples require only post-LGM exposure. Advanced surface weathering implies that our study sites were not eroded by LGM ice, suggesting that ice occupied the uplands prior to deglaciation for ~30 kyr, the burial time needed to zero the ^{14}C system due to radioactive decay. It is unknown whether or not the uplands were occupied by local ice caps or the Greenland Ice Sheet. Nevertheless, one of the most promising sites in West Greenland in support of LGM nunataks appears to instead have been occupied by ice during the LGM. This raises the possibility that other sites around Greenland with high ^{10}Be and ^{26}Al inventories were not likely LGM nunataks; this can be tested with in situ ^{14}C measurements from those regions.

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Late Quaternary and Holocene ice shelf sediment records from NE Greenland

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The NE Greenland Ice Stream (NEGIS) is the largest ice stream draining the Greenland Ice Sheet (GrIS) and holds a sea-level equivalent of 1.1-1.4 m. This ice stream is stabilised by two floating ice shelves, 79N and Zachariae Isstrom. Since 2010 Zachariae Isstrom has experienced an accelerated rate of grounding line retreat (~4 km) and significant ice shelf loss. This suggests that this sector of the GrIS is now responding to changes in oceanic and/or climatic conditions. However, the adjacent 80 km long 79N ice shelf has shown comparatively little change over the same time period with some model outputs predicting this ice shelf will remain stable in the future, despite evidence that it previously collapsed during the Holocene Thermal Maximum. To place these observations into a longer-term context a better understanding of the response of NEGIS to past oceanic and temperature change beyond the instrumental record is necessary.

The project 'NEGIS' led by Durham University, and in collaboration with AWI and the GRIFF project, aims to reconstruct the history of the NEGIS from the Last Glacial Maximum (LGM) to present to better understand past ice stream response to a warming climate. Here we present preliminary results and interpretations from an offshore dataset collected on the RV Polarstern, cruise PS100, in 2016. Gravity cores up to 11 m long, supplemented by swath bathymetric and sub-bottom profiler data, were acquired during the cruise. Core analysis has included logging from x-radiographs, MSCL data logging of physical properties, foraminifera analysis and preliminary radiocarbon dating. Data collection was focused principally in the Norske Trough and the area directly in front of the 79N ice shelf, a sub-ice shelf environment as recently as 2014. Ice shelf presence is recorded in a transect of 25 cores extending from the outer shelf to the 79N floating ice tongue. Ice shelf recession is characterised by a vertical transition from laminated sediments with no ice rafted debris, interpreted as sub-ice shelf lithofacies, to massive mud containing gravel to pebble sized clasts representing the ice-shelf breakup. Preliminary analysis indicates that the sub-ice shelf facies are poor in foraminiferal abundance, but where present, the foraminifera are dominated by polar glacimarine species. However, just prior to ice-shelf break up an increase in foraminifera abundance occurs with a species assemblage dominated by *Cassidulina neoteritis,* an Atlantic Water indicator. This species continues to dominate the species assemblage in ice-shelf free conditions. This pattern implies that Atlantic Waters were present prior to ice shelf breakup and had a continued presence after ice shelf disappearance. This suggests that oceanic forcing likely played a significant role in the deglaciation of the NEGIS. Dating this transition in cores from across the NE Greenland continental shelf will provide the first constraint on both ice stream and ice shelf retreat since the LGM.

Arctic paleoceanography of Marine Isotope Stage 11 ~ 400 ka based on ostracodes and foraminifera

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Marine Isotope Stage (MIS) 11 was an extended interglacial period characterized by its relatively long duration (15-20 kyr), warm climate, higher-than-present sea level (~ 10-15 masl), and reduced land-ice volume (Kandiano et al. 2016). Arctic amplification (AA) refers to enhanced warming (cooling) in high northern hemisphere latitudes during interglacials (glacials) compared to low latitudes and is often associated with oscillations in greenhouse gas concentrations. AA warmth is evident from Arctic MIS 11 terrestrial (Wennrich et al. 2014), marine (Polyak et al. 2013, Cronin et al. 2013) sediments. A warm MIS 11 interglacial remains a puzzle, however, because atmospheric CO_2 concentrations during MIS 11 were roughly similar to those of the preindustrial Holocene. An improved Arctic paleoceanographic reconstruction for MIS 11 is now possible due to better, integrated chrono-, litho- and biostratigraphy allowing for more confident correlation among sediment cores back to about 500 ka. One marker for MIS 11 is the *Turborotalita egelida* planktic foraminiferal zone, recognized many years ago by Herman (1970) in Alpha Ridge cores, originally included it the *Globigerina quinqueloba* complex (which also included a similar form *Globigerina exumbilicata*, see Herman 1974). The *egelida* zone is now routinely observed in cores from most Arctic Ridges as a 10 to 20 cm-thick layer, dominated by *T. egelida* and other microfossils with minimal ice-rafted sediment, between 1.5 and 5.5 meters core depth depending on sedimentation rate. The *egelida* zone is especially obvious in cores from 700-2500 m water depth on the Northwind, Alpha, Mendeleev, and Lomonosov Ridges. We will present Mg/Ca ratios from the ostracode *Krithe* from 5 cores (Cronin et al. 2017) and oxygen isotope records from 5 benthic foraminiferal species ($\delta^{18}O_{bf}$ - *C. teretis, O. tener, P. bulloides, C. reniforme, C. wuellerstorfi*) from 6 cores. Mg/Ca and $\delta^{18}O_{bf}$ records suggest: 1) the Mid-Brunhes transition (400-350 ka) was centered on MIS 11, after which the Arctic experienced amplified climate response to orbital cycles including formation of perennial sea ice and thick ice shelves during glacial periods, 2) MIS 11 summer sea-surface temperature was ~ 8-10 °C; bottom water temperatures ranged from about -0.3 to + 0.6°C, 3) Excursions in both proxies suggest either a stadial separating MIS 11.3 and 11.1 or a transition into the MIS 10 glacial, 4) Correcting $\delta^{18}O_{bf}$ records using Mg/Ca-based bottom temperatures confirms MIS 11 sea level estimates of ~ 10-20 masl.

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Keynote:

Greenland ice cores tell tales on past sea level changes

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All the deep ice cores drilled to the base of the Greenland ice sheet contain ice from the previous warm climate period, the Eemian 130-115 thousand years before present. This demonstrates the resilience of the Greenland ice sheet to a warming of 5 ^{o}C[1]. Studies of basal material further reveal the presence of boreal forest over Greenland before ice covered Greenland. Conditions for Boreal forest implies temperatures at this time has been more than 10°C warmer than the present.

To compare the paleo-behavior of the Greenland ice sheet to the present in relation to sea level rise knowledge gabs include the reaction of ice streams to climate changes. To address this the international EGRIP-project is drilling an ice core in the center of the North East Greenland Ice Stream (NEGIS). The first results will be presented.

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Keynote:

The marine-geophysical signature of past ice sheets

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The deglaciation of high-latitude continental shelves since the Last Glacial Maximum has revealed suites of subglacial and ice-contact landforms that have remained well-preserved beneath tens to hundreds of metres of water. Once ice has retreated, sedimentation is generally low on polar shelves during interglacials and the submarine landforms have not, therefore, been buried by subsequent sedimentation. By contrast, the beds of modern ice sheets are hidden by several thousand metres of ice, which is much more difficult than water to penetrate using geophysical methods. These submarine glacial landforms provide insights into past ice-sheet form and flow, and about the processes that have taken place beneath former ice sheets. Examples will be given of streamlined subglacial landforms that indicate the distribution and dimensions of former ice streams on high-latitde continental margins. Distinctive landform assemblages characterise ice stream and inter-ice stream areas. Landforms, including subglacially formed channel systems in inner- and mid-shelf areas, and the lack of them on sedimentary outer shelves, allow inferences to be made about subglacial hydrology. The distribution of grounding-zone wedges and other transverse moraine ridges also provides evidence on the nature of ice-sheet retreat – whether by rapid collapse, episodic retreat or by the slow retreat of grounded ice. Such information can be used to test the predictive capability of ice-sheet numerical models. These marine geophysical and geological observations of submarine glacial landforms enhance our understanding of the form and flow of past ice masses at scales ranging from ice sheets (1000s of km in flow-line and margin length), through ice streams (100s of km long), to surge-type glaciers (10s of km long).

The multiple glaciations of Banks Island, Arctic Canada: a re-evaluation of a complex terrestrial record of Quaternary climate change

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The suite of diverse Quaternary stratigraphic exposures on Banks Island is unique within the Canadian Arctic Archipelago, where sediments predating the last glaciation are generally rare. Coastal exposures across the island, each several kilometers in length, constitute a complex, discontinuous record of Pleistocene paleoenvironments that includes intervals of glacigenic and non-glacigenic deposition in terrestrial, lacustrine, and marine settings. These sediments have been traditionally organized into a Quaternary climatostratigraphic framework and commonly cited as evidence of the magnitude and character of past glaciations and interglaciations in the North American Arctic and further considered as potentially correlative to various marine records of Arctic paleoclimate. Recent facies and stratigraphical analyses of the exposures, however, have instigated a fundamental reassessment of the purported climatostratigraphy, favouring instead a more complex set of stratigraphic relationships characterized by widespread glaciotectonism, abrupt glacigenic facies variability, significant unconformities, and major uncertainties in absolute age. We here provide an overview of our recent sedimentologically-based reassessments of the Quaternary stratigraphy and an introduction to a new chronostratigraphic framework for glacial and interglacial events for the region based upon the type sites at Worth Point, Duck Hawk Bluffs, Morgan Bluffs and Nelson River. The results are used to propose new tentative correlations between the many Quaternary exposures on Banks Island, which remain consistent with previously reported palaeomagnetic measurements and have implications for interpretations of offshore seismostratigraphy and paleoclimatic reconstructions of the circum-Arctic.

Svalbard Holocene Review

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This study is a synthesis of published literature of Holocene glacier and climate history from Svalbard and its surrounding waters. A database of ages has been constructed, quality assessed and categorized by archive (marine, terrestrial, lacustrine and cryosphere). Our review summarizes our understanding of glaciers and climate on Svalbard from the end of the Late-glacial (12,000 yrs. BP) to slightly past the end of the Little Ice Age (LIA, 1936) as well as addresses gaps in our current knowledge. Such a state of the art review has not yet been compiled despite over a century of ice front observations, hundreds of Holocene glacier studies and an ever developing understanding of ice dynamics and the Arctic climate system. This overview will: (1) present a brief summary of major shifts in climate and ice cover across the Svalbard region throughout the Holocene (2) introduce a quality assessed database of published ages that constrain glacier fluctuations (ice free, deglaciation, marginal position, advance and retreat) and climatic characteristics (warming, cooling, wetter, and drier) (3) discuss challenges in methodology as well as potentials regarding sedimentary archives and finally (4) address the complexities of glacier systems in response to changes in climate.

Initial results of a seismic survey and lithological, geochemical and palynological investigation of sediment cores from Lake Imandra, Kola Peninsula, Russia

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In the frame of the Russian-German research project “Last and current interglacial environments of Kola Peninsula, as reflected in the sediment record of Lake Imandra” (DFG grant ME 1169/28; SPSU grant 18.65.39.2017) seismic profiling and subsequent coring had been realized on Imandra Lake, Kola Peninsula, in August/September 2017. Two sediment cores were retrieved from the northern part of the Lake (Co1410, N67˚42.946’, E033˚05.107’, and Co1411, N67˚45.026’, E033˚09.922’). Initial data processing include seismic post-processing, lithological descriptions, pollen analysis, and determination of geochemical (XRF scanning, CNS, TOC/TIC) and geophysical (MSC logging) properties.

The preliminary data suggest that the 8.65 m-long core Co1410 contains a Late Glacial and complete Holocene record. The 10.04 m-long sediment core Co1411 contains a more condensed Late Glacial and Holocene sequence. These sediments are bordered by a clearly visible in seismic profiles unconformity, from the underlying older deposits, which likely are of pre-Late Weichselian age. The unconformity is traced back to an overrun of the coring site by the Eurasian Ice Sheet during the Last Glacial Maximum, causing erosion instead of till deposition.

The case of the missing Younger Dryas

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The succession of dramatic cold-warm climate oscillation that ended the Ice Age has left a clear mark in the Greenland ice cores as well as in terrestrial archives, especially in NW Europe. How did the ice sheet margin respond to these dramatic and abrupt temperature oscillations? In West and Southeast Greenland the ice sheet margin at this time was grounded on the shelf, and we know very little about its behaviour.

Here we present new evidence on the deglaciation history of the inner shelf in southern West Greenland. In 2015 we collected 19 samples of bedrock for 10Be cosmogenic dating from six localities along a 300 km stretch of coastline. The inner shelf in this area consists of a strandflat, gouged out by glacial erosion in coarse Archaean orthogneiss. Deglaciation of the shelf may have begun as early as 18.6 ka (Winsor et al., 2015) and at c. 11.5 it reached the coast (Larsen et al., 2014). This leaves a period of 7 ka with ice somewhere on the shelf, but not at the break. The aim of our study is to throw light on the last stage in this period.

In lack of erratic boulders on the rocky and bare islands we had to be content with sampling bedrock surfaces, which may carry inherited isotopes from older exposures, and result in overestimation of the age. To minimise the risk for inheritance we sampled rocky knobs at low altitudes above the marine limit, where the ice would have been thickest and most erosive. As a control of the ages we collected three (or four) samples within a radius of less than 100m at each locality, to be sure that all samples at each site were deglaciated at the same time. The samples have been processed in the laboratories in Buffalo and Aarhus, and ages with overlapping uncertainty from each site have been averaged to get the best estimate of a deglaciation date, leaving older “inheritance-outliers” outside the average.

The derived deglaciation ages for the six sites span the interval from mid Allerød (13.2 ka) to early Holocene (10.9 ka), with a concentration (four of the six sites) in mid-late YD. This suggests that the ice margin in this part of Greenland was retreating and had reached the inner shelf close to the present coast already during YD, and possibly even in Allerød times.

It may seem surprising that while temperatures at the top of the ice sheet were dropping with as much as 10° (e.g.Buizert et al., 2014), the ice margin on the shelf was retreating. However, as reviewed by Larsen et al. (2016), this seems to be the rule for most areas where we have information around Greenland – but a rule that allows for differences. One extreme is Disko Bugt where the ice margin at the onset of YD stood at the shelf edge, 200 km from the coast, while the other extreme is the southern tip of Greenland where the shelf and coastal area had already been cleared of ice before YD (Bennike et al., 2002). Mid way between these extremes are the Uummannaq Trough and in the Sisimiut area where the YD retreat may have been halted by mid-shelf stillstand or readvance (e.g. Roberts et al., 2009; Jennings et al., 2017).

Therefore our results are in concert with previous findings elsewhere in Greenland indicating that YD was generally a period of ice recession, not advance, but the recession-history varied from area to area. This implies that the ice core temperature record cannot be translated directly into ice margin behavior - and that habitual thinking may be an obstacle to finding out what goes on.

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Past and Present Debris flow and Slushflow Activity in Western Lovozerskiye Tundry, Kola Peninsula, NW Russia

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Lovozerskiye Tundry is a relatively low (up to 1120 m) mountainous massif about 28 km in diameter, located in center of the Kola Peninsula. It is formed by the Devonian pluton of nepheline syenites partly exposed by denudation. Plateaus with relative heights up to 500 m are deeply incised by glacial troughs and cirques, erosional valleys and tectonic lineaments. Most of the valleys are regularly affected by debris flows and slushflows. The latter represent a specific subtype of debris flows essentially composed by water-saturated snow masses with limited (<12%) content of clastic material occurring in rockfall or avalanche troughs and low-order stream channels [Hestnes, 1998; Bozhinsky et al., 2001]. Widespread occurrence of distinctive large relic landforms and deposits indicates much higher magnitude debris flows in the past, most likely during the last deglaciation, particularly those associated with moraine-dammed lakes outbursts.

The Sengisjok valley (about 7 km long) is one of the largest dissecting the Lovozerskiye Mountains western slope. It runs from the Sengisjavr Lake in the glacial cirque bottom and after several sharp bends discharges into Lake Umbozero. The modern V-shaped valley deeply cuts into the older wide valley bottom of complex origin partly infilled by glacial, glaciofluvial, glaciolacustrine and debris flow deposits. Within it, there are two terrace-like units, lower of which (up to 20-25 m above the river floor) is undoubtedly formed by repeated high-magnitude debris flows. Its unsorted coarse clastic material (boulders up to 3 m in diameter) with dense loamy sand matrix cemented by nepheline gels, up to 15-20 m thick, overlies the laminated glacial lake sediment. The latter rise up to more than 3 m above the bedrock base and consist of varved silt series alternated with layers composed of allochthonous sharp-edged broken clasts (1-3 cm) of the same varved silt. The whole unit is slightly folded and broken by microfaults probably caused by hydraulic shock or overloading by rapidly superimposed accumulation from extreme glacial debris flow.

The present-day Sengisjavr Lake has a low moraine threshold controlling its water level. Several larger water bodies existed in the upper part of the Sengisjok valley since its deglaciation as evident from several separated lacustrine sediment layers exposed along its bottom at different elevations. Apart from the mentioned glaciolacustrine unit, there are laminated silt to fine sand layers 1-2 m thick exposed in the upper reaches. Those are either clamped between debris flow bodies or overlay them forming fragments (5-8 m high) of lake terraces leaning to one another. Such sequences can be tentatively correlated with several moraine-dammed lake outbursts during the earlier colder stages of Holocene when smaller glacier still survived in the headwaters cirque. It can also be possibly linked to extreme debris flow discharges and large-scale deposition on the Sengisjok relic fan (area >4 km^2) at the western piedmont.

Relatively thin younger lake silts and sands (10-50 cm) separate flash flood units underlain by debris bodies with distinctive humic layers (sampled for ^{14}C dating). The former probably represent smaller-scale events during the later warmer period of Holocene, and the latter – much smaller and shorter-lived waterbodies formed locally where stream was dammed by slushflow deposits or slope failures.

The modern Sengisjok valley morphology reflects later dominant incision trend, mainly associated with continuing debris flow and slushflow activity, though at much smaller scales than in the past. In the lower reaches, several well-preserved organic layers buried by debris flows at 1-2 m above the stream were also sampled for ^{14}C dating. During the 2017 field campaign initial stages and consequences of a complex event starting as slushflow and continuing as granular debris flow were observed in the valley on July 3 and described in details. Repeated morphological description and geomorphic mapping of the valley bottom allow suggesting such events occur approximately once per 10 years (at least twice since 2009-2010 field investigations). The study was funded by RFBR project №17-05-00630 and GM AAAA-A16-11632810089-5.

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Holocene lowering of the Laurentide ice sheet affects North Atlantic gyre circulation and climate

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The Laurentide ice sheet, which covered Canada during glacial periods, had a major influence on atmospheric circulation and surface climate, but its role in climate during the early Holocene (9-7 ka), when it was thinner and confined around Hudson Bay, is unclear. It has been suggested that the demise of the ice sheet played a role in the 8.2 ka event (an abrupt 1-3 °C Northern Hemisphere cooling lasting ~160 years) through the influence of changing topography on atmospheric circulation. To test this hypothesis, and to investigate the broader implications of changing ice sheet topography for climate, we analyse a set of equilibrium climate simulations with ice sheet topographies taken at 500 year intervals from 9.5 ka to 8.0 ka. Between 9.5 and 8.0 ka, our simulations show a 2 °C cooling south of Iceland and a 1 °C warming between 40-50° N in the North Atlantic. These surface temperature changes are associated with a weakening of the subtropical and subpolar gyres caused by a decreasing wind stress curl over the mid-North Atlantic as the ice sheet lowers. The climate response is strongest during the period of peak ice volume change (9.5 ka – 8.5 ka), but becomes negligible after 8.5 ka. The climatic effects of the Laurentide ice sheet lowering during the Holocene are restricted to the North Atlantic sector. Thus, topographic forcing is unlikely to have played a major role in the 8.2 ka event and had only a small effect on Holocene climate change compared to the effects of changes in greenhouse gases, insolation and ice sheet meltwater.

New data on the boundaries of the Novaya Zemlya glaciations according to seismoacoustic data

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Marginal moraines of the Neo-Pleistocene glaciations were distinguished on seismoacoustic data from the Barents and Kara sides of the Novaya Zemlya archipelago. In the Barents Sea, we trace the complexes of two stages of the Middle Pleistocene glacier at a distance of up to 210 km from the modern coast of the archipelago. Late-Pleistocene (MIS 4) moraines are located closer to Novaya Zemlya and are not more than 100 km apart. The marginal forms of the last glacial maximum (MIS 2) are spaced a short distance from modern glaciers and distributed only around the North Island of Novaya Zemlya.

Keynote:

New insights into Deglacial and Holocene ice-shelf and ice tongue history in NW Greenland

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Arctic ice shelves are hypothesized to have existed during past glacial periods, but the evidence for them has been elusive. During marine research expedition OD1507 with Swedish icebreaker *Oden* in summer 2015, a.k.a. *Petermann 2015 Expedition*, we collected sediment cores and surface samples from Hall Basin and Robeson Channel, leading toward the Arctic Ocean and from Petermann Fjord, including cores obtained from beneath the modern ice tongue at sites 15 and 25 km from the grounding line; these cores provide key information to identify ice tongue/ice shelf facies in the Arctic. The Petermann Ice Tongue has extended to the outer fjord since at least 1876, as observed during the Nares Expedition. Calving events in 2010 and 2012 reduced the ice tongue length to about 45 km, which allowed access to the middle to outer fjord for acquisition of geophysical mapping and piston and gravity cores from sites recently covered by the ice tongue. We use CT (computed tomography) imaging, sediment grain size, and foraminiferal assemblage analysis of a composite core from the outer fjord in 991 m wd, OD1507-3TC/41GC/3PC and sub ice tongue cores OD1507-03UW and -05UW to assess the environmental changes and ice tongue history in the fjord from the early middle Holocene to present. The outer core site coincides with the pre 2010 position of the ice tongue. Data from sub-ice tongue cores, OD1507-3UW and -05UW, taken on a sill at 570 m wd, 25 km from the grounding line and in the basin 15 km from of the grounding line in 840 m wd, respectively, provide the lithofacies, sedimentological and faunal characteristics to constrain the sub ice tongue environment. Sub-ice tongue sediments from 03UW on the sill are bioturbated, but retain stratification, and are characterized as very poorly sorted, very fine to medium silt devoid of coarse clasts. Sediments in 05UW 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 very fine silt to clay. Multicore tops distributed in the fjord have abundant, diverse fauna with *Stetsonia horvathi* being the most abundant species near the modern ice tongue front while *Elphidium excavatum* and *Cassidulina neoteretis* dominate the assemblages in the outer fjord. The foraminifers in the upper 2 cm beneath the ice tongue occur in low abundances and are very small, but living specimens of many species suggest that a low abundance fauna beneath the ice tongue is sustained by advected food and likely is renewed by advected individuals. We apply these characteristics as guidelines to reconstruct the Holocene development of the Petermann ice tongue and to ascertain when it extended to the outer fjord. We use the information about the modern sub ice tongue environment to interpret lithofacies, grain size properties and foraminifers in several OD1507, HLY03, and 2001LSSL cores from Hall Basin and Robeson Channel, where, Beneath a bioturbated mud unit covering most of the Holocene, the cores contain a thick, distinctly laminated silt and clay unit devoid of coarse clasts and containing sparse foraminiferal fauna. We hypothesize from comparison with the sub ice tongue facies and biostratigraphy in Petermann Fjord, that the widespread laminated clay unit was deposited beneath an ice shelf extending from the Humboldt and Petermann glaciers during deglaciation in the early Holocene. Intervals of ice-shelf instability/grounding line retreat are marked by IRD layers, shifts in sediment composition (Mineralogy and XRF) and faunal assemblages changes that punctuate the overall record of ice retreat archived in the laminated clay.

Recent retreat of Kronebreen, western Svalbard: To which extent is calving activity related to glacier proximal water temperatures in Kongsfjorden?

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Observations suggest that calving rates of fjord terminating glaciers vary strongly with ocean temperature (Luckman et al. 2015), yet in-situ data supporting this hypothesis are scarce. Long-term measurements of water temperatures close to calving fronts are lacking at many key sites in Svalbard.

Here, we present first results from the Long Term Underwater Sensing (LoTUS) program at Kronebreen, western Svalbard. The first generation of LoTUS buoys are small, lightweight thermometers which acquire temperature at a specified water depth and predefined sampling frequency, and which surface at a user-defined date to transmit data collected to an on-shore recipient. The Kronebreen LoTUS campaign was a pilot study, sampling water temperature at 10 minute intervals starting in Aug 2016 and ending in Sept 2017 at a water depth of ca 67 meter, 1200 m from the calving front of Kronebreen. Six two-year LoTUS missions will be completed in November 2018 and are expected to transmit data from Tunabreen/Tempelfjorden, the Seven Island Region (Alexandersson et al., 2018; Noormets et al., 2018a,b, all in this volume), and Erik Eriksen Straight.

The LoTUS timeseries from Kongsfjorden is used to study the relative importance of water temperatures at depth for frontal ablation rates of Kronebreen 2016-2017, in comparison to other climatic drivers such as atmospheric temperature, sea surface temperature, precipitation and sea ice cover. The frontal ablation of Kronenbreen is derived from high resolution ground range detected Sentinel 1 images. A physically based parametrization of submarine melt, adopted from Beckman and Goosse (2003), and in situ collected water temperature and salinity in Kongsfjorden, is used to calculate a submarine melt time series, which is compared to the previously mentioned frontal ablation rate. This shows submarine melt to be of considerable significance, accounting for c. 50% of the frontal ablation rate on average but with this being seasonally variable. Dynamical processes linking submarine melt and frontal ablation cannot be quantified based on the available datasets, but will be targeted in future numerical experiments.

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Glacial Polynyas: A preconditioner for life in an Arctic desert

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Arctic and Antarctic coastal polynyas are sites for deep-water formation and thus help sustain the global ocean circulation. During the last glacial period, formation of coastal polynyas proximal to expansive ice-sheets in both hemispheres has been inferred to maintain limited ventilation of the glacial ocean through brine rejection, sustain an oasis for marine and higher-trophic terrestrial fauna, and play a fundamental role as a moisture source for glacial ice build-up. Nonetheless, the existence of these polynyas is not fully clarified, not least due to complicated identification of proxies for polynya formation, with associated difficulties in determining their spatial extent. Here, we present a new sea ice reconstruction for the southwestern Barents Sea margin spanning the last glacial period. The results show that coastal polynyas formed during the Last Glacial Maximum (LGM) in front of the Svalbard-Barents Sea ice sheet (SBIS) through the combined influence of katabatic winds blowing off the ice sheet, and upwelling of subdued, northward flowing Atlantic Water-derived water masses. Such polynya were important sources for moisture and brines to sustain glacial ice build-up and ocean ventilation, in an elsewhere glacial desert. Photosynthesis-driven primary productivity remained high in seasonally open water conditions – a prerequisite to ensure the survival of marine and higher terrestrial life. Following the catastrophic meltwater discharge from the collapsing SBIS at ~17 ka BP, however, any life-sustainable activity in the polynya collapsed with the rapid sea ice expansion, ultimately covering the entirety of the Nordic Seas.

Volcanic induced river damming causing landlocking of Arctic Char in a Jan Mayen lake

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Jan Mayen is the northernmost island on the North Atlantic ridge system situated some 550 km north of Iceland. The active volcano Beerenberg in the northern part of the island reaches an elevation of 2277 m a.s.l. All historically known volcanic eruptions have taken place in this area, but numerous lava flows and tephra deposits are also found in the south part of the island evidencing large volcanic activity in Late-Glacial - Holocene times.

On the west coast of the island, a small embayment called Maria Musch is connected with the Lake Nordlaguna via a short valley. The lake is situated ca. 2 m a.s.l., is separated from the sea by a 1 km long and up to 200 m wide storm barrier, and has no outlet to the sea. The lake holds a stock of Arctic Char (*Salvelinus alpinus*) which has developed from anadromous char to become landlocked. When and how this happened has been a matter of speculation. Skreslett (1973) suggested that the lake was isolated from the sea some 1500-4000 years ago due to relative sea-level changes. In spite of intensive field investigations over the last few years, the Late-Glacial - Holocene sea-level history of the island still remains unknown. It may be that the ice-cap covering Jan Mayen during the last glaciation was so thin that relative sea level was below present throughout this time period.

Facing the sea, in the northern part of the Maria Musch bay, the back wall of a volcanic crater separates the bay from the lake to the north. Pyroclastic material from this eruption covers the bay area and the valley connecting the lake with the bay. Dates of driftwood and whale bones, underlying these pyroclastic deposits in the bay, indicate the eruption took place after AD 1150. Basal dates in sediment cores from the lake imply that the eruption occurred prior to AD 1300. Based mainly on the distribution of pyroclastic material, we suggest that a brook from the lake with its mouth to the sea in the Maria Musch bay was blocked by pyroclastic fall-out from this eruption at some time between AD 1150 and 1300 causing Arctic char to become landlocked.

This case story from Jan Mayen may be nice in itself, but the investigations have some wider implications that will be discussed briefly: 1) the tephra from this eruption is geochemically indistinguishable from ash stemming from an eruption on the east coast that took place in AD 1732 (Gjerløv 2015), 2) a comparison of DNA between the local Arctic Char population and its North Atlantic origin may provide a further indication of the lineal separation and its age, and 3) the Late-Glacial - Holocene volcanic eruption history compared with the glacial history holds the promise to unravel the influence of glaciation to volcanic systems.

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Late Holocene interaction between ocean circulation and the Northeast Greenland Ice Stream

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Large sections of the Greenland Ice Sheet (GrIS) terminate in the oceans and, therefore, interact with changing ocean circulation through time. Recent studies have highlighted the dynamic response of many tidewater glaciers draining the GrIS showing an acceleration of flow and, in many cases, the break-up and retreat of floating ice shelves and calving margins (e.g. Moon and Joughin, 2008; Murray et al., 2015). This instability has been linked to incursion of relatively warm Atlantic Water as well as increased air temperatures and sea-ice loss (e.g. Straneo and Heimbach, 2013; Vieli and Nick, 2011).

The Northeast Greenland Ice Stream (NEGIS) is an important component of the Greenland Ice Sheet, draining approximately 15% of the ice sheet with a sea level equivalent of ~ 1.4 m. Recent observations have identified ice shelf loss and grounding line retreat of part of NEGIS post 2010 suggesting this sector of the GrIS might be starting to respond to climate forcing. The aim of the 'NEGIS' project is to better understand the interaction between NEGIS and climate from the LGM through to recent decades. A series of gravity cores and box cores were collected along with Hydrosweep swath bathymetric and Parasound sub-bottom profiler data concentrating on the Westwind and Norske Trough systems, two cross-shelf troughs originating from the present day margin of NEGIS. The data were collected through collaboration with the Alfred Wegener Institute as part of the GRIFF project supported by two cruises of the RV Polarstern in 2016 and 2017.

This presentation will focus on the Late Holocene period investigating the evidence for changes in ocean currents on the Northeast Greenland continental shelf and their possible influence on the tidewater margins of NEGIS. Here we present preliminary results from two box cores, one collected from immediately in front of the modern day 79N Glacier ice shelf and the other from further offshore from the inner section of Norske Trough. The chronology for the cores is constrained based on ^{210}Pb profiles and preliminary radiocarbon dates. We use the benthic foraminiferal fauna to investigate variability in ocean circulation, specifically the relative strength of the Atlantic Water inflow along Norske Trough to the present day ice margin. At the present day Atlantic Water flows southwards along the edge of the continental shelf and a component of this Return Atlantic Current flows along Norske Trough forming the basal water mass. Our benthic foraminiferal assemblages record the variability in strength of Atlantic Water flow over the mid- to late Holocene. Preliminary results identify a period of relatively strong Atlantic Water inflow during the mid-Holocene followed by a clear reduction in strength for a time during the Late Holocene and a subsequent increase in strength during the 20th Century. These results provide the first evidence for a variable ocean circulation with the potential to influence ice margin dynamics during the mid- to late Holocene.

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Laminated sediments on the NW Barents Sea continental margin: new palaeoclimate insights

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The recent depositional architecture of the north-western Barents Sea continental margin derives from past climate changes with alternating deposition of highly consolidated glacigenic diamicton (continental shelf) and debris flows (continental slope) associated to shelf-edge glaciations, and low-density, normally consolidated biogenic-rich sediments deposited during interglacial conditions. In addition, sub-bottom records outline the presence of acoustically laminated deposits locally having thickness exceeding 10 m, which lithofacies characteristics indicate deposition from turbid meltwaters (plumites) during short-living, phases of glacial retreat (meltwater pulses, MWP). One of the youngest stratigraphic intervals recognized along the NW Barents Sea margin was related to the MWP-1a that was responsible for the deposition of about 1.1 x 1011 tonnes of sediments on the upper slope of the Storfjorden-Kveithola TMFs (south of Svalbard) (Lucchi et al., 2015). New compositional analyses of such plumites revealed a distinct signature that allow us to distinguish deposition from glacial melting form that related to the ice-sheet sub-glacial erosion and transport to the edge of margins. Sediment facies and compositional analyses lead to a new climate-related interpretation of the laminated deposits recognized during Marine Isotopic Stages 3 and 2 on the NW margin of the Barents Sea, including Heinrich Event H2.

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The last glaciation in the volcanic island of Jan Mayen

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The young volcanic island of Jan Mayen is situated in the Norwegian-Greenland Sea north of Iceland. Until 2015 when we initiated a research and mapping project, documentation on the last glaciation on this remote island was almost non-existing. This presentation focuses on the Late Weichselian LGM (Last Glacial Maximum), and we document, for the first time, that the entire island was covered by a Late Weichselian glacier. This is documented through intensive field work showing relationships between volcanic rocks and glacigenic deposits. The chronology is based mainly on cosmogenic dates.

Presently, the active volcano Beerenberg, reaching 2277 m a.s.l., has an ice cap with several outlets, some of them reaching down to sea-level where they are calving into deep water. Well developed marginal moraines outside of the outlets withness that the glaciers were larger at times in the past. The most conspiciuous ones are suggested to be from the Little Ice Age (Anda et al. 1985). The northern part, Nord-Jan, shows a large contrast to the central and southern part of the island, Sør-Jan. Here, there are no signs of moraine ridges, and numerous volcanic craters, domes and lavafields dominate the terrain among some more flatlying surfaces inbetween. These surfaces often have till cover, glacial erratics and are weathered. Along the coast, steep and often inaccessible bedrock cliffs exist as well as long sand beaches with large quantities of driftwood. Many of the mountain peaks in Sør-Jan reach elevations of more than 500 m a.s.l., the highest one is 769 m a.s.l.

Whether or not the entire island was ice-covered during the last glaciation has been a matter of controversy. For instance, Imsland (1978) concluded that Jan Mayen had been without major glaciers during the Pleistocene. However, no glacial-geological focus has been targeting this topic until we started our investigations. We can now document that Nord-Jan was covered by an ice cap reaching down to sea-level during LGM. Field mapping and observations in central and southern part of the island are taken to indicate that the entire island was ice-covered during LGM, and that glaciers extended at least down to present sea level. New observations during field work in 2017 demonstrate that ice covered also some of the higher peaks in Sør-Jan, suggesting that ice may also have reached the shallow shelf south-southeast of the island. However, the latter is not proven yet.

^{36}Cl cosmogenic surface exposure dates from samples taken in the northern and central part of the island, indicate that the LGM glacier had retreated considerably by some 18 – 19 ka BP. Hopefully we can report new dating results currently in progress.

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Evolution of the last Eurasian ice sheets: progress towards DATED-2

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In 2016 we published an empirical reconstruction of the evolution of the extent of the last Eurasian ice sheets, that is fully documented, specified in time, and includes uncertainty estimates (DATED-1; Hughes et al. 2016). It was a 10-year effort to compile and archive all published dates relating to the build-up and retreat of the British-Irish, Scandinavian and Svalbard-Barents-Kara Seas ice sheets. We assessed over 5000 dates for reliability and used the resulting database, together with published ice-sheet margin positions derived from geomorphological evidence, to reconstruct time-slice maps of ice extent for every 1000-years 25-10 ka and for four periods between 40-27 ka. All uncertainties (both quantitative and qualitative e.g. precision and accuracy of numerical dates, correlation of moraines, stratigraphic interpretations) were combined based on our best glaciological-geological assessment and expressed in terms of distance as a 'fuzzy' margin; separation of the maximum and minimum limits indicates the degree of uncertainty for each time-slice at each location along the ice margin. This approach provides a straightforward means to compare results from numerical modelling of former ice sheet extent with geological data. The reconstructions and chronological database are available to download as GIS shapefiles (.shp) and Google Earth compatible (kmz) formats.

Since the DATED-1 census (1 January 2013), the volume of new information (from both dates and mapped glacial geomorphology) has grown significantly (e.g. 32% increase in the number of dates to 1 January 2017, including a 90% increase in dates from terrestrial cosmogenic nuclide dating). Despite addition of 933 new locations, the spatial distribution of chronological information remains similar. Here, we present work towards an updated version of results, DATED-2, that attempts to further reduce and explicitly report all uncertainties inherent in the ice sheet reconstructions, and discuss implications of the revised margins.

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A 24,000 years long, high resolution lake record from the Polar Ural Mountains, Arctic Russia

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The lowlands along the Russian Barents-Kara sea coast have, according to recent reconstructions, been ice free since MIS 4, i.e. from about 60 ka BP (Svendsen et al., 2004). We have therefore during many years cored lakes in this area in search for long continuous sequences, but most lakes were apparently not formed until the permafrost and buried glacial ice started to melt about 15 ka BP (Henriksen et al., 2003). In the end we discovered two promising lakes in the northernmost part of the Polar Ural Mountains.

Here we present some results from the largest of the two, Lake Bolshoye Schuchye. The lake is 140 m deep and seismic surveying shows that it contains a 160 m thick sequence of lacustrine sediments above bedrock. A well-dated 24 m long core, which in the lower half consists of annual varves, have provided new and detailed insight into the glacial and environmental history for the last 24 ka. From downward extrapolation of the sedimentation rates we estimate that basal sediments in the lake are about 50-60 ka old and we postulate that the lake basin shortly before was occupied by a large glacier that now melted away. It seems clear that the lake basin since then has remained ice free up to the present. However, the varves and high sedimentation rates indicate that medium-sized glaciers formed in the surrounding mountains during the LGM, as earlier shown for the mountains to the south (Mangerud et al, 2008).

The sediments have very low carbon content; loss on ignition is mostly 2-3 %, slightly higher in the Holocene sediments. There is nevertheless an excellent preservation of both pollen and, interestingly, DNA molecules of plant and animals throughout the core. The results from the two methods support and complement each other, but the DNA analyses provide a much better resolution of taxa; altogether 167 plant taxa were identified, 45% to genus level and 41% to species level. From 24 to 15 ka BP there was an open steppe type of vegetation. From 15 ka shrubs, especially *Salix* sp., increased and during the Early Holocene forests of alder, birch and spruce were established in the lower altitudes.

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Glacial history and palaeo-environmental change of southern Taimyr Peninsula, Arctic Russia, during the Middle and Late Pleistocene

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The Taimyr Peninsula, and the shallow Kara Sea shelf north there off, has over repeated glaciations formed the eastern fringe of the Eurasian Ice Sheet(s) (EIS) and is thus a key geographical component in the reconstruction of the Arctic palaeo-environment and the waxing, waning and disappearance of the EIS over glacial/interglacial cycles. The glacial history for the Severnaya Zemlya archipelago and north and central Taimyr was summarized in Möller et al. (2015), with an emphasis on the last glacial cycle (Marine Isotope Stages (MIS) 5e-2). Our expeditions in 2010 and 2012 concentrated on the southern part of The Taimyr Peninsula. The Quaternary geology south of Lake Taimyr is by no means a *´terra incognita'* on its glacial stratigraphy; decades of stratigraphic investigations along a number of its rivers were carried out in the 1960-1970's, and summarized in Kind and Lenov (1982). It is however, as we see it, a 'house of cards' due to the general lack of age determinations, especially on the older sediment units.

The landscape of southern Taimyr is a subdued lowland (10-50 m a.s.l.) of gently rolling uplands and basins. We find few of the geomorphic features that usually are associated with former glaciated areas. However, a number of ridge complexes up to 15 km wide and 100-150 m high above on-lapping marine and fluvial sediment form very prominent features from the southern foothills of the Byrranga Mountains and ~250 km southwards (Ice Marginal Zones; IMZ). Individual ridge complexes can be followed laterally for 100´s of kilometres, some forming distinct, sometimes complex morainal loops, while others are more diffuse as ridge trends and connections get lost in large interlobate complexes. All features are, however, poorly constrained to their age of formation, and have been suggested from all being of Taz (MIS 6, Saalian) glaciation age to representing complex successions built during different stages of both Early and Late Zykyanka (MIS 5d-2; Weichselian) glaciations.

Our expeditions in 2010 and 2012 targeted stratigraphical work along some of the major rivers on southern Taimyr: we studied sediment exposures along the Bol'shaya Balaknya and the Luktakh-Upper Taimyr-Logata river systems, rivers that we followed from headwaters and downflow. Though the west to east distances between start to end sites in both rivers was only ~170 km and ~190 km, respectively, the over parts heavily meandering rivers made true travel distances approach nearly 500 km along each river. We have documented around 35 stratigraphic sections along these rivers with the depositional chronologically constrained by a comprehensive dating programme comprising some 75 accelerator mass spectrometer radiocarbon (AMS ^{14}C), ~80 optically stimulated luminescence (OSL) and ~40 electron spin resonance (ESR) datings. To this comes cosmogenic nuclide dating (^{36}Cl; 6) on boulders on top of the Ice Marginal Zones (more dates are pending). In short we have identified four interglacial/interstadial (glacio)marine units, of which two are of a pre-Taz (MIS 6) age (most probably MIS 9-11 and MIS 7).

The Taz (MIS 6) glaciation meant a Kara Sea Ice sheet (KSIS) advancing from the north and a Putorana/Anabar Plateau(s) ice cap advancing from the south into a marine basin in the Taimyr lowlands, deforming proglacial marine sediments and depositing till from the south (see poster by Benediktsson and Möller) before the KSIS 'took over' and reversed ice flow towards the south, eventually producing the Taz maximum boundary along the southern part of the Putorana Plateau. Marine and fluvial sediment of Karginsky age (MIS5e) are documented to on-lap onto the Syntabul-Severokokorsk IMZ and to be overlain by till from an Early Zyryanka (MIS5d) KSIS glaciation, reaching well south of Taimyr Lake. The Syntabyl-Severokokorsk IMZ is for the first time directly dated with cosmogenic ^{36}Cl exposure dating to be well set in the Early Zyryanka (96±9 and 102±10 ka; more datings are pending).

As is the case further northwards around the Taimyr Lake basin and the foothill of the Byrranga Mountains, the most widespread stratigraphic unit is (glacio)marine sediment deposited in the marine basin that was distal to, and that followed the receding margin of the KSIS during and after its maximum spreading in the Early Zyryanka (MIS 5d). A large number of OSL sediment datings and overlapping ESR ages on molluscs, all in an age span of 95-70 ka, confirm the chronological standing of these strata. A bit to our surprise is that the mollusc fauna suggest inflow of quite warm Atlantic during these interstadial conditions, as indicated from the occurrence of subarctic species as e.g. *Mytilus edulis*, *Chlamys islandica* and *Macoma baltica*.

During the Middle and Late Zyryanka (MIS 4-2) the southern part of Taimyr was a terrestrial environment, primarily with deposition of fluvial sediments and with aggradation of ice-complex sediment successions (yedoma), the latter hosting abundant megafauna remains. A harsh environment is indicated by numerous sand wedges in till and fluvial sediment and by the syngenetically formed ice-wedges in the yedoma complexes.

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Ice face morphology of Kronebreen, Svalbard: Observations and implications for the calving dynamics, meltwater drainage and sedimentary processes at tidewater calving glacier margins

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Marine geological reconstructions of past glacial activity beyond the time of historic records are based mostly on seafloor landform and sedimentary records. Although a number of individual landform types, such as, for example, lineations, geometric network ridges, small transverse moraines and larger terminal moraines have been associated with particular type of glacial activity, direct observations of their formation are few. Because of the scarcity of direct observations, the knowledge of the process physics of the diagnostic landform record is fragmentary and the current understanding of the landform generation is mostly conceptual. This hampers the quantification of the glacial and sedimentary processes involved as well as the use of the geological records in advanced numerical modeling of glaciers and ice sheets.

Recent high-resolution multibeam surveys at Svalbard calving glacier margins have produced detailed images of the morphology of the tidewater ice cliffs, and the seafloor in front of them. These data reveal a complex underwater ice face morphology featuring near-vertical sections alternating with locally undercut sections as well as ice foot extending out several metres at the base of the cliff. The data also show numerous notches, overhangs and deep indentations at the base as well as several metres to over 10 m high above the base of the ice face. Seafloor in front of the ice cliff features grooves, debris fans and moraine ridges of various sizes.

In this paper, we demonstrate the complexity of the ice margin morphology and the associated seafloor sedimentary features at tidewater calving glacier margin of Kronebreen in Kongsfjorden, Svalbard, and discuss the links between the glacier margin morphology, its dynamics, calving processes, meltwater hydrology and the resulting seafloor landform record.

Was late Weichselian glacio-isostatic recovery of Northwest Iceland controlled by local or distant centre of uplift?

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Studies of the late Weichselian deglaciation in West Iceland have revealed extremely high rates of apparent uplift, rates that exceeded 160 mm·a^{-1} some 14.7 cal. ka BP and that the deglaciation progressed at near temporal and spatial glacio-isostatic equilibrium. We assume that such glacio-isostatic equilibrium also applied to the late Weichselian retreat of the Icelandic Ice Sheet in other parts of the country.

Glacial striae in Northwest Iceland are arranged in an apparent radial pattern with the striae orientated towards the outer coasts implying that the striae were formed by actively eroding glaciers retreating towards local ice-caps in the centre of Northwest Iceland. Numerical modelling of the Weichselian retreat of the Icelandic Ice Sheet has returned local ice-caps in NW Iceland when the Icelandic Ice Sheet reached a minimum in Bølling times. The existence of late Weichselian ice-caps in Northwest Iceland raises a question if the glacio-isostatic recovery was controlled by a local or more distant centre of uplift.

In this paper we examine if raised shorelines, that occur throughout lowland areas of Northwest Iceland at altitudes from about 10 m a.s.l. and as high up as 110 m a.s.l., can be used to decide if the glacio-isostatic recovery of Northwest Iceland was controlled by a local or more distant centre of uplift. Finally, the possible effect of the LGM extent of the Icelandic Ice Sheet, and presumed late Weichselian collapse of its marine based parts on ocean currents in the Irminger Strait is contemplated.

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Extent and timing of retreat of the Northeast Greenland Ice Stream on the continental shelf offshore of Greenland during the last glacial cycle

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The Northeast Greenland Ice Stream is a key sector of the Greenland Ice Sheet because it controls ice flux into the NE Atlantic and it holds a sea-level equivalent of ~ 1.4 m. Recent ice shelf loss and grounding line retreat post 2010 suggest that the ice stream and this sector of the Greenland Ice Sheet are starting to respond to atmospheric/oceanic change. The aim of the project 'NEGIS' is to reconstruct the past behaviour of the Northeast Greenland Ice Stream from the LGM to the late Holocene including the past sensitivity of the ice stream to oceanographic and atmospheric forcing. The project adopts a combined approach of terrestrial and marine geological data collection which will be used to calibrate and validate numerical ice sheet models that can predict ice stream-shelf dynamics over centennial to millennial timescales. This presentation focuses on the offshore component from the continental shelf and upper slope, focusing mainly on new marine geophysical data and sediment cores collected from mid-outer Westwind and Norske Troughs, two major cross-shelf bathymetric troughs. These bathymetric troughs acted as pathways for offshore-directed ice flow across the wide NE Greenland continental shelf during the last glacial cycle. Data collection took place during two research cruises of the RV Polarstern in 2016 and 2017. In total 59 gravity cores, 4 box cores, and 7 multi-cores, supplemented by Hydrosweep swath bathymetric and Parasound sub-bottom profiler data, were acquired during the two cruises. The seafloor geomorphological and acoustic data reveal a range of flow parallel and flow transverse landforms in both troughs. Well-developed mega-scale glacial lineation and drumlins formed in sediment record streaming flow towards the outer shelf/shelf edge. The geophysical data also imaged a range of flow transverse landforms such as grounding-zone wedges and moraines which record episodic grounding line retreat inshore from the shelf edge/outer shelf during deglaciation. Beyond the shelf edge of Norkse Trough the continental slope is characterised by glacigenic debris flows typical of submarine slopes offshore of shelf-edge terminating palaeo-ice streams. Sediment cores from the troughs recovered over-consolidated subglacial tills overlain by deglacial stratified glacimarine sediments recording advance and retreat of the ice stream. Radiocarbon dating of deglacial sediments in these cores is in progress and initial results indicate that deglaciation of the ice stream from the shelf edge of Norske Trough was underway by 17.9 ka cal BP. Collectively these data indicate that the Northeast Ice Stream was grounded to shelf edge and imply a much more extensive Greenland Ice Sheet in this sector during the LGM than has hitherto been demonstrated.

A 3500-year record of sea ice production in the Chukchi Sea and its possible links to multi-decadal climate variability

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Sea ice is one of the most sensitive components of the global climate system. It responds to both dynamic (circulation) and thermodynamic/radiative (temperature) related processes. Combined with the lack of high-resolution marine proxy records, this makes it particularly difficult to determine its range of natural variability. In 2014, the Swedish, Russian, US Arctic Ocean Investigation of Climate, Cryosphere, Carbon Interactions (SWERUS-C3) expedition on icebreaker *Oden* recovered a remarkable sediment core (SWERUS-4PC1) from the Herald Canyon in the western Arctic Ocean (Jakobsson et al., 2017; Cronin et al., 2017; Swärd et al., in review). This record contains a persistent and strong, multi-decadal signal of bottom-water current speed over the past 3000-4000 years that appears to be related to brine production during sea ice growth on the Chukchi and East Siberian shelves. Here we present the initial sedimentological and oceanographic framework for this assertion, and using preliminary results from radiocarbon dating investigate the frequency of variability and potential links to external climate forcing.

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Reconstructing the evolution and proglacial legacy of the last Eurasian ice sheet complex

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The Eurasian ice sheet complex (EISC) was the third largest ice mass during the Last Glacial Maximum, spanning >4,500 km from southwest Britain to northern Siberia and locking up around 20 m of eustatic sea-level equivalent. Through use of a first-order, thermomechanical ice sheet model, validated using independent glacio-isostatic modelling and a diverse suite of empirical constraints, we demonstrate the 3-D asynchronous evolution of the EISC during the last 37,000 years, reflecting contrasting regional sensitivities to climate forcing, oceanic influence, and internal dynamics.

Most rapid retreat of the EISC was experienced across the Barents Sea sector after 17.8 ka BP when this marine-based ice sheet disintegrated at a rate of ~670 gigatonnes per year (Gt a^{-1}) through enhanced calving and interior dynamic thinning, driven by oceanic/atmospheric warming and exacerbated by eustatic sea-level rise. From 14.9 to 12.9 ka BP the EISC lost on average 750 Gt a^{-1}, peaking at rates >3000 Gt a^{-1}, roughly partitioned equally between surface melt and dynamic losses, and potentially contributing up to 2.5 m of global sea-level rise during Meltwater Pulse 1A (14.65 - 14.31 ka BP).

The complex environmental legacy of the EISC can be examined effectively with respect to a range of geosystems using model outputs that account for the evolving relative sea level, patterns of climate forcing, and ice sheet properties. Here, we focus on the impact the evolving EISC had on the proglacial hydrological network. The amalgamation of mega proglacial river catchments across the Eurasian continent consolidated freshwater and sediment discharge through relatively narrow gateways into the Atlantic and Arctic oceans. Furthermore, the evolving ice margins dammed a series of large glacial lakes in the North, Baltic, White, Pechora and Kara seas. These latter two lakes in the Arctic stored up to 25,800 km^3 and 30,200 km^3 of freshwater runoff, respectively – enough to keep the present-day Mississippi flowing for >100 years. The abrupt release of the dammed ice lakes as the EISC collapsed had potentially significant implications for ocean circulation patterns in the sensitive polar North Atlantic during global deglaciation.

Ice stream sensitivity to ocean basal melting in the simulated retreat of the Barents Sea Ice Sheet during the last deglaciation

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The Barents Sea Ice Sheet (BSIS) was a so-called marine-based ice sheet, as its largest portion rested several hundreds of meters below the sea level on the Barents and Kara Seas floor. From a bathymetric point of view, there is a strong similarity between the BSIS at the Last Glacial Maximum (LGM, around 21,000 years ago) and the present-day West Antarctic Ice Sheet (WAIS), as pointed out first by Mercer (1970). In fact, both polar regions are characterized by a wide, relatively shallow continental shelf of few hundreds of meters depth. Although the oceanic contexts differ, it can be important to identify, reconstruct and analyze the dynamical processes driving the past retreat of the BSIS to better understand the present and future evolution of the WAIS. Several recent studies show that ice shelves and marine-terminating glaciers around Antarctica are thinning (Paolo et al., 2015), especially in the sector of the WAIS. This thinning primarily results from the intrusion of warm Circumpolar Deep Water on the continental shelves that induce sub-shelf melting in the cavities (*e.g.*, Pritchard et al., 2012, Rignot et al., 2013), which potentially triggers the retreat of the grounding-line. Theoretical boundary layer studies such as Weertman (1974) or Schoof (2012) suggest that abrupt changes in volume and extent of marine-based ice sheets can occur because of the grounding-line instability in coastal regions where the bedrock slopes landward. In this study, the last deglaciation of the BSIS is simulated by means of a hybrid SIA/SSA thermomechanical Ice Sheet Model (ISM). The ISM is initialized from a spun-up LGM simulation, and climate forcing is interpolated by means of regional climate indexes between LGM and pre-Industrial (1850 A.D., PI) climatologies. The regional climate indexes are based on TraCE-21ka (Liu et al. 2009), a transient global coupled climate simulation of the last 21,000 years. The sensitivity of the ice sheet to ocean temperature changes during the deglaciation is investigated by means of two different sub-shelf melting formulations (Martin et al., 2011 and Pollard & DeConto, 2012), which are forced with simulated ocean vertical temperature and salinity profiles derived from TraCE-21ka simulation (Liu et al., 2009) and selected in the vicinity of the BSIS. The retreat of the BSIS and of the major ice streams draining the ice sheet in the western and northern Barents Sea is analysed and compared to existing geomorphological and geophysical data from DATED-1 dataset (Hughes et al. 2016). Results from our simulations suggest that the sub-shelf melting has a strong control on the BSIS retreat during the deglaciation and plays a fundamental role in triggering grounding-line retreat in fast-flowing areas. This suggests that to correlate the Antarctic response to ongoing and future ocean warming, a close look at the sub-shelf melting modelling is mandatory.

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Implications of strontium-isotope stratigraphy for Plio-Pleistocene Arctic paleoceanography

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Sediment cores from the Northwind Ridge, north of the Alaskan margin, provide the first confirmed Plio-Pleistocene record from the western Arctic Ocean, with calcareous microfossils uniquely preserved to ~5 Ma. Core P1-93AR-P23 (P23) from the ridge flank (~950 mwd), used earlier to reconstruct pre-glacial (estimated early Quaternary) environments in the region (Polyak et al., 2013), was now re-dated and compared to core HLY0503-3TC/JPC (JPC3) from the ridge top (~600 mwd). Ages were estimated primarily using lithostratigraphic cyclicity for glacial strata (late to middle Quaternary, ~0.8 Ma) and strontium isotope stratigraphy (SIS) on benthic foraminifers for visually more homogenous older sediments estimated to extend to at least ~5 Ma near the Pliocene bottom. While the record generated has a very low resolution of just a few mm/ka and appears to be disrupted by hiatuses, especially on the ridge top, it provides a unique opportunity for insights into pre-glacial Arctic oceanic environments near the Bering Strait, an Arctic-Pacific gateway.

Based on multiple physical, paleomagnetic, geochemical, and paleobiological proxies, we identify three major stratigraphic divisions (Units 1, 2a and 2b) roughly representing late to middle ("glacial") Quaternary, early Quaternary to Pliocene, and early Pliocene to possibly late Miocene (undated). Multiple proxies are used to characterize paleo-circulation and depositional processes, while benthic foraminiferal assemblages are utilized to evaluate paleo-sea ice conditions. Early Quaternary and older sediments indicate little to no effect from glaciations, reduced sea-ice conditions, and a periodic strong current impact on the ridge top indicating an enhanced circulation, possibly related to Atlantic water flow. Absence of calcareous fossils in the oldest sediments (Unit 2b) is likely due to dissolution, thus indicating elevated water acidity. Several SIS ages derived from a ~40-cm interval at Unit 2a bottom, with the first significant amount of calcareous foraminiferal tests appearing in the record, yield nearly identical ages of ca. 5 Ma, likely indicating a redeposition pulse that we attribute to the onset of Pacific water throughflow via the Bering Strait. This finding, if confirmed, has a potential to provide a new constraint on the development of oceanic circulation in the northern high latitudes during the late Neogene.

Despite a large hiatus spanning most of the Pliocene in the ridge-top core JPC3 and a lack of datings in the bottom part of core P23, a combination of these records offers a wealth of information on a considerable part of Plio-Pleistocene Arctic paleoceanography since the establishment of the Pacific water throughflow. This development includes a gradual expansion of sea ice, possibly in connection with the history of glaciarization of the Arctic and North Pacific periphery and related climatic cooling. A prominent sea-ice/cooling event, inferred from the extinction of a number of foraminiferal species and a noticeable change in other proxies, occurs around ca. 2 Ma. While its age needs to be further specified, we relate this event to a known climatic cooling at 1.8 Ma (formerly used as Pliocene-Quaternary boundary). A prominent Unit 2/1 boundary, estimated to ca. 0.8 Ma, is marked by an abrupt turnover in practically all proxies, which is consistent with a major climatic shift that occurred during the

late Mid-Pleistocene Transition. Unit 1 exhibits a strong control from glacial cyclicity, with a progressive strengthening of inputs from the Laurentide Ice Sheet primarily affecting the study region, and mostly perennial sea-ice conditions.

Overall results suggest that the Pliocene (after the Pacific water throughflow onset) to early Pleistocene records have a good potential to provide the most relevant paleoclimatic analogs for the rapidly changing, progressively seasonally-ice free Arctic environments of today.

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The onshore imprint of the Northeast Greenland ice stream and 79N ice ice shelf

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Understanding the impacts of climate change on ice sheets and the subsequent changes to global sea-level over 100 - 1000yr timescales are fundamental scientific and societal challenges. This project focuses on the Northeast Greenland Ice Stream (NEGIS); a key sector of the Greenland ice sheet (GrIS) because it controls ice flux into the NE Atlantic (an area sensitive to freshwater input) and it holds a sea-level equivalent (SLE) of ~1.4m. This sector of the ice sheet is predicted to be vulnerable to future climatic changes and is also known to have undergone dramatic retreat during the Holocene Thermal Maximum.

The project aims to reconstruct the past behaviour of NEGIS in order to calibrate and validate the sensitivity of 3D numerical models that can predict ice stream-shelf dynamics over 100 - 1000yr timescales. Over the last two years the project has worked in partnership with the Alfred Wegener Institute, Germany and executed two marine cruises and an onshore work programme. This presentation summarises the findings of fieldwork in 2017.

Along the north edge of 79N abraded terrain, erratic spreads lateral moraines record warm-based ice up to 600- 850m asl, with the ice stream coalescent with local ice caps to the north as ice moved offshore at the LGM. During early deglaciation a series ice contact deltas mark ice stream/ice cap decoupling, surface thinning and the formation of ice-dammed lakes along the margin of 79N. These may mark an upstream response to early ice recession from the continental shelf edge around 17.9 – 15.8 ka cal. BP.

The transition from ice stream to ice shelf in 79N probably occurred between 12 – 10 ka cal. BP, and the migration of the ice stream/shelf system onshore can be tracked using new geophysical and sedimentological data. Once within the confines of the 79N fjord previous work suggests ice shelf collapse ~80 km upstream of the present ice shelf margin by 7.0 BP (Bennike and Weidick, 2001). Epishelf lake and marine sediments as well as fossilized whale, seal, mollusc and fish remains record a period of open marine conditions in 79N fjord during the early Holocene. In the Blaso region (close to the present day grounding line of the ice stream), oscillations between marine, deltaic and epishelf conditions also record both grounding line and ice shelf fluctuations through the Mid to Late Holocene/LIA in response to changing climatic and oceanic conditions.

Active retreat of a marine-terminating glacier: Evidence from Late Weichselian sediments and glaciotectonics in western Iceland

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Large and complete glaciotectonic sequences formed by marine-terminating glaciers are rarely observed on land, hampering our understanding of the dynamics of such glaciers and the processes operating at their margins. During early Bølling (~14.6 cal. ka BP) the coastal areas in W-Iceland became deglaciated following a rapid breakup of the western sector of the marine based part of the Icelandic Ice Sheet. Later, glaciers re-expanded out of the coast in the Borgarfjörður region, W-Iceland and resulted in the large-scale deformation of a sequence of glaciomarine sediments of Bølling-Allerød age (~13.0-14.6 cal. ka BP). Due to isostatic rebound since the deglaciation, these formations are now exposed in the coastal cliffs of Melabakkar-Ásbakkar in the Melasveit district and provide a detailed record of past glacier dynamics and the interrelationships between glaciotectonic and sedimentary processes at the margin of this marine-terminating glacier. A comprehensive study of the sedimentology and glaciotectonic architecture of these coastal cliffs as well a section through the ridge of Belgsholt located north of Melabakkar-Ásbakkar revealed a series of subaquatic moraines formed by a glacier advancing from Borgarfjörður to the north of the study area. Analyses of the style of deformation within each of the moraines demonstrate that they were primarily built up by ice-marginal/proglacial thrusting and folding of marine sediments, as well as deposition and subsequent deformation of ice-marginal subaquatic fans. The largest of the moraines exposed in the Melabakkar-Ásbakkar section is over 1.5 km wide and 30 m high and indicates the maximum extent of the Borgarfjörður glacier. Generally, the other moraines in the series become progressively younger towards the north, each designating an advance or still-stand position as the glacier oscillated during its overall northward retreat. During this active retreat, glaciomarine sediments rapidly accumulated in front of the glacier providing material for new moraines. As the glacier finally receded from the area, the depressions between the moraines were infilled by continued glaciomarine sedimentation. This study highlights the dynamics of marine-terminating glaciers and may have implications for the interpretation of their sedimentological and geomorphological records.

Variable pathways of Atlantic Water flow in the Arctic Ocean during Late Quaternary warm periods

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Today, the patterns of Atlantic Water advection and its pathways within the Arctic Ocean are clearly determined by the Coriolis force. Having entered the deep-sea Arctic Ocean basin, the core of this warm and salty water mass turns eastward and can be traced as a counterclockwise intermediate water current along the entire Arctic continental margin. Additionally, the Atlantic Water spreads as a subsurface water mass in the interior Arctic Ocean.

The pathway of Atlantic Water in the Arctic Ocean in the past can be traced by the distribution of microfossils clearly associated with this water mass, e.g., the subpolar planktic foraminifer *Turborotalita quinqueloba*. New foraminiferal and isotopic data sets from sediment cores obtained from the western and central Lomonosov Ridge during expedition PS87 of RV Polarstern in 2014, supplemented by data from refined analyses of older core material, reveal the flow pattern of Atlantic Water during the three pronounced warm periods since the penultimate glaciation: Marine isotopic (sub) stages (MIS) 1, 5a, and 5e. High-resolution records of MIS 1 from the eastern Fram Strait and the Yermak Plateau show that *T.quinqueloba* abundances rapidly decrease north and northeast of 80°N, even in sediments from the time of maximum Atlantic Water advection during the early Holocene thermal maximum (ca. 10.8-8.5 ka). In the interior Arctic Ocean, MIS 1 sediments are generally barren of *T.quinqueloba*.

Records from MIS5e (Eemian) and MIS 5a reveal a strongly different picture. For the early part of these relatively mild climatic intervals, faunal and isotopic data from the western Lomonosov Ridge (between Greenland the the North Pole) suggest a noticable advection of Atlantic Water, yet of rather low temperature and likely at depths comparable to the modern distribution (i.e., below 150 m) or even deeper. This may be explained by a thick layer of low saline waters near the surface which stemmed from the slow melting of ice sheet remnants on the Eurasian continent and shelves. In the second half of both MIS 5a and 5e, Atlantic Water advection was still strong, but likely occurred at shallower depths, as indicated by unusually large amounts of small *T.quinqueloba* in central Arctic sediments. Atlantic Water was apparently diverted northward from the Fram Strait and spread eastward along the Lomonosov Ridge. A possible explanation is the persistence of an unusually thick layer of a water mass of similarly high density in the upper Eurasian Basin. The origin of this water mass is elusive. Weaker freshwater run-off than today and a thicker low-salinity layer are a possible explanation. However, the opposite, a persistent strong meltwater run-off fostering intense sea ice formation and brine rejection along the Eurasian margin, may have had the same effect. In any case, the new results support the recently published notion that there may have existed at least two interglacial circulation patterns of Atlantic Water in the Arctic Ocean (cf. Löwemark et al., 2016, Quat.Sci. Rev.).

Reconstruction of Arctic sea ice cover: New insights and questions from biomarker and microfossil proxy records

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Over the last about four decades, coinciding with global warming and atmospheric CO_2 increase, the extent and thickness of Arctic sea ice has decreased dramatically, a decrease much more rapid than predicted by climate models. The driving forces of this change are still not fully understood. In this context, detailed paleoclimatic records going back beyond the timescale of direct observations, i.e., high-resolution Holocene records but also records representing more distant warm periods, may help to distinguish and quantify more precisely the natural and anthropogenic greenhouse gas forcing of global climate change and related sea-ice decrease. For reconstruction of past sea-ice conditions the biomarker proxy IP_{25} as well as micropaleontological proxies have been successfully used in numerous studies. The different proxies, however, often give quite different results in terms of variability and extent of past sea-ice cover. Thus, further ground-truth data are needed to test, approve and/or better calibrate these proxies. Here, some of such data is summarized in this overview, pointing to problems and perspectives of the different approaches for sea-ice reconstruction.

First, a nearly circum-Arctic surface sediment database that combines new and published data of IP_{25} and specific open-water phytoplankton biomarkers, are related to modern, satellite-derived sea-ice conditions in (sub-)Arctic regions. These biomarker data are compared with microfossil-based modern sea-ice reconstructions. Second, some examples of sea-ice (biomarker) proxy records representing the last interglacial (MIS 5e) and the Holocene time intervals, are shown. Further details of our AWI studies dealing with the reconstruction of present and past Arctic sea-ice cover, are presented in three posters (Kolling et al., Saina et al., and Syring et al.).

Ice stream activity scaled to ice sheet volume during Laurentide Ice Sheet deglaciation

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The contribution of the Greenland and West Antarctic ice sheets to sea level has increased in recent decades, largely due to the thinning and retreat of rapidly-flowing outlet glaciers and ice streams. This 'dynamic' loss is a serious concern, with some modelling studies suggesting that the collapse of a major ice sheet could be imminent or potentially underway in West Antarctica, but others predicting a more limited response. A major problem is that observations used to initialize and calibrate models typically span only a few decades, and, at the ice-sheet scale, it is unclear how the entire drainage network of ice streams evolves over longer timescales. This represents one of the largest sources of uncertainty when predicting the contributions of ice sheets to sea-level rise. A key question is whether ice streams might increase and sustain rates of mass loss over centuries or millennia, beyond those expected for a given ocean–climate forcing. In this paper, we reconstructed the activity of 117 ice streams that operated at various times during deglaciation of the Laurentide Ice Sheet (from about 22,000 to 7,000 years ago) and show that as they activated and deactivated in different locations, their overall number decreased, they occupied a progressively smaller percentage of the ice sheet perimeter and their total discharge decreased. The underlying geology and topography clearly influenced ice stream activity, but— at the ice-sheet scale—their drainage network adjusted and was strongly linked to changes in ice sheet volume. It is unclear whether these findings can be directly translated to modern ice sheets. However, contrary to the view that sees ice streams as unstable entities that can accelerate ice-sheet deglaciation, we conclude that ice streams exerted progressively less influence on ice sheet mass balance during the retreat of the Laurentide Ice Sheet. This raises some interesting questions about the role of ice streams in ice sheet dynamics, and the source of major jumps in sea level (meltwater pulses) during the last deglaciation.

Quantification of carbon supply and burial in Arctic fjord sediments in response to post-Little Ice Age glaciers retreat, Hornsund, Svalbard

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Carbon sequestration in the oceans and subsequent burial in marine sediments are important parts of carbon cycle, which needs to be quantified in order to be implemented in climate models. Recently fjords were highlighted as globally important carbon sinks, mainly on the basis of studies conducted in temperate fjords. However, an important rising question is if these estimates are also valid for fjords with catchments covered mainly by glaciers, and thus with limited supply of modern terrigenous organic carbon. Many of them witness a rapid glacier retreat, and consequently increase of sediment input and fjord area. In order to assess the impact of rapid glacier retreat on carbon supply and burial rates in an Arctic fjord, an interdisciplinary study was conducted in Hornsund fjord in southern Spitsbergen, Svalbard. The time span of interest is limited mainly to post Little Ice Age period of rapid retreat of tidewater glaciers covering most of the Hornsund fjord catchment.

The present study is based on high resolution data including: multibeam echosounder bathymetry, shallow seismics and high resolution analyses of over 30 sediment cores and end member sediment samples. The sediment analyses included sedimentological description, grain size, ^{210}Pb and ^{137}Cs dating, bulk geochemical analyses and XRF scanning, sedimentary organic carbon age analyses (^{14}C) used as a proxy for modern carbon fraction and stable isotopes analysis of organic matter.

The relatively good historical documentation of glacier front positions and climate during the post-Little Ice Age period allowed to quantify the sediment and carbon fluxes to the new bays in decadal scale. The sediment dispersal pattern seem to be largely affected by glacier retreat rates, changing bay geometry and increase in influence of oceanographic conditions. The sediment accumulation rate in order of few mm to several cm per year and relatively high total organic carbon content (~2%) result in extremely high carbon burial rates (in order of several hundreds of gOC/m^2/yr) - much higher than in temperate fjords. However, analyses of isotopic composition of the carbon revealed that most of the carbon comes from subglacial erosion of older sedimentary rocks, not from modern sequestration of atmospheric carbon.

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Iron input from Svalbard to the Yermak Plateau since MIS 6

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Climate warming in high latitude terrestrial regions has the potential to significantly influence ocean biogeochemical cycling through increased delivery of freshwater, nutrients, and organic material. Changes in iron (Fe) delivery from high latitude terrestrial regions is especially important because Fe is a bioessential micronutrient, can control the sedimentary burial vs. release of macronutrients (phosphorus), and can increase sedimentary preservation of organic carbon. Sedimentary records of past biogeochemical cycling are, therefore, important to evaluate and predict the effects that changes in the delivery of Fe-rich terrigenous material to the Arctic Ocean will have on nutrient cycling and organic carbon preservation.

During a 2015 Polarstern expedition, sediment cores were retrieved north of Svalbard, on the Yermak Plateau. Based on preliminary age constraints, the PS92/39-2 core includes sediments from the penultimate glaciation (MIS 6) to the Holocene (MIS 1). Here we present paired XRF analyses, as well as Fe and P speciation results, to quantify and evaluate changes in biogeochemical cycling in this region during the past two glacial cycles. Initial results indicate a series of high Fe delivery events during the record with Fe concentrations of up to 9.8 wt.%. Pulsed delivery of Fe is likely associated with increased delivery of material from northern Svalbard, which is dominated by Fe-rich Devonian red beds. Tight coupling between Fe and P concentrations throughout the record suggests dynamic nutrient delivery and burial in the region during the last two glacial cycles.

Differences of sedimentary conditions in the Eastern Arctic during the Middle-Late Pleistocene

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The territory of the Eastern Arctic, that includes the shelf of the Laptev, East Siberian and Chukchi seas and the adjacent lands, is now regarded as one of the harshest climatic region of the Arctic. The whole land is referred to a low-temperature continuous cryolithozone. The area reached maximum size in cold epochs of the Middle and Late Pleistocene, when the cryoarid conditions predominated (Velichko et al, 1997). Due to the peculiarities of the atmosphere circulation, it is characterized by an insignificant amount of snow precipitation. Therefore, the glaciers are extremely limited only on the high-latitude arctic islands and in the high-mountainous regions of the Chersky Range. During the Late Pleistocene was the global sea regression. The sea level was fall down from the first ten to 100-120 meters. Significant part of the shelf was drained and included to the western part of Beringia. Subaerial conditions of sedimentation were predominant at the territory during cryochrons. The main cryogenic process was frost cracking (Romanovsky, 1977). Different genetic types of Quaternary sediments were formed as syncryogenic and had high ice content, including huge ice wedges. At present, they are often combined into one complex of deposits that was called Ice Complex (Romanovsky, 1993; Schirrmeister et al., 2013). Ice Complex is single common formation only from the cryogenetic point of view. From the geological and genetic points of views, it is present by different types of alluvial, lacustrine, boggy, slope, fluvioglacial deposits, etc. Therefore, different ice complexes can be highlighted by geological genesis in the region.

The deposits of Ice Complex was formed in the Eopleistocene already at the Kolyma coastal lowland (Sher, 1971, Kaplina, 1981). Three Ice Complexes at least preserved from the Middle and Late Pleistocene to present around the Dmitrii Laptev Strait (Tumskoy, 2012). The oldest Ice Complex was dated by U/Th method in 200-160 kyr BP (Schirrmeister et al., 2002). Thin horizons of peaty lacustrine deposits separate Ice Complexes of different ages. They formed during of thermochrones.

Three horizons of the Ice Complexes present in the Oyogosskiy Yar (south coast of western part of Dmitrii Laptev Strait). The base of Middle Pleistocene deposits lie under modern sea level to the west from Svyatoy Nos Cape and to the east from Oyogosskiy Yar. At these territories, outcrop upper Ice Complex only. Such stratigraphic construction of sections associated with the submeridional zone of tectonic uplifts. Pre-Holocene marine deposits didn`t find in this area. This indicates that during thermochrones sea level didn`t rise to near-modern marks.

Pleistocene marine deposits at the New Siberian Islands are known. They relatively locally distribute at Faddeevsky and Novaya Sibir islands (Trufanov et al., 1979). The thickness of marine sediments reach 40-50 m or more. Thin Late Pleistocene Ice Complex covers them (Pavlova et al., 2010). Massive ground ice bodies associated with the marine deposits closely. They thickness amount up 35-40 m, but they are absent in other areas of the Eastern Arctic (Tumskoy, 2012). Genesis of massive ice are different:

1) normal glacier ice, covered by marine deposits;
2) basal ice in the bottom of glacier ice;
3) segregated ice layers;
4) ice-ground formation;
5) covered ice of snow patches or sea ice.

Glacier and basal ice are widespread on the northern coast of Faddeevsky and Novaya Sibir islands. They allow us to reconstruct the old New Siberian ice sheet at least 250-300 km long at the northern coast of the islands (Anisimov et al., 2006; Basilyan et al, 2010). Age of glaciation is not yet determined reliably. However, it is estimated as the second half of the Middle Pleistocene according to the results of U/Th dating of mollusk shells (Basilan et al., 2010).

Long-lived marine sedimentation conditions in this region associated with slow rates of glacioisostatic uplift. They include other three types of massive ice. Those associated with special freezing conditions of shallow marine sediments during glacioisostatic movements also. Continental deposits of Ice Complex began form at the middle or end of Late Pleistocene only.

There are several hypotheses concerning the origin of the old New Siberian ice sheet. The first one is an independent glacial cover with the center near the De-Long Islands (Anisimov et al., 2006; Basilyan et al., 2008). According to another version (Jakobsson et al., 2016; O`Regan et al., 2017) it could be an ice stream of the North American ice sheet, which spread through the entire Arctic Ocean and reached the northern coasts of the New Siberian Islands. Another opinion is that normal glacier and basal ice are buried grounded icebergs. In this case, the origin of marine sedimentation and three last types of massive ice should be explain as results of tectonic movements.

Finally, authors on the territory of the Eastern Arctic shelf identified two structural-facies zones. The first zone presented by Middle and Late Pleistocene marine deposits with massive ground ice mainly. The second - Middle and Late Pleistocene continental deposits of different genesis: for cryochrones - Ice Complex deposits, for thermochrones - peaty lacustrine deposits mainly. Both zones have a completely different history of development. They are the most interesting objects for the research in this area.

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Glacial deposits of the north-eastern Barents Sea and implications for regional deglaciation patterns

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The north-eastern Barents Sea, including the large and deep Saint Anna Trough, is one of the least-studied sectors of this palaeo-marine based ice sheet. Its deglaciation history is poorly constrained, limiting our ability to reconstruct the pattern of ice flow in the northern Barents Sea; as well as the timing and magnitude of ice, water and sediment discharge into the Arctic Ocean. Here we present new insights into the distribution of glacial sediments and landforms in the Saint Anna Trough and the bank areas south of Franz Josef Land, based on geophysical (acoustic and shallow seismic) datasets.

We see clear evidence of ice streaming within the inner parts of Saint Anna Trough. The distribution of glacial lineations and drumlins reveal that the Saint Anna Trough Ice Stream was fed by tributaries draining the northern central Barents Sea. We see little evidence for ice from the Kara Sea draining into the Saint Anna Trough. A composite pattern of moraines and multiple till units on the flanks of the trough and the adjacent bank areas, reveals a more complex glacial history, indicating periods of overriding and the preservation of deposits from multiple glacial events.

Numerical ice sheet modelling of the Late Weichselian Barents Sea Ice Sheet predicts pervasive cold-based conditions across much of the north-eastern sector, throughout the Late Weichselian, with only the main part of Saint Anna Trough hosting warm-based, actively flowing ice (Patton et al., 2016). This gives rise to low potential erosion rates and increased likelihood for the perservation of relict landforms in those areas outside of Saint Anna Trough.

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Saltmarsh record of post Little Ice Age mass balance changes in southeast Greenland

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Saltmarshes provide excellent archives of relative sea-level (RSL) changes over a range of different timescales. In Greenland they yield precise RSL data over the past few decades to hundreds of years that can help constrain Greenland Ice Sheet mass changes during and after the Little Ice Age (LIA). They are particularly valuable as they provide a longer term context upon which to evaluate recent tide gauge and GPS records which span only the past decade or so. In Southeast Greenland the current rate of crustal uplift recorded by GPS is approximately +7 mm/yr at the open coast and up to +18 mm/yr close to the ice sheet margin, which reflects high rates of recent mass loss.

This study investigates a fossil saltmarsh located within 5 km of the ice sheet margin at the head of Skjoldungen fjord in southeast Greenland. The aim is to use RSL data to establish the timing and magnitude of mass loss since the end of the LIA. This is the first time that saltmarshes so close to the ice sheet margin have been utilised to create high precision proxy-GPS data for the last few hundred years.

Microfossil (diatom) evidence from saltmarsh sediments at the Skjoldungen study site record a recent change from RSL rise to stable RSL, then RSL fall during the past 200 years. We interpret the change from RSL rise to stable RSL as evidence for the initial onset of mass loss locally from the Greenland Ice Sheet at the end of the Little Ice Age. Later RSL fall occurs as mass loss accelerates during the 20th Century. We use a combination of dating methods to establish the timing of the initial RSL slowdown and rates of RSL rise during the LIA and fall during the 20th Century. We then compare our RSL record to geophysical model predictions of local RSL change due to post-LIA Greenland mass loss and consider the contribution of other factors (e.g. thermosteric effects, fingerprint of glacial melt elsewhere) to RSL during the 20th Century in this location.

This study provides the first direct evidence that saltmarsh sediments from near-field sites can be used to reconstruct the timing of recent mass loss change from the Greenland Ice Sheet, extending direct GPS observations back to the end of the Little Ice Age and beyond using geological data.

Poster Presentation Abstracts

Alphabetical by surname

The Seven Islands, Svalbard: glaciation at the margin

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On the Seven Islands, north of Nordaustlandet, Svalbard, decreasing snow cover has made previously inaccessible stratigraphic sections in coastal cliffs possible to investigate. Sections on two of the islands, Phippsøya and Parryøya, reveal mainly raised marine deposits, representing one or more coarsening upward sequences (emergence cycles) at each site, which in turn imply preceding regional glaciations (cf. Alexanderson et al. in press). Optically stimulated luminescence (OSL) ages are pending but radiocarbon (^{14}C) ages and correlation to a previously studied site on Phippsøya (Forman and Ingólfsson 2000) suggest at least two events that occurred during the late Weichselian-early Holocene and prior to 40 ^{14}C ka BP, respectively. These results, along with observations of postglacial land uplift and of transport of erratic boulders to the islands, provide information on the glacial history and dynamics of an area close to the margin of the Svalbard-Barents Sea ice sheet.

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Geomorphological and sedimentological evidence for a palaeo-ice stream in Bárðardalur, North Iceland

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Recent studies of streamlined subglacial landforms support the presence of palaeo-ice stream activity in NW-Iceland (Principato et al. 2016). Elsewhere in Iceland, the configuration and geomorphological footprint of palaeo-ice streaming are generally poorly understood. The geomorpholocial and sedimentological properties of streamlined landforms in the valley of Bárðardalur in N-Iceland are investigated using a combination of remote sensing and fieldwork. Drumlins and mega-scale glacial lineations (MSGL) were identified using satellite imagery from Google Earth, the National Land Survey of Iceland (NLSI) Map Viewer, MAP.IS by Loftmyndir ehf., and from contours on the 5 m mosaic of the Arctic Digital Elevation Model (Arctic DEM). The outlines of the landforms were drawn manually in either Google Earth or using 5 m contours and hillshade model in ArcGIS generated from the Arctic DEM. Quantitative spatial analyses were conducted in ArcGIS using a 20 m DEM of Iceland from the NLSI due to gaps in the Arctic DEM. Landforms were classified by their elongation ratio as either drumlins (< 10) or MSGL (≥ 10). At least 148 streamlined landforms were identified using Google Earth, with 69 drumlins and 79 MSGL. The distribution of elongation ratios is positively skewed, and the average elongation ratio is 11.7:1. Preliminary results suggest that the average density of streamlined landforms is 1.85 landforms per 1 km^2, and packing ranges from 0.0002 - 0.67 landform surface area per km^2, with an average value of 0.14 landform surface area per km^2. Parallel conformity is 6.03 degrees, indicating uniform ice flow direction. The modal orientation of long axes of streamlined landforms is 317.8 degrees, demonstrating that ice flowed from Bárðardalur into the Skjálfandi Bay. Sedimentological exposures in the drumlins and MSGL show that they are generally composed of massive to highly fissile diamicton with moderate to high clast content and occasional lenses of sorted sediments.

The geomorphological and sedimentological properties of streamlined landforms in the Bárðardalur valley suggest the presence of a palaeo-ice stream that supplied ice to the margin of the marine-terminating Iceland Ice Sheet during the Last Glacial Maximum and the following deglaciation. Fieldwork to ground-truth the spatial analyses and verify the preliminary sedimentological investigations is ongoing.

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Puturana ice sheet advance over southern Taimyr, NW Siberia, during the Late Saalian (MIS 6)

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Previous studies in NW Arctic Siberia suggest that local ice caps around the Kara Sea shelf merged there repeatedly to form a Kara Sea Ice Sheet (KSIS). When assembled to a large ice sheet, initial northward flow from the Byrranga Mountains on the Taimyr Peninsula reversed as the ice sheet further expanded southwards. The most extensive glaciation over Taimyr occurred during the Taz/Late Saalian (MIS 6), during which the KSIS advanced from NW onto the Putorana Plateau south of Taimyr. However, stratigraphic sites along the Bol'shaya Balaknya River (situated on southern Taimyr) suggest that the Taz/Late Saalian expansion of the KSIS from NW was preceded by ice coming from the Putorana Plateau to the south, a conclusion based on our site BBR 16. This site reveals a fining upwards sequence from fluvial sands to shallow glaciomarine mud with shell fragments, dated with ESR to 171 ka BP. This sequence is glaciotectonically deformed and unconformably overlain by subglacial traction till. The glaciotectonic deformation as well as clast fabrics in the overlying till, indicate stress application from southerly directions. Our preliminary model suggests a marine transgression due to a growing Putorana ice sheet, before it overrode southern Taimyr during the Late Saalian (MIS 6). This occurred at the same time as a KSIS advanced from the north beyond the Byrranga Mountains. The KSIS subsequently merged with the Putorana ice sheet and eventually pushed the maximum extent of Late Saalian ice well south of the Putorana Plateau.

Holocene paleoenvironments on the Severnaya Zemlya archipelago as inferred from results of radiocarbon dating and sedimentological, geochemical and palynological investigations of sediment core from Lake Tvyordoe, Russian High Arctic

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The Late Quaternary climatic and environmental history of the Severnaya Zemlya archipelago in the Russian High Arctic has been the objective of many paleoenvironmental studies since the 1970s (e.g. Kotlyakov et al., 1991; Bolshiyanov and Makeyev, 1995; Raab et al., 2003; Möller et al., 2007; Andreev et al., 2008; Opel et al., 2013). However, the data yet obtained are highly fragmentary and sometimes contradictory. The understanding is improved by new information derived from a 2.46 m long sediment core from Lake Tvyordoe, located in the northwestern part of Bolshevik Island. This core was investigated by a multi-proxy approach that included first radiocarbon dating along with lithological, granulometrical, palynological, and geochemical analyses. The results provide detailed information concerning the vegetation history, changes in lake level, lake-ice-cover conditions, and water and sediment input since the Last Glacial Maximum (LGM). The age of ca. 24.2 ka cal BP of the fine-grained, laminated clastic sediments at the core base, which suggest lacustrine sedimentation under a permanent ice cover with reducing melt-water supply, as well as a lack of glacial and glacial-lacustrine deposits in the core support earlier assumptions that Bolshevik Island was not covered by the Barents-Kara Ice Sheet during the LGM (Bolshiyanov and Makeyev, 1995; Raab et al., 2003; Möller et al., 2007). The Mushketov Ice Cap, the closest glacier to Lake Tvyordoe, was located within or slightly beyond its present margins. The warmer and wetter climate conditions than before at the termination of the Pleistocene resulted in higher sediment loads. During the early and middle Holocene (ca. 11.2–7.3 ka cal BP), most favourable environmental conditions on the Bolshevik Island existed, when low shrub tundra associations with dwarf birch, willow and alder dominated the vegetation. Some time after 7.3 ka cal BP, a rather abrupt climate cooling occurred. The cold and dry climate during the late Holocene, according to the pollen data (suggesting sparse lichen–moss–grass cover) and relatively low total organic carbon (TOC) content, was rather similar to that of the late glacial.

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Late Quaternary ice sheet dynamics and palaeoceanography in the Baffin Bay region

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The detailed link between ice sheet dynamics and climatic forcing mechanisms such as atmospheric and oceanic circulation is still relatively poorly understood. Baffin Bay is ideally located to record variability in the Greenland, Innuitian and Laurentide Ice Sheet margins during the Late Quaternary and their potential links to climate forcing.

Previous research in the Baffin Bay region has identified sedimentary units characterised by an increase in concentration of detrital carbonate termed Baffin Bay detrital carbonate events (BBDC). These are thought to be linked to iceberg derived flux from the Innuitian and northern Laurentide Ice Sheets. These events are synchronous across Baffin Bay but are out of phase with the widely identified Heinrich Events (specifically Heinrich Event 1 and Heinrich Event 0).

Here we present new multiproxy data from a sediment core located in central Baffin Bay recording the most recent two BBDC events during the last deglaciation. Detailed core analysis includes whole core x-radiographs and MSCL data, IRD counts, laser granulometer particle size, XRF scanning and micropalaeontology (foraminiferal fauna). Variations in Ca concentration based on qualitative XRF scanning are used to identify the BBDC events, these are also correlated with other cores in the region supported by a foraminiferal based radiocarbon chronology. The sedimentological, geochemical and microfossil data are used to interpret the palaeoceanographic evolution of the core site. The results from this study also contribute to ongoing research investigating the relative timing of ice sheet dynamics in the Baffin Bay region (BBDC events) and the North Atlantic Heinrich events. The results presented here supports the recent research noting a poor correlation between the BBDC events and Heinrich events, indicating that the LIS and IIS were likely decoupled from the North Atlantic climate mode during the last deglaciation.

Hilltops Transformation at Marginal Zone of Middle Pleistocene Glaciation, Borisoglebsk Upland, Central Part of Russian Plain

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The Upper Volga region is one of the stratigraphic references for reconstructing geomorphic evolution of northern part of the Russian Plain since termination of the last Middle Pleistocene glaciation (Moscow – Saalian, MIS6) thanks to a large number (>20) of reference sections described in details. At the same time, interpretations and correlations remains controversial for two main reasons: i) different backgrounds and basic concepts adopted by different research groups studying the same set of sections; ii) lack of absolute dating. Since the degradation of Moscow ice cover, prominent geomorphological events at its marginal zone concentrated largely within the fluvial network. Hence, most of the landscape development reconstructions have been strongly biased towards understanding the fluvial landforms, sediment sequences and corresponding incision-widening-infill cycles. However, thorough understanding of clearly notable fluvial activity cycles creating the existing complex hydrographic network does not shed sufficient light on much slower and lower-amplitude evolution of interfluves characterized by a variety of genetic and morphological types (i.e. typical moraine ridges or hills, dead-ice moraine knob-and-kettle topography, glacial melt-water channels and outwash plains, glaciolacustrine depressions, etc.).

The case study area of Borisoglebsk Upland adjoins long-existing tectonic depression with inherited subsidence trend since Pre-Quaternary. Its central part is occupied by Nero Lake providing continuous and prolonged sedimentary record for the basin. The existing palaeolandscape reconstructions for the surroundings are based entirely on integration of the lake sedimentary sequence, valley infills and correlated geoarcheological sites, reflecting local confined conditions. However, deciphering another part of the local environmental change history carved into the interfluve morphology and surface sediments has a great potential to support reliable extrapolation to regional-scale generalizations. Moreover, in most of the studies interfluve surfaces are considered as relatively simply arranged geomorphic, lithogenic and pedogenic background. Origin of texturally differentiated sod-podzolic soils of the region is also a matter of ongoing debate. Contribution and relative importance of surface gleyization, lessivage and podzolization, on one hand, and sedimentation features, on the other, into their formation and evolution has not yet been determined. Nevertheless relic components such as remnants of periglacial microtopgraphic features are observed almost everywhere in the landscape and soil cover structure, testifying dominance of fundamentally different environmental conditions during their formation.

In order to decipher this natural archive, almost devoid of traditional palaeoenvironmental proxies, interdisciplinary research of interfluve surfaces and slopes geomorphic structure, lithology, textures and pedogenic properties of sediments has been carried out. It involved combination of several independent approaches including detailed geomorphic descriptions, DGPS profiling, topographic maps and remote sensing data analysis (open source satellite imagery, global satellite DEMs, aerial photography using UAV), thorough description and sampling of one new hilltop geological section (4 m deep) and 20 cores up to 9 m deep along the selected transect. Integrating the available results, we propose a detailed scenario of the interfluve landscape evolution over the last ca. 150 ka at the Moscow glaciation marginal zone. It includes stages of ice cover degradation and successive glaciofluvial-glaciolacustrine transformation during the end of the Middle Pleistocene when supraglacial and moraine-dammed proglacial lakes strongly controlled rates and distribution of erosion and sedimentation. At the hilltops, they were followed by relatively slow morpholithogenic evolution with continuous polygenic soil formation and superimposed cryogenic periods. Simultaneously, upper parts of glacial depressions (meltwater channels and dead-ice moraine kettles) have been gently infilling and flattening by lacustrine, alluvial and colluvial deposits with at least one distinctive period of fluvial incision during the

Late Pleistocene. The present-day fluvial network often inherits ancient meltwater channels, however, does not penetrate as far into the most elevated parts of interfluves.

Reconstruction of late Holocene oceanography and climate variability in the eastern Baffin Bay area

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A 738 m long marine sediment core, AMD14-204 CasqC, was retrieved from the eastern Baffin Bay during a research cruise on board CCGS Amundsen in 2014. The study of benthic foraminiferal assemblages, XRF core scan data and CT-scans supported by radiocarbon dating of this core allow the reconstruction of the palaeoceanography and palaeoclimate of the eastern Baffin Bay during the last ~4800 cal. BP. Several major changes in oceanographic conditions and climate are reconstructed during this time interval in the eastern Baffin Bay area, which also influenced the nearby Upernavik Isstrøm glacier. Our study reveals that relatively warmer subsurface waters prevailed during the final phase of the warmer 'Holocene Thermal Maximum', linked to the entrainment of relatively warm Irminger Current (IC) water into the West Greenland Current (WGC). This relatively strong advection of IC may also have resulted in relatively strong melting of the Upernavik Isstrøm glacier, causing influx of meltwater to the area. However, at ~3100 cal. BP, the onset of the Neoglaciation, the area experienced an abrupt transition to dominantly agglutinated benthic species, indicating enhanced carbonate dissolution. This was likely in part caused by a reduction of the influx of IC water and increased entrainment of the East Greenland Current into the WGC. The reduction of IC water influx also allowed increased influx of the cold, corrosive Baffin Bay Deep Water. These cold subsurface water conditions persisted throughout the late Holocene, only interrupted by short-lived climate fluctuations superimposed on this cooling trend.

Modelling the controls on the retreat of the Uummannaq ice stream, West Greenland, during the Last Glacial Maximum

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We aim to understand what controlled the retreat pattern of the Uummannaq ice stream (UIS) during the last deglaciation. Evidence for the pattern of retreat is recorded in marine bathymetric and sedimentological data in the central trough (Ó Cofaigh et al. 2013). On land, on the islands that sit within the fjord (Ubekendt and Karrat) and on the fjord margins, geomorphological evidence records the thinning of the ice surface through time the geomorphic landscape (Roberts et al. 2013; Lane et al. 2014). These records are set within a chronological framework of radiocarbon and cosmogenic dates, which suggest that the ice stream was grounded close to the continental shelf edge at the Last Glacial Maximum, and retreated rapidly around 15 ka BP. However, it is unclear what controlled the nonlinear retreat pattern identified in the Uummannaq system.

Modelling the UIS using a 1-D numerical model provides the opportunity to combine the chronology and geometries inferred from the landforms and to test the influence of various controls upon the retreat of the ice stream. The model has the capability to dynamically and robustly simulate grounding line retreat behaviour over millennial timescales (Jamieson et al., 2014). Marine geophysical data and dates from islands are used to constrain the numerical model and sensitivity tests are being conducted to explore its response to a range of forcing patterns. The model retreat is simulated from a steady-state LGM configuration and will be subjected to a series of retreat perturbations forced independently or simultaneously by either rising sea level, sub ice shelf melting and surface melt. The simulated behaviour of the UIS will be compared against the geomorphological and cosmogenic exposure evidence for ice surface thinning onshore.

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Surface exposure dating and glacio-isostatic adjustment: Correcting exposure ages from the Arctic

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Cosmogenic nuclide exposure dating is the principle tool for constraining terrestrial ice sheet extent. The time at which a rock is exposed during deglaciation can be estimated with known rates of radionuclide production and decay. As nuclide production is greater at higher altitudes (Lal, 1991), an accurate measurement of a rock sample's elevation is crucial for the calculation of its exposure age. Typically, it is assumed that the elevation of a sampled surface has either not varied over time or that any effect is negligible. However, glacio-isostatic adjustment studies indicate that many formerly glaciated regions underwent hundreds of metres of vertical deformation during the last glacial cycle (e.g. Steffen & Wu, 2011), potentially influencing cosmogenic production, and therefore exposure ages, in these areas.

Here deglacial surface exposure ages (5-25 ka BP) from across the Arctic (> 60°N) are recalculated by applying time-dependent elevation change corrections. This is done using both ICE5G and ICE6G ice models (Peltier, 2004; Peltier et al., 2015) to derive elevation offsets through time, as well as the recent global ^{10}Be production rate (Borchers et al., 2016) and nuclide scaling scheme (Lifton et al., 2014). Largest exposure age corrections occur in the regions of greatest deglaciation. In the vicinity of the former Laurentide and Fennoscandia ice sheets, the inclusion of such corrections make exposure ages 15-20 % older. This is far greater than the measurement uncertainty and other production rate uncertainties, and highlights the need to adequately correct surface exposure ages from deglaciation ice margins.

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Revision of the Last Glacial Maximum position on the Valday Upland to the south from Ostashkov (Russia)

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The south-east sector of the Scandinavian Ice Sheet (SIS), which mainly referred to the territory of the Russian Federation, has been studied much worse compared to other sectors, and no common view still exist about the glacial boundary in the Last Glacial Maximum (LGM). One of the regions of our investigation is the central part of the Valday Upland where the Upper Volga tongue of the SIS Ladoga stream was active in the Late Weichselian (Chebotareva, 1977). An overview of published literature has shown that at least four versions of the LGM glacial limits exist. To validate the ice sheet borders, different researchers applied methods of glaciomorphological analysis, correlation of end moraines and stratigraphic investigation of sections with the Mikulinian (MIS 5e) Interglacial and Early - Middle Weichselian deposits (Chebotareva, 1977) or analysis of remote sensing data and digital terrain models (Kalm, 2012). Recently, first results of TCN (^{10}Be) dating of boulders has been reported (Rinterknecht et al., 2016), though they have not allowed to elaborate a non-ambiguous figure of the LGM glacial limits.

The authors revised different versions of the LGM position in field, as well as conducted an analysis of the remote sensing data and digital terrain models to identify end moraines. From Ostashkov town to the Yeltsy village, about eight festoon belts crossing the central part of the Valday Upland with a hilly-ridge relief reflecting different stages of the glaciations development were found. The internal structure of the ridges and hills suggests that they were formed in conditions of passive and dead ice melting. The samples of deposits from outcrops were collected for radiocarbon and OSL dating. No evidence of the SIS active geomorphic or sedimentological action was found. According to A. A. Aseev (1974) reduction of the glacier erosion activity within the SIS periphery hinders till accumulation in the marginal zone. Therefore, we have tried to find a stratigraphic border and analyze its relations with the morphology of landforms.

The geomorphometrical study over the area between Ostashkov and Yeltsy allowed to recognize two different morphological units. The northern part of the area is characterized by the development of small hills with clear outlines, weak erosion dissection, and occurrence of a large number of closed boggy depressions and lakes. The southern part is distinguished by the large size of hills and smoothness of their forms; the depressions between hills and ridges are not closed, there are no lakes; the degree of fluvial reworking is much higher. Given that the morphological differences between the two areas are not that great, we used geological evidence to prove the position of the ice sheet boundary. Three exposures were investigated in the field and analytical study of sediments was produced. Field and laboratory data were complemented with 138 borehole sections extracted from unpublished geological survey reports stored in the Federal Geological Archive. It was found that sections with peats and lacustrine sediments of Mikulinian (MIS 5e) age overlaid and not overlaid by till are spatially separated between the northern and southern parts of the study area, respectively.

The compiled data allows us to suggest some corrections for the SIS maximum limits in the Upper Volga region south from Ostashkov (the so called Ladoga ice stream). In the new version, the glacial

limits are located 7 km north-west from the Selizharovo town, i.e. approximately 6 km westward from the position accepted in earlier published studies.

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Pan-Arctic distribution of sea ice biomarkers – a synthesis of old and new surface sediment records

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The reconstruction of past sea ice variability is crucial to understand the present sea ice development and estimate future changes. In order to understand proxy signals in paleorecords it is necessary to standardize the sedimentary signal with the comparison to modern observed environmental parameters. 171 surface sediments from key areas in (sub) Arctic regions, e.g., the Baffin Bay, were analyzed for specific sea ice (IP_{25}, PIP_{25}) and phytoplankton biomarkers (sterols, HBI III). The new biomarker data obtained from the surface samples were combined with previously published biomarker surface data *(Müller et al., 2011; Méheust et al., 2013; Navarro-Rodriguez et al., 2013; Xiao et al., 2013, 2015; Belt et al., 2015; Smik et al., 2016)* to a pan-Arctic database. The new pan-Arctic PIP_{25} database shows a good spatial representation of modern spring sea ice conditions and correlates relatively well with modern sea ice concentrations. The applicability of the HBI III as phytoplankton marker in the $P_{III}IP_{25}$ approach on an over-regional scale indicates promising results, however the applicability in specific areas (e.g., Laptev Sea, eastern Fram Strait) remains uncertain and required further work.

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Arctic sediment transport from land to fjord - Processes and deposits on the tidal flat in Dicksonfjorden, Svalbard

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With continuing glacier retreat, glacier fronts will become land-based, implying that many of the fjords in Svalbard may potentially change from receiving sediment supply directly from tidewater glaciers to having temporary storages in the coastal zone. The research project “Sediment flux from source to sink – the coastal link” aims at increasing the understanding of how sediments are transported from land to fjord basins in fjords of Svalbard, as well as on evaluating the impact of changing sediment supply on biological life. This will be done through comparing a glaciated fjord (Kongsfjorden) and a non-glaciated fjord (Dicksonfjorden). This study presents data from the land-based part of the project, which focuses on describing the coastal sedimentary system on the tidal flat in Dicksonfjorden. A geomorphological map of the tidal flat has been produced, and landforms such as tidal channels, tidal flat, tidal bars, cheniers (beach spits) have been identified. Aerial and satellite images collected in 1938 and 2011 (Norwegian Polar Institute/ USGS Landsat) will be used to describe the development of the delta front. Digital elevation models from two consecutive years have been acquired in order to calculate short-term coastal dynamics. The results will be used to estimate rates of coastal change and quantify sediment volumes in the coastal zone. Sediments from various landforms were described in field. Short sediment cores were described and dated using ^{210}Pb and ^{137}Cs radioisotopes to provide insight into sedimentary processes and accumulation rates. From the 210Pb profiles it is clear that the deposition is non-steady, which is expected in a dynamic setting of a tidal flat. The sediment accumulation rates in the intertidal zone of the tidal flat were found to be on average higher than 0,2 cm/year during the last century. The data acquired on land are combined with sediment trap data reflecting modern sediment supply and are linked to the offshore system investigated through multi-proxy analyses of sediment cores and AUV bathymetry surveys (Holthuis in prep.).

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Clay mineral composition of the Late Quaternary contouritic sedimentation on the NW Barents Sea continental margin: Insights for depositional and palaeoclimatic reconstruction

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This study focuses on the sedimentation history along the NW Barents Sea continental margin after the Last Glacial Maximum (LGM). The sedimentary record contained in the Trough Mouth Fans (TMFs) of the Kveithola and Storfjorden glacial troughs and in the contouritic drift facing the Bellsund Fjord provides several proxies that can be useful for reconstructing the ice-streams dynamics during glacial periods, the onset of deglaciation and the climatic variability during interglacials. This area of the NW Barents Sea continental margin has been investigated during several international oceanographic cruises: The SVAIS cruise onboard R/V Hespérides; the EGLACOM cruise, onboard R/V OGS-Explora; PNRA Project CORIBAR cruise, onboard R/V Maria S. Merian; and the Eurofleets-2 PREPARED cruise, onboard RV G.O. Sars.

Five cores collected during those international cruises have been investigated through XRD analyses on clay minerals and XRF analyses through Avaatech core scan on the whole length of the cores. In polar areas clay mineral analysis can be used for reconstructing sedimentary processes, associated with glacial and interglacial conditions. We discuss the sediment compositional changes in response to the climatic variations that followed the LGM, reflecting changes in ice-stream dynamics and related oceanographic/environmental changes along the margin.

Pleistocene Glaciations along the East Siberian continental margin and their extensions into the Arctic Ocean

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During the last five years data were published, which indicate that Pleistocene ice sheets must have existed in the area of today's East Siberian Sea (Niessen et al. 2013, Dove et al. 2014, Jakobsson et al. 2016, O'Reagan et al. 2017). As documented in our and other hydroacoustic data, the glaciations left behind typical landforms including moraines, glacigenic debris flows, till wedges and mega-scale glacial lineations (MSGL). MSGL related to Siberian ice were found as far as 83°N in the Arctic Ocean on parts of the Lomonosov and Mendeleev ridges down to 1200 m present water depth (mpwd). MSGL on the ridges have counterparts as glacigenic debris-flows along the slopes including those of the East Siberian Sea. Based on the stratigraphical interpretation of a few sediment cores it has been proposed that the East Siberian glaciation has occurred during MIS 6 (Jakobsson et al. 2016, O'Reagan et al. 2017) and, together with ice streams fed from North American, Greenland and Eurasian ice sheets, formed a coherent ice shelf covering the entire Arctic Ocean (Jakobsson et al. 2016).

Our studies focus on two areas of the East Siberian continental slope close to the Chukchi and Laptev seas including the southern parts of the Mendeleev and Lomonosov ridges, respectively. Numerous cores were retrieved after hydroacoustic surveys during expeditions of RVs "Polarstern" and "Araon" in the years 1995, 2008, 2014 and 2012, 2013, 2015, respectively. The core locations are on top of and/or adjacent to glacial landforms and allow interpretation of glacial chronology. Age models (MIS 1 to MIS 6/7) for the two areas near the Lomonosov and Mendeleev ridges have been proposed by Stein et al. (2001, 2017 and 2010, respectively). Stratigraphic correlation of sediment cores is based on physical properties (wet-bulk density and magnetic susceptibility), lithology, color and XRF data. The correlation is robust within each of the areas but still vague between the areas. There is a strong increase in sedimentation rates towards the upper East Siberian continental slope (500-700 mpwd), where cores penetrated into MIS 3 at the most.

Clear evidence for a LGM glaciation along the East Siberian margin is missing because intensive iceberg scouring occurred above 350 m present water level probably during post LGM times. On the slopes of the East Siberian Sea close to the Chukchi Sea, several northerly directed ice advances have occurred. The youngest advance grounded to about 700 mpwd along the continental slope and is dated as early MIS 3. Four older advances grounded between 900 and 1200 mpwd during MIS 4 to 5d, of which ice shelves of the two early advances (MIS 5d and 5b) eroded the top of a sea mount along the Mendeleev Ridge. There are at least three older glaciations visible in acoustic images from the East Siberian continental margin, which probably include and/or predate MIS 6. The available cores did not penetrate these events and the ages remain speculative. On the slopes of the East Siberian Sea close to the Laptev Sea and Lomonosov Ridge, several debris flows indicate northerly directed ice advances, which may be of similar ages than on the Chukchi side (MIS 3 to 5d). None of these grounded on the Lomonosov Ridge, where the youngest MSGL were dated to have formed during MIS 6 at about 800 mpwd. There are at least two older ice-shelf groundings up to 1100 mpwd visible in acoustic images from the southern Lomonosov Ridge, which clearly predate MIS 6 (Stein et al. 2017). Altogether, there were about eight Pleistocene ice advances at the northern margin of the East Siberian Sea, of which the most formed thick ice shelves extending into the Arctic Ocean.

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Dynamics of the North Karelian/Oulu Ice Lobe, central Finland based on LiDAR-DEM interpretation of glacial landforms

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During the last deglaciation between 17 000 and 10 000 years ago, the Scandinavian Ice Sheet (SIS) was composed of ice dome areas and attached ice lobes that hosted ice streams. In its eastern flank, the SIS retreated ca 1000 kilometres from NW Russia to west of the present territory of Finland in 7000 years (e.g. Lunkka et al., 2001; Svendsen et al., 2004; Larsen et al., 2006). During the latter part of the last deglaciation, between ca. 12 500 and 10 000 years ago, seven major ice lobes were operating time-transgressively in the eastern and northeastern part of the SIS (Putkinen et al., 2017). Behaviour of these ice lobes was complex and there is only a limited amount of detailed information on how these ice lobes behaved in space and time (Nikarmaa et al., 2017; Putkinen et al., 2017).

The overall purpose of the present study is to understand the dynamics of the largest ice lobe in Finland, the North Karelian ice lobe (NKIL) which subsequently evolved into the Oulu Ice Lobe (OIL) (Aario & Forsström, 1979; Kleman et al., 1997; Boulton et al., 2001; Putkinen & Lunkka, 2008). The methods used to shed light on the ice lobe dynamics include glacial inversion modelling which is based on mapping and interpreting the glacigenic streamlined terrains from LiDAR DEM data. Automatic or semi-automatic customized algorithms are tested during the project, but over 170 000 individual lineations have been digitized by hand to obtain detailed ice lobe-scale results.

Overall, the orientation and location of Mega Scale Glacial Lineations (MSGLs), megaflutings and large drumlins, reveal that the main factors affecting the behaviour of the NKIL/OIL were bedrock-type and topography. Especially large basins underneath the ice lobe had a great effect on the ice lobe dynamics. Due to these factors, the NKIL/OIL did not behave like a typical terrestrial ice lobe but fanned out to cover such a wide area (Nikarmaa et al., 2017). The results also indicate that there were several narrow corridors of faster ice flow in many areas once occupied by the NKIL/OIL. In fact, the terrain covered by the NKIL/OIL, can be divided into areas of sub-ice lobes with fast ice flow corridors and areas of more passive ice flow regions within the NKIL/OIL. Active and passive areas within the ice lobe are clearly recognizable and can be categorized using bedrock and landform associations including local topography, smaller sub-lobe eskers, hummocky and ribbed moraines and MSGL's. Through the analysis of different sub-ice lobes role and their chronology it is possible to understand more profoundly the dynamics and evolution of the NKIL/OIL.

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Stratigraphy and geochemistry of a till sequence at Tupos, central western Finland

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In order to determine glacial history of the Northern Ostrobothnia in central western Finland a 140 m long sediment core was drilled overlying the Mesoproterozoic Muhos siltstone formation in Tupos 20 km south from Oulu by the Geological Survey of Finland. Stratigraphical investigations from this drill core will be now presented as well as the preliminary geochemical results of the multiple middle to late Pleistocene till beds below 105 metres in this core. Our target will be to reveal glacial events, possible variabilities in ice flow directions and provenance areas by studying tills also for quantitative mineralogy, especially for heavy minerals and compared to a 50 meters thick sediment sequence cored in the close Muhos area that also include multiple till units where the earliest presumably was pre-Weichselian (cf. Lunkka et al., 2013). With the present increased availability of in-situ micro-analytical techniques, provenance studies can well utilize geochemical signals in single grains of a specific mineral and relate that to sediment source rocks and possible varying ice flow directions in glacial environment (cf. Weltje and Eynatten, 2004).

In this study, three grain size fractions in multiple tills are to be analyzed by three-stage analysis. Fine fraction (< 0.06 mm) is analysed by XRF. Heavy minerals of the sand fraction (0.06-0.6 mm) are to be analysed by FESEM and EPMA as well as lithic clast count analysis is made for fraction > 2 mm. According to drill core logs, the preliminary results differ from those of the Muhos site (Lunkka et al., 2013), which is situated about 20 km east of Tupos. In Tupos, the till layers exist only in the depths of 105-140 metres and till stratigraphy are less variable and distinct till beds are missing when compared to Muhos site. In Tupos site the colour of the till is intensively reddish brown throughout the till layers which may reflect that the underlying Muhos siltstone formation has provided materials to overlying tills.

XRF results show no unambiguous differences in geochemical composition between till layers in different depths. Overall, the tills have high Al_2O_3, Na_2O, CaO and K_2O content. The Al_2O_3/TiO_2 ratios are near constant throughout the till layers and represent a proxy indicator of nearly unchanged sediment provenance. Varying elemental concentrations are seen e.g. in Fe_2O_3 (5.6 to 9.2 weight %) and Sr (135-237 ppm) contents between different till layers. The low and narrow range of values of the chemical index of alteration (CIA = $[Al_2O_3/(Al_2O3+CaO+Na_2O+K_2O)]*100$ as molecular proportions where CaO is only the silicate fraction) reflects insignificant change in the intensity of weathering typical for fine fractions of glacial material (cf. Nesbitt and Young, 1982). Advanced study of distribution of heavy minerals can reveal those possible differences in flow directions of ice lobes thus giving also further light for glacial history of eastern flank of the Scandinavian Ice Sheet (SIS) in Northern Ostrobothnia. Stratigraphical and geochemical investigations for both Muhos and Tupos drill cores will be important and needed contributions to an overall glacial advance-retreat reconstruction for the eastern part of the SIS in central western Finland.

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Late Weichselian ice sheet dynamics on the northern Svalbard margin based on submarine glacial landform record from Seven Islands

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The Svalbard-Barents Sea Ice Sheet (SBIS) extended out to the shelf edge around Svalbard during the Last Glacial Maximum. Two major cross-shelf troughs on the northern Svalbard margin, the Hinlopen and Kvitøya Troughs, both accommodated large ice streams draining the SBIS towards the north (Hogan et al., 2010). Based on less pronounced morphology of the Albertini Trough just west of Kvitøya Trough, somewhat smaller ice stream was flowing there. This ice stream drained most likely the local ice cap covering Nordaustlandet as opposed to the larger ice stream in the Kvitøya Trough that was probably fed by the more central part of the Barents Sea Ice Sheet. The ice stream in the Albertini Trough originated mainly in the Albertinibukta but also received input from Duvefjorden (Fransner et al., 2017, 2018). The lack of high-resolution seafloor mapping further west has hampered the glacial reconstructions in the central part of the northern Nordaustlandet shelf.

Based on the asymmetric N-S profiles of the main islands of the Seven Islands - an archipelago of 7 larger and several smaller islands c. 15 km north of Nordaustlandet, Forman & Ingolfsson (2000) suggested that the area has been sculptured by a northwards glacier flow. In 2016, the seafloor around the Seven Islands was mapped with a multibeam echosounder. This study revealed a complex system of glacial landforms on the seafloor, most prominent of which are two large N-S oriented troughs, up to 8 km wide and 250 m deep, west and east of the Seven Islands, respectively. A number of parallel to sub-parallel crag-and-tails in the bottoms of these troughs suggest that the latter accommodated N- to NNW-wards flowing ice streams. Predominantly WSW-ENE oriented small ridges superimposed on the crag-and-tails imply relatively steady retreat of grounded ice in the troughs.

To the north and west of the Seven Islands, several arcuate ridges, up to 40 m high, present beneath 30-90 m water depth, most likely mark the readvances of outlet glaciers fed by a local ice cap covering the archipelago during the late stage of the Last Glacial. Central and southern parts of the Seven Island archipelago are covered with numerous small, parallel ridge-sets with varying orientations. These ridges most likely represent recessional moraines generated by the complex ice flows during the final retreat of the glaciers from the Seven Islands.

In this poster we present new bathymetric data from the Seven Island archipelago and based on the submarine landform record, discuss the Late Weichselian ice sheet dynamics and deglaciation history on the northern margin of the SBIS.

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Benthic foraminifera from the Laptev Sea shelf and their application as a proxy of the river runoff fluctuations during Holocene

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This study is based on two sediment cores from the Laptev Sea. One was retrieved from the south-eastern part not far from the cape Churkin (72°67'N 137°53'E), another one from the north-eastern part, north of Stolbovoy island (74°62'N 135°99'E). Both cores have a length of 215 cm and recovered Holocene sediments (presumably down to 4500-6000 cal. Ca). Cores are not dated but known records from surrounding areas provide a chronological framework for interpretation (Bauch et al, 2001,Taldenkova et al, 2005). The Laptev Sea shelf is highly influenced by the Lena River runoff. Analyzing foraminiferal distribution we focused on the detection of the freshwater discharge fluctuations which should be recorded in fauna composition. Foraminiferal fauna is presented in both cores by common shallow inner-shelf species (*Ammotium cassis, Reophax subfusiformis, Elphidium incertum, Haynesina orbiculare*, *Elphidiella groenlandica, Buccella frigida*) and opportunists: *Elphidium clavatum* and *Cassidulina reniforme*. From all these species *Ammotium cassis* and *Elphidium incertum* occurred to be the most indicative and sensitive to freshwater runoff, so we used it as a proxy of increase of influence of Lena River. If comparing investigated cores, more clearly the fluctuations of the Lena River runoff are detected in the north-eastern part of the Laptev Sea.

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Quaternary Climate Fluctuations as Etched in the Geology and Geomorphology of the Southern Middle Russian Upland

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The Middle Russian Upland occupies the central part of the East European Plain. Our study area is located in the Upland's south, in the basin of the rivers Don and Tikhaya Sosna. At the time of the Last Glacial Maximum (LGM) the area's northern edge was covered by thick ice. Our structural and geomorphological analysis of the area revealed the presence of erosion-shaped denudational, erosion-shaped accumulational and purely accumulational surfaces of different ages. Each surface comes with its own complex of recent deposits, in which climate history is easily read (Romanovskaya et al, 2016, 2017).

The highest elevated (220 m to 230 m above sea level) and the oldest daylight surface dates from the Late Miocene. A surface at about 200 m dates from the Late Miocene and the Pliocene. Surfaces at about 180 m and 150 m date from the Eopleistocene and the Early Pleistocene, respectively. The former surface lies on “Kiev-type” deposits, and the latter - on fluvioglacial deposits from the time of the maximum Dnepr (or Don) Glaciations. The valleys of the rivers Don and Tikhaya Sosna display fluvial terraces above their floodplains, all formed under the influence of the Don, Dnepr, Moscow and Valdai Glaciations.

Our finest and most detailed study of a cross-section of Quaternary deposits was carried out at the multilevel archaeological site Divnogorie-9 (50º96′49″N, 39º30′31″E). Radiocarbon dating of fossils and paleosol layers found within the Divnogorie-9 site has returned 14 ka to 12 ka BP. The Divnogorie section exposed brownish paleosol, loess-like loam and numerous pale yellow calcareous loess layers.

All these sections exposed brownish paleosol, loess-like loam and numerous pale yellow calcareous loess layers. Besides there are numerous loess cross-sections made at an archeological site further northeast in the Don valley - namely, at the widely-known Kostenki-Borshchevo Paleolithic site, located at 51º23′40″N, 39º02′48″E and aged at 37 ka to 18 ka BP. Loess is made of eolian-glacial deposits and is considered to be an almost ideal geological chronicler of impacts of rapid climate change. This has been shown to be fully applicable to the loess layers of the Great European Loess Belt formed between the Fennoscandian Ice Cap and the North Atlantic Ocean (Antoine et al., 2009). Our rock-magnetism study of these deposits has shown that their formation was driven by regional paleoclimate. We conclude that the loess-like features of the Middle Russian Upland came into being under climatic conditions similar to those that shaped the Great European Loess Belt. We believe these features may actually represent an eastward extension of the latter.

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Holocene stratigraphy and depositional environments of the southeastern Barents Sea based on palynological and microfaunistic data

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We present new data on bio- and lithostratigraphy along with sedimentary environments of deglacial to Holocene sediments from the southeastern Barents Sea. Proxies used include lithology, grain size, coarse debris, and composition of fossil remains (pollen, spores, aquatic palynomorphs, ostracodes, benthic and planktic foraminifera). Stratigraphic records are partially constrained by radiocarbon ages (mostly in the Holocene) and are supplemented by subbottom geophysical data. Some of the sediment cores used in this study have been reported in earlier publications (e.g., Voronina et al., 2001), but we provide additional data generated for these records.

Based on the coherent stratigraphic distribution of multiple proxies, we distinguish three main sedimentary units representing major stages in the development of post-glacial sedimentary environments, likely related to changing climatic conditions. Unit 3 presumably characterizes proglacial environments of the early deglaciation (tentatively >15 ka). This unit is represented by relatively fine-grained, dark grey sediment matrix with numerous coarse terrigenous clasts, low concentration of microfossils, predominated by redeposited, mostly Mesozoic pollen, sparse dinocysts of a cryophylic species *Islandinium* var. *minutum*, and a mixed foraminiferal assemblage with signs of redeposition.

Unit 2 represents later deglacial conditions (estimated ca. 12-15 ka) and is composed of finely laminated, grey to brownish sandy/silty muds with coarse clasts interpreted as iceberg-rafted debris. Terrigenous palynomorphs have a high contents of cereals and wormwood, while an impoverished aquatic association is mostly represented by *Islandinium* var. *minutum*, and a low-diversity foraminiferal assemblage is predominated by *Elphidium excavatum* f. *clavata*. This lithological and biostratigraphic composition indicates deposition in distal glaciomarine environments under mostly cold and dry climatic conditions.

Unit 1, younger than ca. 12 ka, is composed of soft, olive-grey muds with blackish patches of reduced organic matter (iron monosulfides) and polychaete tubes._Palynomorphs are characterized by high contents of birch and pine pollen, with occurrences of pollen of broad-leaved plants, and an abundant cysts of *Operculodinium centrocarpum*. Benthic foraminifers have a higher diversity and variable abundance with characteristic peaks of arctic species, such as *Cassidulina reniforme,* and occasional presence of species more typical for lower latitudes. This composition suggests more stable, full-saline marine environments with variable sea-ice conditions and an influence of Atlantic water advection. This Unit can be subdivided into three intervals corresponding to the climatic evolution during the early (ca. 12-10.5 ka), early to middle (ca. 10.5-6 ka), and late Holocene (< ca. 6 ka).

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The INBIS Channel (NW Barents Sea): a rare example of a high-latitude channel system

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The INBIS (Interfan Bear Island and Storfjorden) Channel System is a rare example of deep-sea channels on a glaciated continental margin. This channel system is located between the Bear Island and the Kveithola-Storfjorden Trough Mouth Fans on the SW Barents Sea continental margin. A new compilation of seabed acoustic data shows that a series of 40 gullies, about 150-600 m wide, and 10-60 m deep, are incised the upper part of the continental slope. The gullies increase in size downslope, merging into larger tributary channels that finally converge into the INBIS deep sea channel. The lateral minor tributary of the INBIS channels apper buried below glacigenic debris flows representing the fringes of adjacent Trough-Mouth Fans glacigenic systems. This observation suggests that the INBIS Channel System was not generated primarily by the glacigenic debris flows associated to ice sheet transport during shelf edge glacial maximum. We infer that this gully-dominated part of the INBIS Channel System developed mainly during the deglaciation by basal erosion generated by dense sediment laden meltwaters and during interglacial periods by channalized dense water (brine) cascading from the continental shelf to the deeper areas along the slope. The gully-dominated upper slope area remained preserved by the destructive glacigenic input because protected by to the shielding presence of the Bear Island ice cap, a slow-moving type of ice that possibly did not reached the shelf edge as testified by the presence of two distinct shelf-edge moraines observed on the bathymetry.

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Holocene variability in sea ice, primary productivity and terrigenous input in Melville Bugt, northern Baffin Bay

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In recent years, Arctic sea ice has been shown to be a crucial component of the climate system, changing and affecting the gas exchange, salinity, heat and moisture between ocean and the atmosphere. Current developments in the use of IP_{25} (Ice proxy with 25 carbon atoms only synthesized by Arctic sea ice diatoms; Belt et al., 2007) have proven it to be a suitable proxy for palaeo-sea ice reconstructions over shorter to longer timescales (e.g., Müller et al., 2009; Belt et al., 2015; Stein et al., 2016). For Melville Bugt (MBT) in the NE-Baffin Bay, a climate-sensitive region characterized by strong seasonal sea ice variability and strong melt-water discharge from the Greenland ice Sheet, however, such proxy records are not available so far. In order to fill this gap, we present a high-resolution Holocene sea-ice record from Core GeoB19927-3, recovered in the southern MBT off West Greenland (location: 73°35.26' N, 58°05.66' W; water depth: 932 m; recovery: 1147 cm). Our IP_{25}, open-water phytoplankton biomarker and PIP_{25}-based sea ice reconstruction reflects seasonal to ice-edge conditions near the core site during most of the Holocene period. PIP_{25} index and TOC records indicate a sea ice retreat and warmer conditions between about 11.1-9 ka BP in the early Holocene. Subsequent cooling was followed by sharp increase in seasonal ice cover between 8.6-7.8 ka and a drop in TOC values. This is followed by Holocene optimum-like conditions around 7.2-6.5 ka as indicated by lower PIP_{25} and higher amount of phytoplankton biomarkers. In the mid-Holocene between 7.2-2.1 ka, our proxies

indicate colder conditions than before and appear to follow episodic sea ice advances (and retreats) at ~5.3 and ~4.0 ka. The late Holocene was marked by a decline in total sediment accumulation rates and total organic input and enhanced sea ice cover indicating persistent cooling conditions. Our reconstructions reveal several oscillations with increasing/decreasing sea ice cover that might be related to Holocene climate events such as the 8.2 ka cold event and the Roman Warm Period/Medieval Climate Anomaly. Furthermore, we find temporal links between our biomarker sea ice records with diatom-based sea ice reconstructions off West Greenland (Krawczyk et al., 2017) especially during mid to late Holocene, suggesting regional temporal and spatial variability in Baffin Bay. The observed change in sea ice seems to be connected to regional and global changes in oceanic circulation and solar forcing in the North Atlantic.

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Reconstructing Atlantic water advection in Rijpfjorden, Northern Svalbard during Late Pleistocene and Holocene

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Glacio-marine sediments were retrieved from Northern Nordaustlandet, Svalbard, during an expedition with the R/V Helmer Hanssen in the autumn of 2017. Gravity cores (GC) HH17-04 and HH17-05 were recovered from Rijpfjorden (a poorly studied, remote fjord). Radiocarbon ages obtained from samples comprised in the (GC) HH17-05 reveal that perennial sea ice cover decayed and Atlantic water (AW) rapidly resumed its flow into the fjord shelf prior to 10.5 BP kp. This study analyses the variations of Atlantic water advection captured by changes in benthic foraminiferal faunal distribution (>.0125 mm) and in the isotopic composition of calcareous foraminiferal tests in the Northern Svalbard shelf and Rijpjforden during the deglaciation and the Holocene. Core HH17-05 GC collected in the inner fjord at a water depth of 217 meters shows glacier proximal and nearshore Arctic benthic foraminiferal assemblages. The most abundant species from this site comprise: E. excavatum, N. labradorica, C. teretis, C. reniforme, C. lobatulus, B. frigida, E. barletti, et. Core HH17-04 GC obtained at the mouth of the fjord at a water depth of 273 meters should reflect assemblages containing a higher predominance of sub-polar, benthic species of foraminifera with more affinity to warmer and more saline water masses. Atlantic water advection is the predominant heat transfer mechanism in the northern high latitudes and a forcing factor in the Arctic climate. A better understanding of the AW advection in Rijpfjorden will contribute to multidisciplinary investigations related to the distribution and decay of sea ice and the oscillation of ocean-atmospheric circulation.

Subglacial hydrology of the Barents Sea Ice Sheet and implications for ice dynamics

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During the late Weichselian glacial maxima, the Barents Sea Ice Sheet (BSIS) extended across the entire Barents Sea epi-continental shelf, and was up to 3000 m thick. A large portion of the BSIS was grounded well below sea level, providing a good palaeo-analogue for the contemporary West Antarctic Ice Sheet. Large, marine-terminating palaeo-ice streams drained the ice sheet, which were active throughout deglaciation. Recently acquired marine geophysical data has facilitated improved reconstructions of ice dynamics and retreat through the central Barents Sea. Within these datasets, evidence for vast subglacial river networks is observed, and indicates that subglacial hydraulic activity was prevalent and likely played a key role influencing the dynamic behaviour of overlying ice and nearby ice streams. We present new geomorphological evidence and review existing evidence for a range of hydrological phenomena in the central Barents Sea, including drainage through dendritic, sinuous, and braided channels cut into the bed, complex drainage systems cut into basal ice, and fill/drain cycles in interconnected subglacial lakes. Empirically constrained modelled ice sheet surfaces and isostatically corrected topographies are utilised to generate subglacial hydraulic potential surfaces. These indicate the potential for high numbers of both shallow and deep subglacial lakes at the onset of major palaeo-ice streams, and persistent water routing through the central Barents Sea. Using this combined approach, we reconstruct the subglacial hydraulic conditions of the central Barents Sea Ice Sheet and assess potential implications for ice dynamics.

Post-surge structural development of Múlajökull, Iceland, and the link to subglacial landforms

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Previous structural glaciology studies indicate that flow within outlet glaciers and ice streams is partitioned into multiple flow sets which can be divided into a series of structural domains. The footprint of these structural domains may then be preserved in the geomorphological record in the form of elongate subglacial bedforms, ribbed moraine, shear margin moraines, and crevasse-squeeze ridges. Detailed analysis of the strain and structural history of the ice can not only aid the interpretation of glacial geomorphology, but also our understanding of glacier/ice sheet dynamics and the evolution of these ice masses.

Our study focuses upon the post-surge surface structure of Múlajökull in central Iceland, as well as the sedimentology and distribution of crevasse-squeeze ridges exposed in its forefield. Detailed structural mapping, glacial geological and geomorphological methods, drone and aerial images, photogrammetry and remote sensing are used to investigate the structural architecture of this surge-type glacier and relate it to the landform record. Detailed mapping of the fracture pattern within the marginal zone (~1 km) of Múlajökull has enabled the glacier to be differentiated into 22 structural domains. This complex fracture pattern can be correlated with the underlying subglacial bed topography, which is characterized by an over-deepening and an arcuate ridge, and a series of elongate drumlinoid landforms under the current ice margin (Lamsters et al. 2016; Benediktsson et al., 2017; Finlayson et al. submitted). Our results indicate that Múlajökull comprises a rapidly flowing central section bounded by slow flowing sections on either side. The boundary between the relatively faster and more slowly moving parts of the glacier is marked by a series of poorly to well-developed brittle shear zones characterized by sigmoidal, en-echelon tension fissures which can be used to establish the sense of shear within the ice. Analysis of these brittle deformation structures reveals a complex flow pattern at the margin of Múlajökull which can be linked to a complex interplay between the subglacial geomorphology and glacier flow. A study of crevasse-squeeze ridges in front to the current (2015) ice margin shows that they are mainly composed of massive diamicton containing blocky clasts and localized pockets of sorted sediments. The distribution and orientation of these ridges has been correlated with fracture pattern on the surface of Múlajökull indicating that these crevasses may have penetrated the entire thickness of the glacier, with the ridges forming as a result of the squeezing up of mobile sub-glacial sediments (till) into these open longitudinal fractures.

The relationship between ice surface structures and landforms exposed upon ice retreat is still poorly understood but may have bearing on our understanding of ice flow within both past and present glaciers and ice sheets.

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Sea ice variability off NE Greenland over the past 10 ka

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Understanding the processes controlling the natural variability of Arctic sea ice, as one of the most dynamic components of the climate system, can help to constrain the effects of future climate change in this highly sensitive area. High-resolution biomarker analyses from the northern North Atlantic/Fram Strait area may provide insight into variations of sea ice coverage, oceanic and atmospheric circulation and the biotic response to these changes. In our study, we concentrate on a 260 cm thick sedimentary section of Core PS93/025-2 recovered on the NE-Greenland continental shelf at 80°28.9' N/ 08°29.4' W in a water depth of 290 m. This western Fram Strait area is influenced by the cold surface waters from the East Greenland Current and glacier advances from the 79° North East Greenland Ice Stream. Multiproxy biomarker measurements have been carried out to reconstruct the Holocene history of sea-ice cover (IP_{25}, PIP_{25}), primary production (brassicasterol, dinosterol, HBI-III) and terrigenous input (ß-sitosterol, campesterol). Our new biomarker data from the AMS^{14}C-dated Core PS93/025-2 characterized by high sedimentation rates, allow a high-resolution reconstruction of paleoenvironmental change during the past 10 ka. These data indicate increasing sea ice cover from the Early Holocene towards the present. A distinct transition from low to marginal and partly extended sea ice conditions occurred at ~8.2 ka.

Holocene deglaciation, sea-level changes and shifts in sediment supply recorded in High Arctic paraglacial coastal systems – Central Spitsbergen case studies

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Understanding the High Arctic coastal zone evolution is crucial to decipher landscape changes and associated shifts in sediment fluxes triggered by climate change. The gravel-dominated paraglacial coastlines of the Svalbard Archipelago provide an excellent location to examine the processes that control High Arctic coastal change. Of special interest are the mechanisms by which coastal systems respond to enhanced landscape change following deglaciation. Existing sediment budget studies in Svalbard have focused attention on quantifying the volumes of sediment transported by glacial rivers and derived from glacier erosion and reworking of fluvial catchment sediment. Little attention has been paid to the functioning of sediment storage and reworking systems within coastal zone over various stages of the Holocene.

Our research aims to address this deficiency by improving our understanding of the mechanisms of Holocene adjustment of the High Arctic coastal zone to non-glacial conditions. In this paper, we summarize the results of a pilot study led by our research team along paraglacial coast in Central Spitsbergen at two key sites for relative sea-level change investigations Billefjorden and Tempelfjorden. Our research was based on a combination of methods including aerial photogrammetric and GIS analyses, ground penetrating radar surveys, sedimentological tests of coastal deposits, novel approach in radiocarbon dating of uplifted beaches and field-based geomorphological mapping (Long et al. 2012; Strzelecki et al. 2017; Strzelecki et al. 2018).

Our results document significant changes in rate of relative sea-level fall, sediment flux and coastal response (rate of coastal progradation, style of beach ridge formation) under intervals characterized by warming climate, retreating local ice masses, a shortened winter sea-ice season and thawing permafrost.

We discuss our new data in the context of previously published RSL data and coastal evolution studies from Svalbard. The approach is potentially applicable elsewhere in Svalbard and the High Arctic to address questions of RSL change and beach ridge chronology, and hence wider questions regarding palaeoclimate and ice load history.

This paper is a contribution to the National Science Centre project ‘Model of the interaction of paraglacial and periglacial processes in the coastal zone and their influence on the development of Arctic littoral relief’ (award no. 2013/08/S/ST10/00585).

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Changes in organic-carbon fluxes across southern Lomonosov Ridge and adjacent Siberian continental margin (Arctic Ocean): Sea ice vs. primary production vs. terrigenous input

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The sea-ice cover with its strong seasonal variability in the marginal (shelf) seas is one of the important and most obvious characteristics of the modern and ancient Arctic Ocean, that strongly influences the entire environment and climate of the Arctic Ocean and beyond. Formation and melting of sea ice results in distinct changes in the surface albedo, the energy balance, and the temperature and salinity structure of the upper water masses. Furthermore, the sea-ice cover strongly affects the biological productivity, as a more closed sea-ice cover restricts primary production whereas in the marginal ice zone high primary productivity may be reached. In addition, sea ice may contain terrigenous organic matter being transported far into the central Arctic Ocean. Thus, sea ice has a strong influence on the Arctic Ocean organic carbon cycle.

Here we present new biomarker records from four multicorer (MUC) cores across the southern Lomonosov Ridge towards the Siberian continental margin, including the sea-ice specific biomarker IP_{25}, marine biomarkers (brassicasterol and dinosterol) and terrestrial biomarkers (campesterol and β-sitosterol). These records are compared and discussed with unpublished biomarker data obtained from studies of sediment trap and water column samples recovered in the same area. The new data from the MUC cores indicate that core PS87/099 which is on the top of the ridge has the highest concentrations not only in IP_{25}, but also in marine and terrestrial biomarkers whereas the cores PS2754, PS2756 and PS2761, located at the western and eastern slopes of the southern Lomonosov Ridge, have much lower concentrations in these biomarkers. Supported by the sediment trap and water column biomarker records, these data point to increased fluxes of all these different biomarkers on top of the ridge indicative for relative stable ice-edge conditions. Furthermore, the differences in the composition and amount of the biomarkers may be related to lateral transport as well as differences in water depths and degradation processes. Our biomarker data may help to identify and distinguish between the different origin of the organic matter (sea ice vs. primary production vs. terrigenous input) and processes controlling the organic carbon cycle on southern Lomonosov Ridge. It is planned to extend these investigations to longer sediment cores in order to reconstruct past changes in organic carbon flux and the relationship to climate and sea-ice variability.

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Holocene water mass history off NE Greenland - New insights from high-resolution sediment record PS93/025 (western Fram Strait)

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While the Holocene history of the eastern Fram Strait seems well investigated, no high-resolution paleoenvironmental records were available from the western Fram Strait so far. Our sedimentary record, obtained during expedition PS93.1 (2015) of RV Polarstern on the outermost NE Greenland shelf, allows for the first time to reconstruct Holocene paleoenvironmental changes potentially related to variations in Atlantic Water advection and the export of freshwater and sea ice from the Arctic Ocean.

The 260 cm long sedimentary record from site PS93/025 (80.5°N, 8.5°W; 290 m WD) was investigated for sediment composition, foraminifer contents, grain size variations (sortable silt), contents of ice-rafted debris and the isotopic composition of planktic and benthic foraminifers. Radiocarbon datings reveal an age of 10.2 cal-ka for the core base and continuous sedimentation throughout most of the Holocene.

The deposits are generally very fine-grained (<10% sand) and show a distinct fining-upwards trend. A comparison of foraminifer and coarse fraction abundances shows strong similarities. Apparently, the contribution of coarse terrestrial material from iceberg transport was extremely low throughout the last 10.2 cal-ka. The composition of the ice-rafted debris (>150 µm) shows only minor variability and is dominated by crystalline rocks, quartz and feldspar (ca. 70%). Carbonates are rare (<1%), suggesting that North American glaciers were not a significant source for icebergs. Foraminifer abundances (both planktic and benthic) are high in Early Holocene sediments until ca. 7 cal-ka and decrease rapidly thereafter, probably because of a decreasing advection of Atlantic Water to the NW Fram Strait and seasonally open waters. Occurrences of subpolar foraminifer *Turborotalita quinqueloba* in deposits older than 7 cal-ka support this view. Sortable silt grain sizes are high (29-31 µm) in the older part of the record and gradually decrease between 7 cal-ka and 4 cal-ka. After ca. 4 cal-ka, sortable silt shows values of 20-23 µm and little variation. This change may result from a decline of bottom current velocities on the outer NE Greenland shelf after 7 cal-ka, related to a decrease of Atlantic Water advection. Additionally, it may reflect a shift towards the modern mode of sea ice sediment transport which is dominated by grains in the clay to fine silt range. The difference between planktic and benthic oxygen isotope data is low in the Early Holocene (ca. 0.8‰) and increases around 7 cal-ka to values around 1.5‰, likely reflecting a stronger stratification caused by lower salinities in the subsurface water if compared to bottom waters on the outer shelf. Overall, our results reveal a sequence of coeval changes in Holocene environments on both sides of the Fram Strait.

Atlantic Water heat transfer through the Arctic Gateway (Fram Strait): a comparison between Eemian and Holocene

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The last interglacial (MIS 5e, Eemian) in the Arctic region is often described as a time with warmer conditions and significantly less summer sea ice than today. The role of Atlantic Water (AW) as the main oceanic heat flux agent into the Arctic Ocean remains, however, unclear. Using high-resolution stable isotope, lithic and faunal records from the only deep Arctic Gateway, the Fram Strait, we note for the upper water column a diminished influence of AW and generally colder-than-Holocene sea surface conditions. Maximum subsurface AW heat advection occurred during late MIS 5e and was superimposed on a longer-term cooling trend at the sea surface. In contrast, an intensified AW heat transfer through the eastern Nordic Seas and into the high Arctic occurred during early Holocene and was coupled with a peak sea surface warmth and a sea-ice minimum in the Fram Strait. When compared to the early Holocene, a less pronounced signal of the AW flow into the Arctic region during the last interglacial could be explained by: 1) a thicker post-Saalian halocline and a greater water depth flow of AW; 2) a longer-lasting Saalian deglaciation which delayed the surface warming relative to solar radiation; 3) a reduced strength of AW inflows related to the oceanic-atmospheric system, i.e., wind patterns, oceanographic fronts and gyre intensities; 4) some bias due to a variable preservation of biogenic carbonate. We suggest that the existing views on the AW influence in the polar North across the last two interglacials as well as during preceding deglaciations should be revisited to allow for better interpretations of circum-Arctic fossil records.

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