5th International Conference on Palaeo-Arctic Spatial and Temporal (PAST) Gateways

22-26 May 2017

Kristineberg Field Station
Sven Lovén Centre/University of Gothenburg Fiskebäckskil, Sweden

Bolin Centre for Climate Research

Stockholm University

Contents

Front picture: Kristineberg, © University of Gothenburg
This book of abstracts was compiled by E. Kirchner.

Welcome

The Network Steering Committee and the Local Conference Organizing Committee of the PAST Gateways (Palaeo-Arctic Spatial and Temporal Gateways) Fifth International Conference welcomes you!

The 2017 PAST Gateways conference is organised by the University of Stockholm and will be held at the Kristineberg Research Station, Sweden from 22-26 May 2017. PAST Gateways is an IASC endorsed network research programme, the scientific goal of which is to understand Arctic environmental change during the period preceding instrumental records and across decadal to millennial timescales. The focus of the programme is on the nature and significance of Arctic gateways, both spatial and temporal, with an emphasis on the transitions between major Late Cenozoic climate events such as interglacials to full glacials and full glacial to deglacial states, as well as more recent Holocene fluctuations. The four broad themes of the programme are: (1) Growth and decay of Arctic Ice Sheets; (2) Arctic sea-ice and ocean changes, and (3) Non-glaciated Arctic environments including permafrost, which have been expanded for the conference by the topic (4) Holocene Arctic environmental change. Abstracts of all oral and poster presentation as well as background information to the conference can be found in this abstract volume. For general information on the PAST Gateways network, please see http://www.geol.lu.se/pastgateways/.

48 participants from 12 countries have registered for the conference, to discuss 26 oral and 23 poster-presentations.

The Organizing Committee would like to thank all those who have contributed to the success of the conference. A special acknowledgement goes to the Bolin Centre for Climate Research, who provided financial support for this meeting.

We hope you enjoy the conference.

For the Local Conference Organizing Committee and on behalf of the PAST Gateways Steering Committee

Nina Kirchner
Helena Alexanderson
Riko Noormets
Martin Jakobsson
Colm o'Cofaigh

Schedule

Tuesday May 23

09:10-09:30 **Organizers:** Welcome and practical information

Session 1, 09.30- 10.50

09:30-09:50 **H. Alexanderson:** A 200 ka glaciation history from NW Svalbard

09:50-10:10 **W. Farnsworth:** Advances in deglaciation on Svalbard

10:10-10:30 **K. Streuff:** Submarine landform assemblages and sedimentary processes in front of Spitsbergen tidewater glaciers

10:30-10:50 **R. Noormets:** Ice sheet dynamics and deglaciation history of the northern Svalbard margin

Coffe break, 10.50-11.10

Session 2, 11.10-12.30

11:10-11:30 **C. März:** New insights into diagenetic processes in Arctic Ocean sediments and impacts on manganese stratigraphy

11:30-11:50 **L. Löwemark:** Glacial hiatuses in Arctic deep marine sediment

11:50-12:10 **T. Cronin:** Arctic Ocean Quaternary Temperature Records from Ostracode Mg/Ca ratios and Benthic Foraminiferal δ 18O

12:10-12:30 **L. Polyak:** Quaternary development of the Chukchi-Alaskan margin and the adjacent western Arctic Ocean: interaction of glaciations, sea ice, and oceanic circulation

Lunch break, 12:30-14:00

Session 3, 14.00-15.20

14:00-14:20 **Ö. Gustafsson:** Organic matter and methane from cryogenic compartments in the drainage basins and subsea systems of the East Siberian Arctic Ocean

14:20-14:40 **M. Miles:** Sea ice and abrupt changes in the Holocene

14:40-15:00 **A. De Vernal:** Late Quaternary sedimentary/biogenic fluxes along the Lomonosov Ridge under sub-perennial to perennial sea-ice

15:00-15:20 **A. Dominiczak:** How recent sedimentary record can enhance understanding of glaciomarine paleo-environments

Coffe break, 15.20-15.40

Session 4, 15.40-16.20

15:40-16:00 **A. Zhuravleva:** Meltwater release from a receding East Greenland ice sheet margin after the penultimate glaciation

16:00-16:20 **C. O'Cofaigh:** Geomorphological and sedimentary imprints of the Northeast Greenland Ice Stream on the continental shelf offshore of Greenland

16:20-16:40 **T. Lakeman:** Debuttressing of marine-based sectors of the Laurentide ice sheet during ice stream retreat, western Canadian Arctic Archipelago

Poster session, 16.50-18.00

All posters on display.

<u>Wednesday May 24</u>

Conference excursion, led by Helena Alexanderson. 08.30-ca 18.00.

We will drive through the bedrock-and-clay-dominated landscape of Bohuslän on Sweden's west coast. We will make a few, lengthier stops to visit sites representing geological events from the Proterozoic to the Holocene and see how humans through time have explored and exploited the landscape.

We will see the remains of the world's largest Quaternary shell deposits at Uddevalla, admired by Linnaeus in the 18th century but later used up for chicken feed and road construction. Near the Åbyfjord we will enjoy bedrock morphology, lunch and Bronze age rock carvings. In Hunnebostrand we will squeeze through clefts in granite to study the combination of Mesozoic weathering and Quaternary

glacial erosion and to learn about the stone industry of Bohuslän. Additional topics of the day will for example include quick clays, coastal sedimentation and polluted marine sediments.

Note: at all sites there will be some walking (a few hundred meters to a bit more than one km), mainly on paths or grasslands. At one site (Hunnebostrand), parts of the path are very uneven (bouldery) or narrow. Bring suitable footwear.

For more infomartion, see the field guide.

Thursday May 25

Session 1, 09.30- 10.50

09:30-09:50 **E. Gasson:** Exploring the potential for a pan-Arctic ice shelf using numerical modeling

09:50-10:10 **M. Petrini:** Reconstructing the post-LGM decay of the Eurasian Ice Sheets with Ice Sheet Models; data-model comparison and focus on the Storfjorden (Svalbard) ice stream

10:10-10:30 **M. oRegan:** A Pre-LGM glacial trough on the East Siberian continental shelf

10:30-10:50 **E. Ivanova:** Eurasian ice sheet decay and postglacial conditions in the Barents Sea: New insights from deep-sea trough records

Coffe break, 10.50-11.10

Session 2, 11.10-12.10

11:10-11:30 **C. Pearce:** Late Holocene sea ice conditions in Herald Canyon, Chukchi Sea

11:30-11:50 **M. Jakobsson:** A new timing and perspective on the post-glacial flooding of the Bering Strait

11:50-12:10 **A.Tessin:** Nutrient cycling on the Yermak Plateau over the past 180 ka

Lunch break, 12:30-14:00

Session 3, 14.00-15.20

14:00-14:20 **A. Lysså:** Multiple glaciations at a young volcanic island - Jan Mayen

14:20-14:40	**E. Larsen:** Late-Glacial - Holocene glacier and volcanic activity in Jan Mayen: challenges and potential
14:40-15:00	**J. Anjar:** Cosmogenic surface exposure dating (36Cl) of the glacial activity on Jan Mayen
15:00-15:20	**K. Strand:** Quantitative provenance analysis implications for late Pleistocene deglaciations on land and marine setting

Coffe break, 15.20-15.40

Poster session, 15.45-17.00

All poster on display

Evening session, 18.00 onward

18.00 -	Conference dinner, Gullmarsstrand Hotel

Abstracts – oral contributions (following the order of presentation at the conference)

Tuesday 23 May 2017, 11.10-12.30

A 200 ka glaciation history from NW Svalbard

Helena Alexanderson[1,2], Mona Henriksen[2], Heidi T. Ryen[2,3] Jon Y. Landvik[2] & Gustaf Peterson[4]

[1]Lund University; [2] Norwegian University of Life Sciences, [3]Norwegian Water Resources and Energy Directorate, [4]Geological Survey of Sweden

In the Kongsfjorden area in NW Svalbard, there are several stratigraphic sites containing information on Quaternary environmental change, and which can be used to reconstruct local depositional conditions, regional events such as large-scale glaciations and relative sea-level change. Here, we present results from an investigation of one of these sites, the Kongsfjordhallet coastal sections, which are located on the northern shore of Kongsfjorden.

The sedimentary units at Kongsfjordhallet represent five high relative sea level events, which imply preceding regional glaciations (Henriksen et al., this volume). Together with the record from nearby Leinstranda (Alexanderson et al. 2011) we can thus identify six, possibly seven, large glacial advances during the last 200 ka in the Kongsfjorden region. Two of these occurred during the Saalian and at least four during the Weichselian. The glaciations are constrained in time by the ages of the high relative sea level events to just prior to ~190 ka, ~130 ka, ~100-85 ka (possibly two events), ~60 ka, ~35 ka and ~14 ka.

Our study encompasses only the upper 15 m of the coastal cliff sections at Kongsfjordhallet (corresponding to succession A of Houmark-Nielsen and Funder 1999), and there is an additional ~20 m of sediments below our Unit 1, which is promising for future studies aiming to go further back in time.

References

Alexanderson, H., Landvik, J. Y. and Ryen, H. T. 2011. Chronology and styles of glaciation in an inter-fjord setting, northwestern Svalbard. Boreas 40, 175-197.

Henriksen, M., Alexanderson, H., Ryen, H.T., Landvik, J.Y. & Peterson, G. this volume: Non-glacial deposits key to the late Quaternary history of NW Svalbard.

Houmark-Nielsen, M. and Funder, S. 1999. Pleistocene stratigraphy of Kongsfjordhallet, Spitsbergen, Svalbard. Polar Research 18, 39-49.

Advances in deglaciation on Svalbard

Wesley R. Farnsworth[1, 2], Ólafur Ingólfsson[1, 3], Lis Allaart[2], Lena Håkansson[1], and Anders Schomacker[2]

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Despite warm regional fjords, a variety of data suggest extensive glacier advances on Svalbard in connection with the Pleistocene-Holocene transition. We present the first well-constrained Late-Glacial-Early Holocene end moraine on Svalbard (De Geerbukta) and compare the synchronicity of this glacier event to 15 other transitional glacial deposits. We introduce an additional 30 locations identified through remote sensing where glacial deposits have been cut or beached by Early Holocene raised marine shorelines, suggesting similar relative ages. Contrary to traditional understanding, all evidence suggests that Late-Glacial-Early Holocene glacial expansion was considerably larger than during the extensively studied Neoglacial - Little Ice Age (LIA) glacial expansion. Given the widespread occurrence of the Late-Glacial-Early Holocene transitional deposits on Svalbard, we suggest that the culmination of the Neoglacial advances during the LIA does not mark the maximum extent of most Svalbard glaciers during the Holocene; it is just the most studied and most visible in the geological record. The better we are able to constrain the timing, rate, and synchronicity of these glacial advances on Svalbard, the better we will understand the transition from glacial to interglacial mode, deglaciation dynamics, and the behavior of modern marine-based ice sheets in changing climates.

Submarine landform assemblages and sedimentary processes in front of Spitsbergen tidewater glaciers

Katharina Streuff[1],Colm Ó Cofaigh[1], Riko Noormets[2], Jerry Lloyd[1]

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New swath-bathymetric data from the inner parts of the three Svalbard fjords Ymerbukta, Trygghamna, and Magdalenefjorden reveal the landform assemblages deposited in front of tidewater glaciers in west and northwest Spitsbergen. Overridden moraines in Ymerbukta, a tributary of Isfjorden in central west Spitsbergen, record several re-advances of the Esmarkbreen glacier at the head of the fjord after deglaciation, and glacial lineations formed in seafloor sediments are indicative of fast ice advance during one of these events. A terminal moraine and associated debris lobe mark the maximum ice extent during the Holocene, which, implied by the presence of crevasse-squeeze ridges, is likely related to a previous surge of Esmarkbreen. Several De Geer moraines provide evidence for subsequent slow and step-wise retreat. In the adjacent

Trygghamna and in Magdalenefjorden in northwest Spitsbergen the landforms are similar but the absence of overridden moraines and glacial lineations shows that the glaciers probably only re-advanced once during the Holocene and that ice flow was relatively slow. Terminal moraines and associated debris lobes mark the maximum extent of these advances and formed during the Little Ice Age (LIA). In Magdalenefjorden the relatively small size of the debris lobe suggests that the ice margin was at its maximum position for only a short period of time, or that sediment availability was restricted during the LIA advance. Similar to Esmarkbreen the retreat phase of the glaciers in Trygghamna and Magdalenefjorden was also characterised by periods of still-stand or small re-advances, although the comparatively small number of De Geer moraines in all three fjords shows that these landforms probably formed much less frequently than previously thought.

Sub-bottom profiler data, four sediment cores and six radiocarbon dates from Magdalenefjorden further provide information about the Holocene sedimentary environments in a northwest Spitsbergen fjord. The main source of sediment is glacial meltwater entering the fjord from the surrounding coastline, which has led to the accumulation of thick sequences of fine-grained mud. Stratified and laminated muds record glacier-proximal conditions, probably related to a LIA re-advance of Waggonwaybreen around 300 cal a BP, where the interplay of a range of glacimarine processes led to the formation of partially rhythmic couplets of one coarser and one finer layer, accumulated at a rate of around 3 cm a^{-1}. Such sediments are often observed in ice-proximal glacimarine environments and are probably formed from seasonal variations in meltwater and/or sediment supply. Numerous monosulphid layers indicate that the seasonal control on biological productivity may have aided the formation of individual laminae. Multiple sandy layers intercalated with the glacimarine mud provide evidence for the occurrence of gravitational mass-flow events like turbidity currents. In ice-distal settings, the muds are internally massive or weakly stratified, may show traces of bioturbation, and accumulate at a lower rate of 0.04-0.49 cm a^{-1}. Occasional clasts and diamictic layers show that the depositional environment in Magdalenefjorden is also influenced by sedimentation from icebergs and sea ice, but the ubiquitous glacimarine mud underscores the decisive predominance of meltwater-related sedimentation in the fjord.

Ice sheet dynamics and deglaciation history of the northern Svalbard margin

Riko Noormets[1], Oscar Fransner[1], Teena Chauhan[2], Anne Flink[1], Martin Liira[3], Kelly Hogan[4], Julian Dowdeswell[5], Matt O'Regan[6], Martin Jakobsson[1, 6]

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Ice sheet configuration and dynamics on the northern Svalbard margin has mostly been studied in connection with the major cross-shelf troughs, such as Hinlopen and Kvitøya Troughs. These troughs accommodated ice streams that drained the northern part of the Svalbard-Barents Sea Ice Sheet and delivered large amounts of sediments to the continental shelf edge and slope during the glacial periods. There are less data available from the shallow shelf areas between the glacial troughs implying that the glacial setting between the troughs is less well-known than that of the troughs.

Here we present new marine geophysical and sedimentological data collected from the continental shelf and slope north of Nordaustlandet. 2D seismic data revealed a number of sediment foresets in the outer Albertini Trough attributed to the ice sheet reaching the shelf edge during Plio-Pleistocene. High-resolution multibeam bathymetric and shallow sub-bottom acoustic data revealed different sets of glacial lineations, two major grounding zone wedges and numerous recessional moraines on the continental shelf providing evidence for the retreat of the grounded ice sheet margin punctuated by occasional readvances of the ice margin across most of the shelf during the last deglaciation. The scarceness of recessional moraines in the northern Albertini Trough implies a locally floating ice margin there. Streamlined landforms and glacial lineations on the inner shelf indicate that the ice flow sourced mainly in the Rijpfjorden, Duvefjorden and Albertinibukta. Orientation change of glacial lineations from S-N to SSW-NNE suggests that the ice flow from the westerly sources became more dominant during the ice margin readvance at a later stage of the deglaciation. Large grooves at the outermost shelf have been interpreted as scarps of listric faults that have developed in the thick accumulations of glacial sediments. The locally downfaulted bedrock beneath the glacial-interglacial sediments at the trough mouth contributed to the formation of these thick and unstable sediment succession by providing ample accommodation space. Numerous iceberg ploughmarks on the outer shelf provide evidence for massive calving of the ice sheet margin during the deglaciation.

Sediment cores provide detailed evidence on the sedimentological and paleoceanographic environment during and after the deglaciation, and the age constraints for the decay of the Late Weichselian Svalbard Barents Sea Ice Sheet on the continental shelf north of Svalbard.

Tuesday 23 May 2017, 11.10-12.30

New insights into diagenetic processes in Arctic Ocean sediments and impacts on manganese stratigraphy

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Over the past years, significant progress has been made in our understanding of early diagenetic processes in Arctic Ocean sediments. This has been instrumental in understanding certain paleo-environmental proxy records that are frequently used in the Arctic to correlate glacial and interglacial deposits across the Arctic Ocean, namely brown Mn-rich layers that are typically considered to document warmer interglacial/interstadial conditions. The combination of sediment and pore water geochemical analyses in particular has unequivocally shown that Mn is being re-distributed in Arctic marine sediments, with the potential to overprint primary climate-related signals (e.g., Li et al., 1969; Dickens et al., 2007; März et al., 2011; Meinhardt et al., 2016). Here we present geochemical data from various parts of the Arctic Ocean that highlight the following concepts: A) Mn diagenesis occurs in most Arctic Ocean margin sediments, but its intensity and impact on the sedimentary Mn record is variable and likely depends on the amount of reactive organic matter buried in the sediments and sedimentation rates. B) Pore water data allow us to recognize depositional settings where Mn diagenesis is currently taking place, and shows that authigenic Mn (oxyhydr)oxide re-precipitation is likely coupled to nitrate reduction. C) There is a systematic relationship between the degree of diagenetic overprint experienced by individual Mn layers and their trace metal contents (layers gaining Mn by diagenesis have high Mo/Co ratios, while layers losing Mn by diagenesis have low Mo/Co ratios) that can be recognised without pore water data and is consistent with bioturbation studies (e.g., Löwemark et al., 2012, 2014). D) As a future perspective, an in-depth understanding of the complete formation history of individual Mn layers in the context of Arctic environmental conditions will only be possible by combining paleo-environmental information, sediment and pore water geochemistry, and reaction-transport modeling.

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März, C., Stratmann, A., Matthiessen, J., Meinhardt, A.-K., Eckert, S., Schnetger, B., Vogt, C., Stein, R., Brmsack, H.-J., 2011. Manganese-rich brown layers in Arctic Ocean sediments: Composition, formation mechanisms, and diagenetic overprint. Geochimica et Cosmochimica Acta, 75, 7668-7687.

Meinhardt, A.-K., März, C., Schuth, S., Lettmann, K.A., Schnetger, B., Wolff, J.-O., Brumsack, H.-J., 2016. Diagenetic regimes in Arctic Ocean sediments: Implications for sediment geochemistry and core correlation. Geochimica et Cosmochimica Acta, 188, 125-146.

Glacial hiatuses in Arctic deep marine sediment

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It is well-known that many deep-marine cores from the Arctic basins display a hiatus at the time of the last glacial maximum. How wide-spread this hiatus is, and if there is a distinct pattern in the spatial distribution of this pattern, is however not well understood. Neither is the potential occurrence of earlier glacial hiatuses well known. The recognition of this kind of hiatuses in the sedimentary column is essential both for inter-core correlations, and for environmental reconstructions. Failure to identify these hiatuses may lead to biased or erroneous paleoenvironmental reconstructions, and can easily lead to downwards propagating errors in stratigraphic correlations. It is therefore crucial to improve our understanding of these hiatuses, and how to identify them in core.
Here the potential of using continuous XRF core scanner data to identify these hiatuses is explored on a number of examples primarily from the Eurasian basin. Sedimentological and geochemical properties are compared for cores where the presence or absence of a glacial hiatus has been constrained using radiocarbon dating. If unequivocal criteria for the presence of hiatuses in Arctic Ocean sediment cores can be established for the last glacial interval, then these criteria offer the potential of identifying intervals of missing sediment in older parts of the records.

Arctic Ocean Quaternary Temperature Records from Ostracode Mg/Ca ratios and Benthic Foraminiferal $\delta^{18}O$

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Arctic Ocean temperatures influence sea-ice cover, deep-water formation, heat storage, carbon cycling, and ecosystems, yet paleotemperature reconstructions for the Arctic are scarce. The magnesium to calcium ratio (Mg/Ca) of benthic ostracode shells is a useful proxy for paleothermometry due to the thermo-dependence of Mg-uptake into the ostracode shell during molting. Stable oxygen isotopes ($\delta^{18}O$) from benthic foraminifera are also a potential ocean water temperature proxy if a species' vital effects, global land ice volume, and regional hydrography are considered. To reconstruct temperature changes in the last 600 ka in the central Arctic Ocean, we analyzed ostracode Mg/Ca ratios (the genus *Krithe*) and foraminiferal $\delta^{18}O$ (*I. teretis, O. tener, P. bulloides, C. reniforme, C. wuellerstorfi)* in eight sediment cores recovered on the Mendeleev and Northwind Ridges (700-2726m water depth). We focused on the interglacial periods Marine

Isotope Stages (MIS) 5 and 11 and the mid-Brunhes Event (MBE) at about 400 ka. Our results suggest the MBE represents a major shift in Arctic Ocean temperatures, circulation and ecosystems. These changes are likely linked through poorly constrained feedbacks relating to large scale climatic, glaciological and atmosphere-ocean carbon cycling. We will discuss the strengths and limitations of using paired Mg/Ca ratios and oxygen isotope proxy records in Arctic paleoceanography.

Quaternary development of the Chukchi-Alaskan margin and the adjacent western Arctic Ocean: interaction of glaciations, sea ice, and oceanic circulation

Leonid Polyak[1], Geoffrey Dipre[1], Seung-Il Nam[2], Joseph Ortiz[3], Anton Kuznetsov[4]

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One of the most striking expressions of climate change in the Arctic is the the retreat of summer sea ice in the western Arctic Ocean, attributed largely to the inflow of warm Pacific water through the Bering Strait in addition to the atmospheric warming. The long-term history of this inflow and its interactions with Arctic hydrography and ice conditions can be addressed by investigating sedimentary records from the Chukchi-Alaskan margin, including the continental shelf north of the Bering Strait and the adjacent borderland that extends far into the western Arctic Ocean. While complex depositional environments in this area, affected by currents, sea-ice, and glaciations, do not allow a single record of the entire Quaternary paleoceanographic history, a combination of sediment cores and seafloor profiling data from key sites on the shelf and borderland provide valuable insights. In particular, we aim at characterizing time periods with potentially reduced sea ice conditions, such as before or at the early stages of major Northern Hemisphere glaciations and during prominent interglacials, including the Holocene, which is represented by the most complete and detailed records.

A provisional stratigraphy and reconstruction of paleoceanographic conditions on orbital time scales has been recently outlined for a sedimentary record from the top of the Northwind Ridge (Chukchi Borderland) extending to estimated ~1.5 Ma and containing uniquely abundant calcareous microfossils (Polyak et al., 2013). This record has been interpreted as a stepwise transition from mostly seasonal to perennial sea ice, along with an increase in glacial impacts on sedimentary environments. Further insights were gained by adding a neighboring sediment core with a more compressed but stratigraphically longer record, and new age controls were obtained by means of strontium isotope dating. According to these age constraints, the new record dates to ~5 Ma and contains well preserved calcareous microfossils back to >3 Ma. Based on paleobiological (foraminifers), physical (grain size, X-ray tomography) and geochemical (XRF) proxies, we identify three major stratigraphic divisions roughly representing glacial (early to middle) Pleistocene, early Pleistocene, and Pliocene. In addition

to diminutive effect from glaciations, the pre-glacial proxy record is interpreted as reduced sea-ice conditions along with elevated current activity, especially in the Pliocene. These results indicate a significance of the Plio- to early Pleistocene environments for evaluating the projected future changes in the Arctic Ocean.

As opposed to stratigraphically long but strongly compressed and often incomplete sedimentary records from the borderland and the adjacent deep Canada Basin, sediment depocenters on the Chukchi-Alaskan shelf provide continuous, medium to high resolution records formed since the last deglaciation and sea-level rise. Notably, a large depocenter at the Alaskan margin has sedimentation rates estimated as high as a few millimeters per year, thus providing a decadal to near-annual resolution. This high accumulation can be explained by sediment delivery via the Alaskan Coastal Current originating from the Bering Sea and supposedly controlled by the Aleutian Low pressure center. Preliminary results from sediment cores recovering the last several centuries, along with a comparison with other paleoclimatic proxy records from the Arctic-North Pacific region, indicate a persistent role of the Aleutian Low in the Bering Strait inflow and attendant deposition. More proxy studies are underway to reconstruct the history of this circulation system and its relationship with sea ice extent. The expected results will improve our understanding of natural variability in oceanic and atmospheric conditions at the Chukchi-Alaskan margin, a critical area for modulating the Arctic climate change.

References

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Tuesday 23 May 2017, 14.00-15.20

Organic matter and methane from cryogenic compartments in the drainage basins and subsea systems of the East Siberian Arctic Ocean

Örjan Gustafsson[1,2] with many colleagues to be acknowledged in the presentation

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The enormous quantities of frozen carbon in the Arctic, presently held in surface soils and in shallow subsea sediments, may act as capacitors of the carbon system, is viewed as wild cards in affecting the future climate, yet uncertainties abound. Our long-term Swedish-Russian-US-EU collaboration through programs such as the International Siberian Shelf Study (ISSS), the Swedish-Russian-US Investigation of Carbon-Cryosphere-Climate Interactions in the East Siberian Arctic Ocean (SWERUS-C3) and the ERC-AdG Cryosphere-Carbon on Top of the Earth (CC-TOP) contributes observational basis for the deeper understanding of

both carbon stocks, remobilization to and fate on the East Siberian Arctic Shelf (ESAS); a prerequisite for any meaningful predictions of the future trajectory of this Cryosphere-Carbon (CC) system.
The ESAS is the World's largest yet shallowest shelf sea, holding 80% of coastal permafrost (PF), 80% of subsea PF and 75% of shallow hydrates. Recent findings are challenging earlier notions by revealing complexities in terrestrial PF-C remobilization and extensive venting of methane from subsea PF/hydrates. This talk will highlight some recent findings on the operation of both the contemporary and the Holocene-scale cryosphere-carbon system and invite for discussion on future directions.

Sea ice and abrupt changes in the Holocene

***Martin Miles*[1]**

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Arctic sea ice is not only a passive indicator but also an interactive agent of climate change, e.g., Dansgaard-Oeschger (D-O) events during past glacials and, more recently, Great Salinity Anomalies (GSAs) resulting from enhanced export of Arctic sea ice to the North Atlantic. Models suggest that sea ice may also be essential for sustained centennial-scale climate anomalies such as the Little Ice Age (LIA). The East Greenland Current (EGC) is the Earth's largest pathway of Arctic sea ice and freshwater transport, with linkages to ocean circulation and climate-system variability, e.g. GSAs. Despite its importance, the long-term natural variability of this sea-ice stream is not well constrained. Previous paleo-proxy reconstructions have been fragmentary, often focused on isolated records, and with uncertainties from using a single-proxy rather than a multi-proxy approach.

Here we present a multi-proxy data synthesis focused on constraining and understanding changes in EGC sea Ice and climate-system linkages, focused on the past millennium including the Medieval Climate Anomaly (MCA) and Little Ice Age (LIA). These goals are addressed through an integrated synthesis of data records derived from marine sediment core records indicative of sea-ice and ocean conditions based on multiple proxies, including direct sea-ice proxies (IP25) and indirect indicators (mineralogical, e.g., ice-rafted debris, and biological indicators, e.g., foraminifera and diatoms). Based on several criteria we have evaluated and selected 12–15 commensurate records spanning the length of the extended EGC pathway (including the Jan Mayen Current and East Icelandic Current) around Cape Farewell and along southwest Greenland.

We find reasonable coherence between the disparate records, particularly in the reduced sea ice during the MCA and a rapid change at the abrupt onset of the LIA in the 1300s, when when markedly enhanced export of arctic sea ice from the Arctic Ocean can be inferred from a statistically extreme positive anomaly apparent in the records throughout the extended EGC pathway. This century-scale GSA event resulted in abrupt increases of sea ice, polar waters and ocean stratification downstream. It is shown that these changes in sea ice and ocean

conditions occurred decades before previously documented changes in large-scale atmospheric circulation around 1400. Positive anomalies in sea ice and polar waters are generally persistent through the following centuries, though with large fluctuations across a range of time scales. The spatial and temporal evolution of events supports the role of sea-ice feedbacks suggested from model experiments, both those with external forcings (volcanism and solar), e.g., Moreno-Chamarro et al. (2016) and without external forcings (Drijfthout et al. (2013).

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Late Quaternary sedimentary/biogenic fluxes along the Lomonosov Ridge under sub-perennial to perennial sea-ice

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Micropaleontological, geochemical and radiocarbon analysis of 6 box cores collected from west to east along the Lomonosov Ridge during Polarstern expedition PS87 (cf. Stein et al., 2015) were conducted in order to document biogenic fluxes under sub-perennial to perennial sea-ice cover. The results show contrasted regime between the western sector under perennial multi-year sea ice cover (PS87/23, PS87/30, PS87/55) and the eastern sector close to the Laptev Sea (PS87/70, PS87/79, PS87/99), where seasonal opening of the sea ice cover has been observed, at least occasionally during the last decades. In the western sector, ^{14}C dating of planktic foraminifers indicates very low sediment accumulation rates of the order of 5 mm/kyr. The biogenic content is characterized by abundant and well-preserved faunal remains, which are dominated by planktic foraminifers, but also include benthic foraminifers, ostracods, pteropods, and echinoderm spines. Whereas the biogenic carbonate content of fossil-rich layers is very high, organic walled dinocysts and other organic microfossils are practically absent, indicating low dinoflagellate productivity and/or near total oxidation of organic matter. At the surface of box cores, abundant macrofossils were recovered. They include mollusc shells, polychaete tubes and fish otoliths showing various stages of preservation. Some specimens bear strong oxidation or bio-erosion features, which likely relate to long exposure at the sea floor, consistent with low sedimentation rates. In contrast, the western sector of the Lomonosov Ridge is characterized by relatively high sedimentation rates (> 2 cm/kyr), but low biogenic carbonate content. In the easternmost cores PS87/79 and PS87/99, planktic foraminifers are recovered exclusively in the upper 16 cm and 10 cm, which represent the last ~ 10 and 3 kyrs respectively. They show fragmentation, which suggests that poor preservation of biogenic carbonates is at the origin of the scarcity in the

microfauna in the early and mid-Holocene sediments. Palynological analyses reveal close to barren assemblages in the upper part of cores PS87/79 and PS87/99, but relatively abundant dinocysts below, in the interval almost barren in carbonate microfossils. Furthermore, the dinocyst assemblages recovered in the early-mid Holocene intervals are dominated by phototrophic taxa, which strongly suggest seasonal sea-ice free conditions. Hence, the overall data led to three conclusions : (1) under perennial sea-ice in the western Lomonosov Ridge area, low detrital inputs result in extremely low sediment accumulation rates and high concentration of heterotrophic biogenic remains, nevertheless corresponding to low fluxes possibly from lateral transport. (2) Unlike the Canadian Arctic of the Lomonosov Ridge, the Russian sector experienced frequent seasonally sea ice-free conditions during the early-mid Holocene. (3) The biogenic carbonate preservation seems better in perennial sea ice environment than in areas of seasonal sea ice cover, where primary productivity leads to organic carbon fluxes at the sea floor and enhanced exchanges at the ocean-atmosphere interface.

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How recent sedimentary record can enhance understanding of glaciomarine paleoenvironements

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Glaciomarine sedimentation is known to be linked with glaciological and oceanographic processes as a response to changing climate. The link is obvious but complex, thus interpretation of sedimentary archives, especially those which are distant in time requires good understanding of glaciomarine environment. Paleo-interpretations are mainly influenced by spatial and temporal resolution of available data as well as gaps within and limited supporting and supplementary information. The situation is significantly different in the context of recent sedimentation, except of sedimentary record, we have different supporting information, like satellite and aerial images, oceanographic measurements, weather logs and other observations.

On Svalbard since the end of Little Ice Age we have encountered fast withdrawal and loss of mass of many glaciers, particularly rapid in case of tidewater glaciers, where in an effect a new bays were formed and serve as glaciomarine sediment accumulation areas. Detailed study of sedimentation was performed in Hornsund fjord on Svalbard, by means of coring and sediment profiling. 30 gravity cores and 18 box cores were collected along with detailed seismoacoustic survey (Chirp) during three cruises on board of R/V Helmar Hansen in 2007, 2014 and 2015.

High temporal and spatial resolution of study shows local sedimentation vulnerability for different factors, like distance from sediment source, pre

deposition morphology, glacier mass balance and others. We would like to underline that seemingly the same conditions can result in different records of the same glaciomarine environment.

The study was funded by Polish National Science Centre grant No. 2013/10/E/ST10/00166.

Tuesday 23 May 2017, 15.40-16.40

Meltwater release from a receding East Greenland ice sheet margin after the penultimate glaciation

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Proximal evidence of the surface ocean response to the size reduction of the Greenland Ice Sheet (GIS) during the Last Interglacial (MIS5e) and preceding glacial termination (T2) remains largely elusive. Using a new sediment record from the western Iceland Sea, the behavior of the northeastern GIS and its relation to the (subpolar) North Atlantic surface hydrography is examined. Extremely light oxygen isotopic (δ18O) values are found off central East Greenland during early MIS5e and point to enhanced meltwater release, potentially from the northeastern sector of the GIS. Data from downstream the cold East Greenland Current (EGC) and its eastward branches suggest a far-reaching effect of this meltwater not only in the Nordic Seas but also in the SE Labrador Sea. In particular, whereas an early MIS5e warming (at ~128.5-126.5 ka) in the two regions coincided with the relative reduction of meltwater input into the EGC, the subsequent cooling noted at ~126.5 ka followed a renewed major freshwater event off central East Greenland. Our data further indicate persistent freshwater influence from the East Greenland margin over the entire MIS5e interval and, in addition, also reveal a late MIS5e meltwater event. The latter event occurred just prior to the last glacial inception and emphasizes the importance of Greenland meltwater as forcing factor on interglacial climates.

Geomorphological and sedimentary imprints of the Northeast Greenland Ice Stream on the continental shelf offshore of Greenland

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The Northeast Greenland Ice Stream is a key sector of the Greenland Ice Sheet (GrIS) because it controls ice flux into the NE Atlantic and it holds a sea-level equivalent of ~ 1.4 m. Unlike other sectors of the GrIS, the ice stream and the ice shelves that front it, have exhibited little response to increased atmospheric and oceanic warming over the last 20 yers. However, recent ice shelf loss and grounding line retreat (~ 4 km) post 2010 suggest that the ice stream and this sector of the GrIS is starting to respond to atmospheric/oceanic change (Khan et al., 2014; Mouginot et al., 2015). The ice stream is also known to have undergone dramatic retreat during the Holocene Thermal Maximum (Bennike and Weidick, 2001). The project 'NEGIS' is a collaboration between Durham University and AWI and its overall aim is to reconstruct the past behaviour of the NE Greenland Ice Stream from the LGM to the late Holocene including the past sensitivity of the ice stream to oceanographic and atmospheric conditions. 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. Fieldwork associated with the project comprises two research cruises on board the research vessel 'Polarstern' in 2016 and 2017 to collect sediment cores and geophysical data and an onshore programme in 2017 to collect epi-shelf lake cores, geomorphological data and samples of erratic boulders and bedrock for cosmogenic nuclide surface exposure dating. During Polarstern cruise PS100 in 2016 37 gravity cores and 4 box cores, supplemented by swath bathymetric and sub-bottom profiler data, were acquired. Data collection was focused principally in the Norske Trough and the area in front of the 79N ice shelf although acoustic data were also collected from areas in the Westwind Trough and across the Belgica Bank. These bathymetric troughs acted as pathways for ice flow offshore during the last glacial cycle. The acoustic and core data revealed a range of flow parallel and flow transverse glacial landforms in the form of drumlins, mega-scale glacial lineations, grounding-zone wedges and moraines as well as overconsolidated subglacial tills, all of which indicate an extensive ice sheet advance to the shelf edge. The inner shelf and the wide embayment in front of the 79N ice shelf front is characterised by stratified basins separated by ice scoured bedrock highs. Sediment thicknesses in the basis can reach over 70 m and basin fills are characterised by stratified muds that most probably represent deglacial and Holocene glacimarine sedimentation.

Debuttressing of marine-based sectors of the Laurentide ice sheet during ice stream retreat, western Canadian Arctic Archipelago

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New geophysical surveys of the Beaufort Sea shelf and slope, and of adjacent marine channels within the Canadian Arctic Archipelago, constrain the limits and dynamics of the former northwest Laurentide ice sheet. Recent research has established the timing and rates of ice stream retreat in Amundsen Gulf during

the last deglaciation, and highlighted important impacts on the late-glacial stratigraphy and paleoclimate of the Arctic Ocean basin. This study focuses on the interaction between deglacial ice stream dynamics and the behavior of adjacent, marine-based sectors of the northwest Laurentide ice sheet. Seismic stratigraphy and facies analysis, utilizing available 3.5 kHz subbottom echosounder data and sediment cores, illustrates that following episodes of ice stream retreat from Amundsen Gulf, adjacent marine-based glacier lobes advanced northward onto the channel flanks and deposited thick sequences of glaciogenic diamicton. The diamictons are acoustically-transparent but sedimentological analysis of their distal margins confirms stratified elements, likely indicating a mixed facies assemblage resulting from glaciogenic debris flows, iceberg rain-out, and subglacial deformation. The diamictons are interbedded with stratified glaciomarine sediment along their distal margins before pinching out. A significant phase of ice stream retreat, from the outer shelf to central Amundsen Gulf involved the abandonment of a regional glacial erosion surface, and is dated to prior to ~13 cal ka BP. Based on the documented seismostratigraphy, this phase of ice stream retreat predated deposition of a prominent diamicton on the southern flank of the channel. Here, the diamicton can exceed ~40 m in thickness and extends to a maximum depth of ~450 m. An ice keel turbate obscures the diamicton in water depths shallower than ~375 m. Deposition of the diamicton is interpreted to be the result of debutressing of the marine-based glacier lobe by the ice stream in Amundsen Gulf, which likely altered regional stress fields and established new, widespread calving margins. Ongoing research is focused on establishing a robust chronology of ice marginal deposits in order to quantify rates of ice sheet advance and retreat, and to further understand the ability of ice stream dynamics to initiate changes in regional ice sheet behavior. Future results will be incorporated into numerical models of the former North American ice sheet complex to further understand controls on ice sheet dynamics and to quantify late-glacial meltwater and iceberg fluxes to the Arctic Ocean.

Thursday 25 May 2017, 09.30-10.50

Exploring the potential for a pan-Arctic ice shelf using numerical modeling

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Recent research campaigns to the Arctic Ocean have revealed evidence for ice grounding in water depths of up to 1 km at several locations in the central Arctic Ocean (Jakobsson et al., 2016). It has been hypothesized that a thick ice shelf covering the entire Arctic Basin may have led to the formation of these features (Jackobsson et al., 2016; Nilsson et al., 2017). The hypothesis of a pan-Arctic ice shelf follows a number of publications in the 1970s discussing the potential for an extensive Arctic ice shelf in broad analogy to the marine-based West Antarctic ice

sheet (Hughes et al., 1977, Mercer, 1970). Here we explore the potential for pan-Arctic ice shelves and the ice sheet configurations that could support their existence using climate and ice sheet modeling. We also explore how differences in climate forcing may explain why a thick ice shelf cover occurred during certain glacial maxima and not others.

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Reconstructing the post-LGM decay of the Eurasian Ice Sheets with Ice Sheet Models; data-model comparison and focus on the Storfjorden (Svalbard) ice stream dynamics history

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The challenge of reconstructing palaeo-ice sheets past growth and decay represent a critical task to better understand mechanisms of present and future global climate change. Last Glacial Maximum (LGM), and the subsequent deglaciation until Pre-Industrial time (PI) represent an excellent testing ground for numerical Ice Sheet Models (ISMs), due to the abundant data available that can be used in an ISM as boundary conditions, forcings or constraints to test the ISMs results. In our study, we simulate with ISMs the post-LGM decay of the Eurasian Ice Sheets, with a focus on the marine-based Svalbard-Barents Sea-Kara Sea Ice Sheet. In particular, we aim to reconstruct the Storfjorden ice stream dynamics history by comparing the model results with the marine geological data (MSGLs, GZWs, sediment cores analysis) available from the area, e.g., Pedrosa et al. 2011, Rebesco et al. 2011, 2013, Lucchi et al. 2013. Two hybrid SIA/SSA ISMs are employed, GRISLI, Ritz et al. 2001, and PSU, Pollard & DeConto 2012. These models differ mainly in the complexity with which grounding line migration is treated. Climate forcing is interpolated by means of climate indexes between LGM and PI climate. Regional climate indexes are constructed based on the non-accelerated deglaciation transient experiment carried out with CCSM3, Liu et al. 2009. Indexes representative of the climate evolution over Siberia, Svalbard and Scandinavia are employed. The impact of such refined representation as opposed to the common use of the NGRIP δ18O index for transient experiments is analysed. In this study, the ice-ocean interaction is crucial to reconstruct the Storfjorden ice stream dynamics history.

To investigate the sensitivity of the ice shelf/stream retreat to ocean temperature, we allow for a space-time variation of basal melting under the ice shelves by testing two-equations implementations based on Martin et al. 2011 forced with simulated ocean temperature and salinity from the TraCE-21ka coupled climate simulation. In this presentation, we will show work in progress, address open issues, and sketch future work. In particular, we invite the community to suggest possibilities for model-data comparison and integration.

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A Pre-LGM glacial trough on the East Siberian continental shelf.

Matt O'Regan[1], Jan Backman[1], Natalia Barrientos[1], Thomas M. Cronin[2], Laura Gemery[2], Nina Kirchner[3], Larry A. Mayer[4], Johan Nilsson[5], Riko Noormets[6], Christof Pearce[1,7], Igor Semilietov[8,9], Christian Stranne[1,4], Martin Jakobsson[1]

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Ice sheets extending over parts of the Siberian continental shelf have been proposed during the last glacial period, as well as older Quaternary glaciations. The sparse data available over this sector of the Arctic Ocean has left the timing, extent and even existence of these ice sheets largely unresolved. Here we present new geophysical mapping and sediment coring data from the East Siberian shelf and slope collected during the 2014 SWERUS-C3 expedition (SWERUS-C3: Swedish – Russian – US Arctic Ocean Investigation of Climate-Cryosphere-Carbon Interactions). The multibeam bathymetry and chirp sub-bottom profiles reveal a set of glacial landforms that include grounding zone deposits along the outer continental shelf seaward of which lies a thick sequence of glaciogenic debris flows. The glacial landforms are interpreted to lie at the seaward end of a glacial trough – the first to be reported on the Siberian shelf. Stratigraphy and dating of sediment cores show that a drape of acoustically laminated sediments covering the glacial deposits is older than ~50 cal. kyr BP. This implies that glacial ice did not occupy the trough during the Last Glacial Maximum and provides direct evidence for extensive glacial activity on the Siberian shelf during either the early Weichselian, or more likely the Saalian. i.e. Marine Isotope Stage 6.

Eurasian ice sheet decay and postglacial conditions in the Barents Sea: New insights from deep-sea trough records

Elena Ivanova[1], Ivar Murdmaa[1], Anne de Vernal[2], Bjørg Risebrobakken[3], Claude Hillaire-Marcel[2], Alexander Peyve[4], Camille Brice[2], Elvira Seitkalieva[1], Sergey Pisarev[1]

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Recent reconstructions (Hughes et al., 2016) suggest the onset of the Scandinavian-Barents Sea ice sheet retreat at 21-20 cal ka BP. Our data provide new information on the deglaciation and settings of postglacial conditions in the northern Barents Sea. They further document diachronous deglaciation and iceberg calving. In particular, multi-proxy data from the AMS-^{14}C dated sediment core S2528 show that glaciomarine sediments with high content of iceberg-rafted detritus and *in situ* benthic foraminifers accumulated in the Kvitøya Trough, probably since 19.8 cal ka BP, thus indicating early deglaciation of the area. Calibration of radiocarbon dates with Calib 7 and Bayesian age-depth model of core S2528 define the boundary between proximal and distal glaciomarine conditions as well as the terminus of iceberg calving at *ca*. 17 cal ka BP, i.e. earlier than in several previously studied (e.g. Murdmaa et al., 2006) locations in the Barents Sea. The petrography of ice-rafted debris from the Kvitøya Trough suggests a proximal provenance from the NE Svalbard area, with a globally northward drifting of icebergs along the trough during the early deglaciation. Data also indicate penetration of a sub-surface Atlantic Water (AW) mass in the Kvitøya Trough, since at least 17 cal ka BP. AW flowed through Fram Strait, then along the Eurasian margin, the NW Barents Sea and further into the Laptev Sea,

peaking during B/A and YD/Preboreal times. Reconstructions from the northern Svalbard continental margin (Ślubowska et al., 2005), Franz Victoria Trough, NE Barents Sea (Lubinski et al., 2001), and Laptev Sea (Taldenkova et al., 2012) are consistent with our observations. From ~ 15 to ~10-8 cal ka BP, benthic $\delta^{18}O$ data indicate the gradual transition from glaciomarine to marine conditions, whereas light planktic $\delta^{18}O$ values at the YD reflect freshwater/meltwater discharge from the Arctic, possibly from the McKenzie River, together with strong isotopically-light brine formation. However, a dense sea-ice cover persisted until about 8 cal ka BP, which points to a decoupling between surface and subsurface conditions throughout the deglaciation. In contradistinction, in the southern more Erik Eriksen Trough, iceberg calving ended at ~12.5 cal ka BP, and marine conditions were likely established a few hundred years earlier than in several other locations. At this site S2519, micropaleontological assemblages of the YD interval suggest the development of a polynya with a high bioproductivity. Later on, during the Holocene, AW persistently penetrated into the northern Barents Sea, as a sub-surface water mass, through Fram Strait and along the Eurasian continental margin, as well as along the Franz Victoria Trough to Erik Eriksen Trough route. In the Kvitøya Trough, after 8 cal ka BP, warming likely associated with AW influence at surface is documented by dinocyst assemblages. This study has been supported by the Russian Science Foundation project 14-50-00095, OSL project 15-08, Natural Sciences and Engineering Research Council (NSERC) of Canada and the *Fonds de recherche du Québec – Nature et Technologies* (FRQNT).

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Thursday 25 May 2017, 11.10-12.10

Late Holocene sea ice conditions in Herald Canyon, Chukchi Sea

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Sea ice in the Arctic Ocean has been in steady decline in recent decades and, based on satellite data, the retreat is most pronounced in the Chukchi and Beaufort seas. Historical observations suggest that the recent changes were unprecedented during the last 150 years, but for a longer time perspective, we rely on the geological record. For this study, we analyzed sediment samples from two piston cores from Herald Canyon in the Chukchi Sea, collected during the 2014 SWERUS-C3 Arctic Ocean Expedition. The Herald Canyon is a local depression across the Chukchi Shelf, and acts as one of the main pathways for Pacific Water to the Arctic Ocean after entering through the narrow and shallow Bering Strait. The study site lies at the modern-day seasonal sea ice minimum edge, and is thus an ideal location for the reconstruction of past sea ice variability. Both sediment cores contain late Holocene deposits characterized by high sediment accumulation rates (100-300 cm/kyr). Core 2-PC1 from the shallow canyon flank (57 m water depth) is 8 meter long and extends back to 4200 cal yrs BP, while the upper 3 meters of Core 4-PC1 from the central canyon (120 mwd) cover the last ~3000 years. The chronologies of the cores are based on radiocarbon dates and the 3.6 ka Aniakchak CFE II tephra, which is used as an absolute age marker to calculate the marine radiocarbon reservoir age. Analysis of biomarkers for sea ice and surface water productivity indicate stable sea ice conditions throughout the entire late Holocene, ending with an abrupt increase of phytoplankton sterols in the very top of both sediment sequences. The shift is accompanied by a sudden increase in coarse sediments (> 125 μm) and a minor change in $\delta^{13}C_{org}$. We interpret this transition in the top sediments as a community turnover in primary producers from sea ice to open water biota. Most importantly, our results indicate that the ongoing rapid ice retreat in the Chukchi Sea of recent decades was unprecedented during the last 4000 years.

A new timing and perspective on the post-glacial flooding of the Bering Strait

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A new age and perspective on the flooding of the Bering Strait and following onset of Pacific water influx into the Arctic Ocean after the last glaciation is here

provided from analyses of geological and geophysical data acquired during the SWERUS-C3* 2014 Expedition with Swedish icebreaker *Oden* (Jakobsson *et al*., 2017). The data analyzed include multibeam bathymetry, chirp sonar sub-bottom profiles, and sediment cores from the Herald Canyon, located east of Wrangel Island and immediately north of the Bering Strait. In core 4-PC1 retrieved from 120 m water depth in Herald Canyon we observe a drastic transition in sediment physical and chemical properties, beginning at ~412 cm down core and ending at ~400 cm. Over this transition, sediment bulk density changes from >1.6 g/cm^3 to ~ 1.3 g/cm^3 in the lower and upper half, respectively. Furthermore, measured $\delta^{13}C_{org}$ ranges from around -25 and -22 ‰ and biogenic silica increases from around 0-1% below the transition to approximately 15% in the upper sediments. We interpret these changes to mark the transition at the coring site from a near shore enviroment to open marine conditions. This occurred when the sea level rose enough to flood Bering Strait and Pacific water began flowing into to the Arctic Ocean. The event is dated to ~11,000 cal yrs BP based on a series of radiocarbon dates predating the shift and thus generally younger than proposed in most previous studies and corresponding to the time of Meltwater Pulse 1b (MWP1b). Previous studies, including stabile isotope composition of foraminifera, whale migration into the Arctic Ocean, mollusc and insect fossils and paleobotanical data have suggested a range of ages for the Bering Strait reopening, mainly falling within the Younger Dryas stadial (12,900-11,700 years BP).

* SWERUS-C3: Swedish – Russian – US Arctic Ocean Investigation of Climate-Cryosphere-Carbon Interactions

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Nutrient cycling on the Yermak Plateau over the past 180 ka

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Over the past several decades, Arctic sea ice extent has drastically decreased. Sea ice retreat is expected to continue, with model simulations predicting that the Arctic Ocean will become seasonally ice free within several decades. Changes in sea ice extent are likely to have significant effects on nutrient availability and, subsequently, primary productivity. Nutrient cycling in the Arctic Ocean is poorly constrained in the modern, and even less is known about how nutrient

availability will evolve as sea ice continues to retreat. Sedimentary records of past biogeochemical cycling are, therefore, important to evaluate and predict the effects changing sea ice export and oceanographic conditions will have on nutrient cycling within the Arctic Ocean.

During spring 2015, sediment cores were retrieved north of Svalbard near the modern summer sea ice margin during the TRANSSIZ expedition ("Transitions in the Arctic Seasonal Sea Ice Zone"). Based on preliminary age constraints, the longest of these cores (PS92/39-2) includes sediments from the penultimate glaciation (MIS 6) to the Holocene (MIS 1). Here we present paired high resolution scanning XRF and lower resolution wavelength dispersive XRF analyses 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.% and Fe/Al ratios of up to 1.3. 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. Our results also suggest that the last two deglaciations were characterized by distinctly different patterns of biogeochemical cycling, suggesting that oceanographic and sea ice dynamics may have produced different responses in nutrient cycling during Termination 1 and Termination 2.

Thursday 25 May 2017, 14.00-15.20

Multiple glaciations at a young volcanic island - Jan Mayen

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The volcanic island of Jan Mayen, situated in the Norwegian – Greenland Sea, has an arctic – maritime climate influenced by the northwards flowing Atlantic current and the southwards flowing East Greenland current, suggesting the island to be sensitive to climatic changes. In 2015 we started a project to investigate glacial and climate history of the island. In this presentation we focus on the glacial history of the island until the Last Glacial Maximum (LGM).

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. Well developed marginal moraines in front of the many outlets witness that the glaciers were larger at some time. The northern part of Jan Mayen where Beerenberg is located, shows a large contrast to the central and southern part of the island. Here, there is no signs of moraine ridges, numerous volcanic craters and lawaflows dominate the terrain among some more flatlying surfaces inbetween. Along the coast, steep and often inaccessible bedrock cliffs exist as well as long

sand beaches with large amounts og driftwood. Many mountain peaks at the southern part reach elevations more than 500 m a.s.l., the highets one 769 m a.s.l.

Whether or not the entire island has been ice-covered previously has been a matter of controversy. Interpretation of remote sensing data in combination with field mapping in central and southern part of the island indicate that the entire island was ice-covered during LGM, and that glaciers extended at least down to present sea level. ^{36}Cl cosmogenic dates from samples taken in the northern-central parts, indicate that glaciers had retreated considerably by some 18 – 19 ka BP. New dating results from central-southern parts are to be reported spring 2017.

Stratigraphic investigations in coastal cliffs indicate that the island was covered by ice also prior to LGM. At several locations, glacigenic diamictites at stratigraphic position below LGM are found in association with lava flows. Interaction between glaciers and volcanic eruptions cause complex sediment associations, but also provide opportunity for dating glacial events. Ar/Ar and K/Ar dating is in progress in order to constrain pre-LGM glacial events, and preliminary results indicate that two large Weichselian ice advances may have taken place in Jan Mayen prior to LGM.

Late-Glacial - Holocene glacier and volcanic activity in Jan Mayen: challenges and potential

Eiliv Larsen[1], Astrid Lysså[1], Naki Akcar[2], Johanna Anjar, Svante Björck[3], Fredrik Høgaas[1], Martin Jakobsson[4], Martin Ludvigsen[5], Stefan Wastegård[6]

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Jan Mayen is the northernmost island on the North Atlantic ridge system situated some 550 km north of Iceland. During the Last Glacial Maximum the entire island and possibly also adjoining sea areas were ice covered. Ice thicknesses were greater in the south compared with the present ice-covered Beerenberg area in the north. Cosmogenic dates from end moraines outside of the Little Ice Age moraines indicates early to mid Holocene glacial events. During the Little Ice Age most outlet glaciers on the slopes of the Beerenberg volcano extended down to sea level. Since then, the glaciers have wasted back considerably and today only a few glaciers extend to sea level.

Nordlaguna, a lake on the west coast, is the only proper lake on the island. The lake basin might have originated as a volcanic crater, and as such may hold a long stratigraphic record. Coastal sections, side scan sonar, ground penetrating radar, penetration echo sounder and sediment cores are used to investigate the lake basin history and its sediment fill. So far the full paleoclimatic potential of

the lake is uncertain, but dates so far evidences high sedimentation rates. Today the lake has no outlet. Preliminary data indicate that a former lake outlet was blocked by volcanoclastic material from a local eruption that took place between ca. AD 1150 and 1300. This is likely also the time when a stock of Arctic Char in the lake was isolated from the sea. The lake is situated only ca. 2 m a.s.l. In spite of this, we do not know if there is a potential for a marine record. This is due to an unknown relative sea-level history owing its uncertainty both to glacio-isostatic and volcanic related tectonics.

So far the glacial reconstruction has suggested that there might have been enhanced volcanic activity during the last deglaciation, perhaps due to glacial unloading caused by activation of shallow magma chambers. Whether this holds true or not, only further dating of glacial and volcanic events both in the lake cores and other terrestrial settings can reveal.

Cosmogenic surface exposure dating (^{36}Cl) of the glacial activity on Jan Mayen

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Jan Mayen is the northernmost island on the North Atlantic ridge, situated 550 km north of Iceland. Glacial sediments and landforms are relatively common on the island but so far only the youngest moraine system, corresponding to the Little Ice Age, has been dated. To extend the glaciation chronology on Jan Mayen 43 samples were taken for cosmogenic surface exposure dating (^{36}Cl) during fieldwork in 2014 and 2015. The samples were taken from landforms ranging from the fresh Little Ice Age moraines to the older till surfaces on central Jan Mayen with the aim of providing a chronology of glacial events from the first deglaciation of the island after the Last Glacial Maximum to the local readvances during the Little Ice Age. The samples were analysed at the Institute of Geological Sciences, University of Bern and measured at ETH Zürich.

The samples give mostly reasonable ages that are consistent with the relative ages of the landforms. However, the lack of independent age control and the limited knowledge of the paleoenvironmental history of Jan Mayen means that it is challenging to constrain key variables such as local production rate, isostatic rebound or erosion. Here we discuss the problems and potential for ^{36}Cl dating on Jan Mayen and the implications for the glaciation chronology.

Quantitative provenance analysis implications for late Pleistocene deglaciations on land and marine setting

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Quantitive provenance analysis (QPA) is the useful assessment of the types, amounts and rates of sediment supply from certain parental rock assemblages to a final sedimentary depository (cf. Weltje and von Eynatten, 2004). All factors controlling the compositional modifications need to be always clarified when a parent rock transform to a final deposit. Data acquisition in QPA should include analysis of bulk mineralogy and geochemical content and the selective analysis of a specific group of minerals, most frequently heavy minerals as well as important varietal studies for geochemical and possible radiometric signatures of single grains. With the present increased availability of in-situ micro-analytical techniques, provenance studies can well utilize geochemical or isotopic signals in single grains of a specific mineral (cf. Morton and Hallsworth, 1994, 1999).

QPA of late Pleistocene sediments provide critical data for evaluation of possible pathways and source areas and in the Arctic, especially for consider deglaciation and ice sheet disintegration and for discuss on ice rafting and inputs of melt water as well as overall drainage distribution. Heavy minerals in coarse fractions can be examined in order to estimate provenance signatures and locations of sedimentary source regions with a comparison to published mineralogical and geochemical data.
On land setting there is critical to evaluate heavy mineral content of different diamict beds also for possible indications of a short term oscillation of the ice sheet or for glaciofluvial reworking or glaciolacustrine intervals instead of just trying to determined major changes in directions of ice streaming. A field example comes from the Rautuvaara section in northern Finland (Lunkka et al., 2014) where it seems that provenance changes for the late Pleistocene Scandinavian Ice Sheet are rather minimal but intensive oscillation of ice sheet have occurred with deposition of distinct diamict beds and the preserved glaciolacustrine intervals between.

In marine environment there is a specific need to evaluate sediment source for components of crystalline rock as well as a possible involvement of marine sediments recycling in forming the complete heavy mineral assemblages. Isotopic and age characteristics of crystalline rocks as well as comparing the isotopic characteristics of the IRD with those of Late Pleistocene ice-proximal sediments around the continental margins can be an useful approach. Example for complexity comes from the late Glacial to Holocene sediments in SW Barents Sea. The Fennoscandian, Spitsbergen and Barents Sea ice sheets behaved in a very dynamic way when these were disintegrated and multiple sources for ice drafting material is more that evident in the SW Barents Sea. There is a specific need for evaluate sea bottom erosion and reworking phenomena occurring after the formation of the major submarine glacial landforms (cf. Andreassen et al., 2008; Rüther et al., 2011). Besides of crystalline rock provenance provinces the erosion products of the Mesozoic sediments in the bottom of the Barents Sea

need to be considered as a possible source of certain heavy minerals being a mix from Fennoscandia/Urals/Novaya Zemlya/Taimyr/Svalbard. Also, if any possible it would be useful to consider lithic fragments in studied sediments to do comparison with possible source rocks (cf. Wassmyr and Vorren, 1990).

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Abstracts – poster contributions (sorted alphabetically after author's last name)

Petrographic study of coarse grains in sediment cores from the central Arctic Ocean: Implications for the history of ice rafting during the late Quaternary

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This study is based on core sediment records from the central Arctic Ocean spanning the last two glacial/interglacial cycles (ca. 200 kyrs). Sediment cores were recovered during the PS72 (2008) and PS87 (2014) Expeditions of the RV "Polarstern": PS72/340-5 and PS72/344-3 - at the Mendeleev Ridge (Stein et al., 2010), PS87/023-1, PS87/030-1 and PS87/056-1 - at the Lomonosov Ridge (Stein, 2015).

We focused on petrographic classification of coarse grains (> 0.5 mm) isolated from sediments. Identification of grains was performed at the Otto Schmidt Laboratory for Polar and Marine Research (St.Petersburg) using the optical binocular Olympus SZX-12. Additionally, grain surface was treated with HCL 10%-solution to check for the presence of detrital carbonates. Clast types were classified following the published studies from the Arctic Ocean which utilized the same size fractions (Bischof et al., 1996; Phillips & Grantz, 2001; Taldenkova et al., 2010).

In core PS72/340-5 from the Mendeleev Ridge, grains > 2 mm are mostly represented by clastics (sandstones), carbonates, quartz and quartzites. Occasionally, other grains such as granitoids, shales and chert were found. Larger dropstones (> 2 cm) from the Mendeleev Ridge are mainly represented by dolomite. Morphometry of these dropstones clearly indicates iceberg transportation. In the 0.5-2 mm fraction, quartz, sandstones, carbonates, chert and granitoids dominate. Shales occur in some core intervals.

In core PS72/344-3 (closer to the East Siberian Sea continental margin) grains > 2 mm are almost absent. In the 0.5-2 mm fraction, quartz grains, carbonates and sandstones dominate. Manganese micronodules are abundant in the interval corresponding to MIS 4, probably indicating restricted circulation of water masses in this area.

On the whole, grain numbers in the fraction 0.5-2 mm decrease towards the East Siberian margin (from core PS72/340 to core PS72/344), similar to the bulk dolomite content and amount of larger dropstones. Sediments are generally very fine-grained throughout the cores. Peaks of all the clast types in these two cores are synchronous, probably indicating events of abrupt iceberg discharge.

In core PS87/023-1 at the North American margin, grains > 2 mm are dominated by carbonates and sandstones with occasional occurrence of shales, granitoids and quarzites. Carbonate grains are observed throughout the whole core section. This confirms that the North American land masses can be the primary source of detrital carbonate in the coarse fraction of sediments from the Arctic Ocean (Bischof et al., 1996).

In cores PS87/056-1 and PS87/070-1 (central Lomonosov Ridge) the number of grains > 2 mm does not exceed five. In the fraction 0.5-2 mm quartz grains and shales dominate; sandstones, quarzites and coal are common. Carbonate grains were found in several intervals in both cores. Quartz and carbonate peaks are not in phase, which can be indicative of two different source areas supplying IRD to the core sites (Bischof, 2000). At the Lomonosov Ridge, larger dropstones (> 2 cm) mostly represent sandstones and quartzites, as well as gneiss and shales. Morphometry of these dropstones indicate iceberg and sea-ice transport, some material has evidence of riverine transport.

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The ISOARC project: From source to sink – Monitoring the isotopic fingerprints of Arctic moisture

Jean-Louis Bonne (1), Martin Werner (1), Hanno Meyer (2), Sepp Kipfstuhl (1), Benjamin Rabe (1), Melanie Behrens (1), Lutz Schönicke (2), Hans Christian Steen Larsen (3)

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In order to constrain the isotopic fingerprint of the Arctic hydrological cycle, a new generation of Picarro water isotope analyzers using CRDS (cavity ringdown spectroscopy) is used to monitor the isotopic composition of atmospheric water vapour at different sites. Since July 2015, within the ISOARC project water vapour stable isotopes (HDO and $H_2{}^{18}O$; d excess) have been continuously measured: (1) on-board Polarstern (as oceanic moisture source) and (2) at Samoylov Island in the Lena Delta in northern Siberia (72°22’ N, 126°29’E) as sink in the water cycle.

On Polarstern the water vapour has been sampled during ship cruise at 30 meters above sea surface. In addition to these water vapour measurements, ocean surface waters have been sampled on a daily basis and were later analysed in the laboratory for its water isotope composition. Data comprises two summer Arctic campaigns in 2015 and 2016 covering a large region of the Arctic Ocean, including the North Pole in September 2015. In the central and eastern Arctic Ocean, a large area of complete sea ice cover revealed a strong impact on the moisture above the ice cap under very cold conditions.

On Samoylov Island, water vapour has been sampled from an inlet situated at 5 m height above the Siberian tundra typical for the Lena Delta. Isotope measurements were compared with meteorological and surface data collected throughout the year in the Lena delta, as well as to data from other sites such as Svalbard or Iceland run by partner institutes. We were able to measure the isotope composition to low humidity levels in Arctic winter.

This water vapour network is a new approach into the understanding of the Arctic hydrological cycle at the regional scale. A first model-data comparison of our measurements with simulation results by the isotope-enabled atmospheric general circulation model ECHAM5-wiso have depicted relevant model biases in the Arctic realm, particularly close to the sea ice covered areas.

Sediment studies in Lake Nordlaguna - an enigmatic lake basin at the foot of the Beerenberg volcano, Jan Mayen

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Lake Nordlaguna is the only proper lake on Jan Mayen, situated along the northeastern coast in the central part of the island, southwest of the Beerenberg glacier-covered volcano. It is 1.6 km long and almost 900 m wide at its widest part. Most of the basin is >25 m deep with a maximum depth of 35 m in its southwestern part. The lake, situated a few meters above sea level, has no outlet but the lake water seeps through the 100-200 m wide barrier separating it from the sea. It is made up of sands, stones and boulders, and possibly also by bedrock in its core. The surface of the barrier is abundant in rounded stones and boulders as well as drift wood, which together with eroded channels in the barrier, show that storms have impact on the lake. This is also evidenced by the fact that the lake water is slightly brackish and that drift wood is common on the lake bottom. Most of the lake has very steep bottom topography from the shore down to its deeper parts. However, at places sediment plumes have been built up into the lake, both at the barrier and where streams end up into the lake. An important sediment source is also eolian sand transported from the barrier onto the lake ice in winter; when the ice melts in spring the material is dropped to the lake bottom.
Our preliminary working hypothesis of the origin of the lake is that it is a caldera, now filled up by sediments and water. This is based on the roundish shape of the basin, the steep walls partly surrounding the lake, the steep topography within the lake and the large barrier to the sea which could be remnants of a collapsed crater wall.

So far two piston cores, approximately 1 m long, were retrieved with a Nesje corer from the lake. The sediments were very stiff and hard to penetrate, and it seemed impossible to drill further with this equipment. One core (NL1B) was retrieved from the deepest part in the south at a water depth of 35.8 m, while the other core (NL2) was taken at 25 m water depth in the northern part of the lake. The compact sediments are dominated by sand, silt and clay, and the latter contains some organic matter, with some units clearly laminated. The lithology gives an impression of being heavily influenced by tephra material, and some units (and subunits) even appear to be pure tephras. The geochemistry of the supposed tephra layers gives the same signature: the Eggøya composition of the large local eruption at AD 1732. More geochemical analyzes will, however, be carried out to investigate the possibility of more than one local tephra fall out.
Radiocarbon dating of the two cores shows that the uppermost parts of both cores are very young, i.e. recent sediments, while dating of the lower parts show some conflicting ages. In NL1B the lowermost part (94-96 cm) is dated to 600-700 cal yr BP, which coincides perfectly with the age obtained from 93-96 cm in NL2. However, ^{14}C measurements of the lowest part (105-108 cm) of NL2 have

resulted in an age of almost 17000 cal yr BP. All ^{14}C analyses were performed on macroscopic plant remains from aquatic mosses and terrestrial plants, which rules out "bulk sediment effects" on the ^{14}C results. More samples for ^{14}C analyzes have been submitted from the lower part of NL2, but these are still not measured. At this stage we do, however, regard the old age at NL2 as an outlier, though difficult to explain, and that the cores represent a maximum age of ca 1000 yrs. Possible tephra layers were found at 78 cm (NL2) and ca 70 cm (NL1B), which could originate from the Eggøya eruption at AD 1732, but other tephra-like horizons are common in the cores.

XRF analyses from the two cores show that the variability of the measured elements is significantly larger in the shallower NL2 core than in NL1B, with the most distinct shift in the former at c. 64 cm depth. This represents a lithologic change from unit 3 to unit 4 in NL2; from brown-grey laminated slightly organic silty clay to blackish fairly coarse grained sand with a fining upwards trend. Elements indicating marine influence (e.g. Cl and Rb) imply that the lower part of NL2, and partly also NL1B, may have been more affected by marine waters than the upper sediments. Presence of arctic char in the lake indicates that the lake may previously have been in contact with the sea, but screening for diatoms has not shown any sign of a marine flora.

Much remains to be done before we can conclude more about the origin and history of this lake. Seismic profiles in the lake have shown a distinct echo at a depth where the cores end. Is this a tephra layer or the bottom of the lake? To solve this crucial question, drilling with an Uwitec sediment sampler will be carried out in the spring of 2017.

New Holocene lake sediment record from Severnaya Zemlya Archipelago

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Over the last few decades a significant number of comprehensive paleogeographic studies were carried out on Severnaya Zemlya, related to a long and complex history of glaciations and associated sea-level changes from the middle to the late Pleistocene (Bolshiyanov and Makeyev, 1995; Raab et al., 2003; Möller et al., 2007). At the same time relatively little is known about environmental changes during and after the Pleistocene/Holocene transition (ca.

11,500 cal. yr to present). Some of the studies have raised a question about only the early Holocene (Andreev et al., 2008).

The multi-proxy paleolimnological studies of Lake Tvyordoe sediment core (79°14′43″N; 101°48′55″E) presented here provide some new insight into the Late Glacial – Holocene environmental changes on Bolshevik Island, Severnaya Zemlya Archipelago as indicated by core lithology, particle size distribution, pollen, diatoms and geochemical proxies. Age model is based on pollen stratigraphy and AMS-dating. Vegetation history, lake level fluctuations, ice-cover conditions, water and sediment income from the catchment are reconstructed.

The Lake Tvyordoe sediment core (246 cm long) obtained during the fieldwork in 2015 in the northwestern part of Bolshevik Island. The lake has almost isometric shape, it is 9.5 km^2 large and at its maximum 10 m deep. The modern lake level is situated about 41 m a.s.l. It is assumed that lake basin has tectonic origin and based on bathymetric chart it is a part of a fault, elongated from SW to NE.

The lake has an ice cover most of the year. With an average lake ice thickness about 2 m, Lake Tvyordoe does not freeze to the bottom and has a profundal zone where there is no wave motion and wind mixing, that leads to continuous and undisturbed sedimentation.

For the particle size analysis of fine fraction (<63 μm) we have used the SediGraph method, based on Stokes Law and which uses a paralleled X-ray beam to detect changes in suspended sediment concentration during settling. The coarse fraction (>63 μm) was analyzed using the Sonic Sifter. In total 23 samples were analyzed.

Total carbon and total nitrogen was analyzed using the Element Analyzer Vario EL III. TC, TN and C:N ratio were defined allowing to judge about lake productivity and genesis of organic matter, accordingly. In total 50 samples were studied taken with a 5 cm step.

The sample preparation for palynology was carried out by standard methods (Berglund, Ralska-Jasiewiczowa, 1986) with the use of hydrofluoric acid. The percentage of taxa was calculated from the total pollen sum of trees, shrubs and herbs and only for the samples, where the sum was more 50 pollen grains. For algae the percentages were calculated in all samples. In total 29 samples were analyzed.

For diatom studies from one to five g of air dried sediment (d) were treated with H_2O_2 to destroy organic matter, washed in distilled water and centrifuged with heavy liquid of 2.6 g specific gravity. The liquid containing diatoms was separated and centrifuged thrice with distilled water. After the concentrate of diatoms was been diluted with 5-20 ml distilled water (b), 0.1 ml of sample volume (e) was put on the cover glass (18×18 mm) (c) and mounted in aniline-formaldehyde resin A.A. Elyasheva. 500 diatom frustules were identified on several microscope fields (f). The number of frustules (a) per 1 g of sediment was calculated by: $a = 500*b*c*d^{-1}*e^{-1}*f^{-1}$(Davydova et al., 2001). In total 17 samples were analyzed.

The lowermost interval consists of mineral deposits without the inclusion of organic material (246-230 cm) and corresponds to the first pollen zone. It is characterized by low TC values (0.5-1.0%) and C:N ratio=7 that confirm low productivity of the lake and sedimentation in cold climate under a permanent ice cover. The first stage characterizes the cold and dry Late Glacial climate.
Fragments of badly decayed plant remains begin to be present at the second interval (230-170 cm). TC values increase up to 3.5-4.3%, and average C:N ratio=7.5, that indicates favorable conditions for growth of aquatic vegetation and destruction of the permanent ice cover on the lake. Dwarf birch appears in the pollen spectrum that indicates a climate warming. The decrease of pollen of wormwood and cereals together with the increase of sedge pollen indicates the moistening of the catchment area due to more amount of precipitation and/or thawing of permafrost. The second stage corresponds to the deglaciation time and climate warming during the Pleistocene/Holocene transition, which occurred on Severnaya Zemlya archipelago about 11,500 cal. yr BP (Andreev et al., 2008).

The third interval (170-60 cm) is the warmest and moistest and corresponds to the third pollen zone. The maximum values of TC (9.4%) coincide with the peak of alder pollen (interval 120-140 cm), interpreted as a thermal optimum of the Holocene. Diatoms also indicate favorable conditions for phytobenthos and the enrichment of lake waters with nutrients and organic matter. The coarser grain size of sediments (including the inclusion of pebbles) indicates shallow water conditions, probably due to more intensive evaporation. The last is confirmed by the increased C:N ration: 10 in average and 11-12 at depths of 148-149, 128-134, 88-94 cm corresponding to layers of badly decayed plant remains.

The upper interval (60-0 cm) corresponds to the IV pollen zone and again consists of mineral deposits without of organic material. The TC values gradually fall to the upper bound from 3.0% to 1.5%. This stage corresponds to a climate cooling, when the lake froze through to the bottom. The pollen content is extremely low, probably, because of preventing the pollen sedimentation by permanent lake-ice cover.

Two hiatuses in the sediment sequence have been recognized. The first one is at the depth of 230 cm, associated with lake level decreasing and intensive erosion during the Pleistocene/Holocene transition. The second hiatus is at the depth of 8.5 cm, connected with climate cooling, when the lake froze through to the bottom. Obtained results of AMS dating of the lower part of Lake Tvoyrdoe sediment core (9,398-8,631 cal. yr BP (COL3918.1) at the depth of 242-243 cm) are contradictory and do not correlate with the results of other analyses. Therefore the age model will be specified after receiving some more datings.
The multi-proxy studies of Lake Tvoyrdoe sediments are still ongoing.

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Initial results of 54 m long sediment core investigation from Lake Bolshoe Schyuchie (Polar Ural) in the frame of Russian-German PLOT project

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The Russian-German PLOT project aims at investigating the climatic and environmental history during Late Quaternary times along a more than 6000 km long longitudinal transect crossing northern Eurasia. For this purpose, sediment records from several large lakes shall be investigated. The transect include lakes Ladoga (North-West of Russia), Bolshoe Shuchye (Polar Ural), Levinson-Lessing, Taymyr (Taymyr Peninsula), and Emanda (Yakutia). The local climatic and environmental histories shall be compared along the transect, using the well-dated record from Lake El´gygytgyn as reference site.
During the spring 2016, 54 m long sediment core from the central part of Lake Bolshoe Schyuchie (130 m of water depth) had been collected using an improved percussion piston corer.
We are going to present initial results of lithological core description and palynological study of corecatcher samples. According to established pollen stratigraphy, the upper most nine meters of the sediment sequence accumulated during Holocene. The border in-between MIS 2 and MIS 3 sediments appears on 25 meters core depth. The low part of the core, most likely, had been accumulated during MIS 3 entirely.

Analysis of Ostracoda in Central Arctic Ocean: Application to Late Pleistocene–Holocene paleoceanography (~50 ka to present)

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Limited knowledge exists about Arctic oceanographic and sea ice variability in the geological past due to the short period covered by instrumental records and the complexity of atmosphere-ice-ocean processes that cause environments to change. To contribute to the growing literature on this topic, we reconstructed Late Pleistocene–Holocene (~50 ka to present) paleoceanography in the central Arctic Ocean using radiocarbon-dated (AMS) sediment cores from the Lomonosov Ridge (~85.15°N, 151.66°E) that were collected during the 2014 SWERUS-C3 Expedition. Marine ostracodes are useful in paleoceanographic studies because many species have geographic and/or bathymetric distributions controlled by water mass properties, such as bottom water temperature, salinity, ventilation and organic carbon/nutrients. Fluctuations in dominant ostracode species down a sediment core indicate changes in the environment. Key taxa used as environmental indicators in this study include *Acetabulastoma arcticum* (perennial sea ice), *Polycope* spp. (productivity and sea ice), *Krithe hunti* (partially sea-ice free conditions, deep water inflow), and *Rabilimis mirabilis* (high nutrient, AW inflow). Results indicate seasonally sea-ice free conditions during Marine Isotope Stage (MIS) 3 (~57-29 ka), rapid deglacial changes in water mass conditions (15-11 ka), seasonally sea-ice free conditions during the early Holocene (~10-7 ka), and perennial sea ice during the late Holocene. Comparisons with faunal records from other cores from the Mendeleev and Lomonosov Ridges suggest generally similar patterns. Deposition of calcareous material at the SWERUS-C3 core site suggests that ice cover during the last glacial maximum may have been less extensive here at the southern Lomonosov Ridge than farther north, towards Greenland. The new data also provide evidence for abrupt, large-scale shifts in ostracode species depth and geographical distributions during rapid climatic transitions.

Marine terraces of Western Taimyr and Kara Sea Islands vs. Kara Sea Ice Sheets

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Taimyr & Severnaya Zemlya archipelago, washed by Kara and Laptev shelf seas, is a key region for reconstruction of the Arctic Late Cenozoic paleogeography. At the present time, the ideas about prevailing glacial conditions in the region during the whole Neoplestocene, with the Kara shelf as the center of the former glacial shields, are dominating. These reconstructions are based solely on the analysis of the features of the relief and the genetic interpretation of the land sections. Relief and sediments of the shelf and islands are almost not taken into account. At the same time, the bottom of the Kara Sea almost does not bear traces of glaciation, only the flooded marginal moraines of the past glaciers that were expanding, the centers of which were located on the Severnaya Zemlya, are recorded here. Furthermore, the shelf is dissected by a dense network of river paleovalleys, formed during the regressive epochs. Large margin-shelf troughs - St.Anna and Voronin - are not of glacial, but of tectonic origin. Geological study of the Kara shelf and islands is extremely weak. Much better is the level of geological study of the Taimyr Peninsula, which was explored in recent years by both Russian researchers and international projects.

In 2014-2015 years field research was carried out by the Polar Marine Exploration Expedition on the north Kara shelf, also the coast of Taimyr and the islands of the Kara Sea has been researched.

Marine sediments which are widely spread along the coast of Taimyr and on the islands of the Kara Sea where investigated. The most dates, obtained by the ^{230}Th/U method from the sediments of marine terraces 5-10 m high, located on Kara shelf islands (Ringnes, Tsyrkul, Troinoy), correlate with the Karginsky (MIS 3) horizon. On the Sverdrup Island, at an altitude of 5-10 m above sea level, the marine deposits of the Kazantsevsky (MIS 5) horizon (72-77 kyr) are outcropped.

The accumulative ridges on the Mikhailov Peninsula (Western Taimyr) according to IR-OSL-dates (63-65 kyr) are correlated with the glacial Zyryansky (MIS 4) horizon and, at the same time, represent ancient sea shore ridges.

Well-sorted laminated marine sands from the north-west coast of Vostochniy Kamenniy Island can be correlated with (MIS 7), according to IR-OSL dates (225-325 kyr).

Sediments containing peat and wood are mainly of Early Holocene age, as detected by radiocarbon dates. Our proxy data suggest the warm climatic conditions in the region during most of the Holocene epoch and the gradual cooling of the climate.

Thus, our new geochronologic data from the newest deposits of the coast of the Western Taimyr and the islands of the Kara Sea make us reconsider the scenario of the paleogeographic development of this region in the Neopleistocene. In the study region the sea condition are reconstructed over a long period - from MIS 5 to MIS 3. Even the "glacial" stage MIS 4 is represented by the regression coastal shafts (ridges) of the Zyryansky sea basin.

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Non-glacial deposits key to the late Quaternary history of NW Svalbard

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Raised marine deposits found in coastal areas of the Arctic have been instrumental in reconstructing not only past sea-level change but also past glaciations during the Quaternary. This is because the high relative sea level indicated by the marine sediments is largely due to isostatic loading and thus implies a preceding regional (ice-sheet scale) glaciation.

In the Kongsfjorden area in NW Svalbard, there are several sites with such raised marine deposits, some of which are exposed in eroded coastal cliffs. Kongsfjordhallet at the northern shore of Kongsfjorden is one of these sites, and where successions of Quaternary sediments are exposed in up to 40 m high coastal cliffs (Houmark-Nielsen & Funder 1999).Here, we present results from a more detailed sedimentological and stratigraphical investigation of the uppermost 15 m of the coastal sections.

As in most other coastal cliff exposures in the area, subglacial tills are scarce at Kongsfjordhallet and the volumetrically dominating sediments are of marine and littoral origin, representing partial shallowing-upward sequences (cf. Alexanderson et al. 2011). However, interestingly, we also find alluvial and periglacial deposits, which are not commonly recognized in this type of settings. These deposits include weathered coarse alluvium, sandy fluvial channel fills as well as cryoturbated and soliflucted material, and which form positive evidence of non-glaciation at the site.

Luminescence dating provides a chronological framework for these deposits and show that they range in age from ~190 ka to the last deglaciation (Alexanderson

et al., this volume), and that they represent five cycles of glaciation and subsequent deglaciation during high but falling relative sea levels.

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Late Quaternary variability in Arctic sea ice and related organic carbon accumulation: Combined biomarker records from northern Fram Strait

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The recent dramatic decline of Arctic sea over the last decades and its controlling processes are still poorly understood. In order to distinguish between natural and anthropogenic processes controlling these changes in sea ice, we have to look back to the past beyond the times of direct measurements. For this purpose, we carried out a multi-proxy approach combining organic-geochemical data (bulk parameters: TOC, C/N, $\delta^{13}C_{org}$; biomarkers: HBIs [IP_{25} (Belt et al., 2007), dienes, trienes], sterols, GDGTs) with sedimentological data (lithology, physical properties, IRD) determined in sediments of Yermak Plateau Core PS92/039-2. This core is situated close to the modern summer ice edge and thus very sensitive to environmental changes. The core represents the time span from MIS 6 to 1 (approx. 180,000 years) and hence allows the reconstruction of sea ice variability and related environmental changes during glacial/interglacial changes.
Sea ice was present throughout the entire record but shows significant temporal variability decisively affected by movements of the Svalbard Barents Sea Ice Sheet (SBIS). Glacial intervals are characterised by the occurrence of marginal sea ice, probably steered by a major northward advance of the SBIS. Katabatic winds from the protruded ice sheet combined with upwelling of warm Atlantic Water along its shelf edge probably triggered the presence of a wide coastal polynya north of Svalbard with parallel ice edge formation at the Yermak Plateau. Maximum accumulation of terrigenous organic carbon, IP_{25} and the phytoplankton biomarkers (brassicasterol, dinosterol, trienes) can be correlated to distinct deglaciation events. More severe sea ice cover prevailed at the Yermak Plateau during interglacials, however superimposed by a distinct variability in extent. The general close proximity to the sea ice margin is further indicated by sea surface temperatures below 2.5 °C, calculated using the relative abundance of specific hydroxylated isoprenoid glycerol dialkyl glycerol tetraethers (OH-GDGTs; Lü et al., 2015).
These outcomes are compared to preliminary biomarker results of sediment core PS93/006-1 from the northwestern continental margin of Svalbard. Covering the same time interval from MIS 6 to 1, the combination of both core records

provides important insights of the overall paleoceanographic development of the Fram Strait in the Late Quaternary.

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White Sea Islands: Genesis and the Holocene Palaeogeomorphology

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At present, the northern regions attract attention of scientists and politicians all over the world. The White Sea is characterized by the ecological diversity and complex geological history. Numerous islands of the White Sea are a good model for studying the interaction of endogenic and exogenic factors of landform (relief) formation. The irregular distribution of islands reflects also the heterogeneity of the geological and geomorphologic structure of the White Sea region. Therefore, the study of islands morphology and history of their development is one of the priorities in marine geomorphology.

The present study deals with the investigation of land formation processes. We attempt to reconstruct the natural history of islands in the Pleistocene and Holocene. The research area includes the Kandalaksha Bay of the White Sea. It is characterized by a numerous islands of various dimensions, shape, shore and internal parts relief structure, and sets of relief-forming processes.

In 2011-2013 we studied Luven'gskiy, Severniy, Kuzakotskiy and Keretskiy archipelagoes. The work includes geological and geomorphological descriptions of the main points of research area, geomorphological cartography and the profiling of the shore islands using GPS, photo-documentation, interpretation of topographic, bathymetric, geological and tectonic maps (1:25 000 –1:10 000000). Also we used information on the relative elevation rate of the Earth's crust and the White Sea level in Pleistocene and Holocene.

The relief of all investigated islands is represented by forms created by the following combinations of processes: 1) glacial-tectonic and marine wave processes; 2) tidal and wind effected phenomena; 3) glacial-tectonic, marine and gravity processes, and 4) glacial-tectonic, marine, lake and biogenic processes. Tectonic rising plays the main role in the islands relief formation. During the land rising above the sea level, its area and height increases leading therefore to the relief complication.

We created paleogeomorphological schemes for each of the studied sites. These schemes reflect the main elements of the islands' surface at a certain stage of the Pleistocene and Holocene periods. The main forms of the islands' relief within studied archipelagoes were formed during the last 7-8 thousand years: the Tape I transgression, the Tape II regression and the Ostrea transgression.

Ice stream bedforms and deglacial ice sheet margins south of Jotunheimen, southern Norway

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The pattern, rate, and magnitude of ice sheet decay following the Younger Dryas chronozone is generally poorly documented in Scandinavia, despite its utility as an analogue for the future evolution of extant ice sheets. This knowledge gap has persisted mainly due to a paucity of geochronological constraints, which has precluded regional ice-marginal correlations in areas that formerly supported regional ice divides. High-resolution digital terrain models derived from LiDAR surveys provide the basis for new, detailed reconstructions of ice sheet decay during the early Holocene. The study area is situated south of Jotunheimen, where late-glacial ice-flow was predominantly east- to southeastwards from a regional ice divide that also supplied a tidewater trunk glacier in Sognefjorden. A prominent feature of the new geomorphological dataset is widespread ice stream bedforms (including flutes, drumlins, ice-moulded bedrock, crag and tails) occurring in association with eskers and fields of ribbed moraine. The character and distribution of ice stream bedforms and ribbed moraine record spatially and temporally variable glacier dynamics. For example, apparent superimposition of ribbed moraine over streamlined bedforms record episodes of ice stream shutdown during deglaciation. In contrast, ribbed moraine situated at the heads of ice stream flow-sets and typically at higher elevations, likely denotes former ice stream onset zones. In addition, mapped lateral and end moraine systems may record periods of positive net mass balance that are possibly correlative to late Pleistocene to early Holocene climatic deteriorations such as the Pre-Boreal Oscillation (PBO). Ongoing research is focused on establishing a robust chronology (i.e. TCN, ^{14}C, tephras) of early Holocene ice sheet fluctuations, including the timing of ice stream dynamics, and rates of ice sheet thinning and retreat. As well, geophysical and sedimentological investigations of ribbed moraine and streamlined bedforms will determine their modes of formation and place constraints on the behavior of deglacial ice streams. Results will elucidate the early Holocene evolution/collapse of ice accumulation centres in central Norway, and test relationships to regional paleoclimate and glaciological modeling.

Terrestrial carbon in Chukchi Sea shelf sediments portrays thermo-erosion in Beringia since the last glacial

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Rising temperatures perturb Arctic carbon cycling and can affect atmospheric CO_2 concentrations. We here assess carbon mobilization from thawing permafrost during post-glacial warming periods using a molecular and isotopic endmember approach ($\Delta^{14}C$, $\delta^{13}C$, CuO-derived lignin phenol biomarkers) in Chukchi Sea shelf sediments. Analysis of biogenic silica and $\delta^{13}C$ in core sediments from the Herald Canyon (SWERUS-L2-4-PC1) reveal a rapid transition from a coastal setting towards a marine environment ~11 cal ka BP, as indicated by lighter $\delta^{13}C$ values in the pre-Holocene (-25 ‰) and heavier, typically marine $\delta^{13}C$ values in the Holocene (-22 ‰; Jakobsson et al., 2017). To further characterize the carbon source we analyzed the radiocarbon (^{14}C) concentration of the bulk sediment and compared it with the year of sedimentation (age model based on carbonate material from Jakobsson et al., 2017). Pre-Holocene sediments contained elevated contributions of pre-aged carbon with an average offset of 13.3 ka to the year of deposition. Holocene sediment carbon lies only 3.1 ka off the carbonate-based age curve. Additionally, initial analysis of lignin phenol (CuO oxidation products) concentrations indicate overall elevated terrestrial biomarker fluxes in the older core units. Abundance ratios between individual lignin phenols (cinnamyl/vanillyl phenols, syringyl/vanillyl) may suggest a strong contribution of soft plant tissues (e.g. grass-like material). This ratio pattern is also characteristic for old Pleistocene Ice Complex (Tesi et al., 2014) and resembles the carbon fingerprint of early Holocene East Siberian Sea shelf sediments (Keskitalo et al., 2017). Hence, we conclude that post-glacial permafrost thaw may have released large amounts of old carbon before the Bering Strait opened due to eustatic sea level rise (i.e. coastal erosion during marine transgression). This would be in striking contrast to the Laptev Sea which received more carbon from contemporary pools (e.g. soil active layers) of the Lena River watershed during the same warming event (Tesi et al., 2016). Our data may also show that thermo-erosion accompanied the successive sea level rise of the Chukchi Sea

during post-glacial warming periods. The activation of old permafrost carbon likely enhanced mineralization rates and ultimately resulted in atmospheric CO_2 emissions during transport.

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Clay mineral distribution in post Last Glacial Maximum sediments on the southern and western Svalbard continental margin

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The Kveithola and Storfjorden troughs are two glacial depositional systems, situated South of the Svalbard Archipelago (North western Barents Sea), that during the last glaciation (MIS-2) have hosted ice streams, which contributed to the build-up of the relative Trough Mouth Fans (TMFs) on the continental slope. The sedimentary record contained in TMFs 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. The TMF slopes facing the two troughs have been investigated during several international oceanographic cruises: SVAIS onboard R/V BIO Hespérides; EGLACOM, onboard R/V OGS Explora; PNRA Project CORIBAR, onboard R/V Maria S. Marien; Eurofleets-2 PREPARED, onboard RV-G.O. Sars.
For this study we have focused on XRD analyses on clay minerals, collected from seven cores, taken during these cruises, and XRF analyses have also been conducted on the whole length of the cores. Clay mineral assemblages are controlled by source rock composition, physical-chemical weathering, transport and depositional mechanisms. In polar areas clay mineral analysis can be used also for reconstructing sedimentary processes, associated with glacial and interglacial conditions. Moreover in the North western Barents Sea smectite is considered a good proxy for reconstructing the North Atlantic Current strength,

giving thus additional indication on the palaeoceanographic conditions associated with climatic changes.
Here we present a first correlation among these cores, aiming to describe the clay mineral distribution in response to the climatic variations that followed the Last Glacial Maximum and describe the changes in ice-stream dynamics and related oceanographic/environmental changes along the margin.

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Late Cenozoic sediments and past sedimentation rates on the Mendeleev Rise

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Two stratigraphic models were proposed for deep-sea Arctic bottom sediments: the "old" (Clark et al., 1980; Not and Hillaire-Marcel, 2010) and the "young" (Adler et al., 2009; Polyak et al., 2004) ones. The first model is based on paleontological evidence, paleomagnetic data and U-Th datings and implies a mean sedimentation rates of about 0.1 -0.3 cm/kyr. The second "young" model assumes relatively high sedimentation rates (1.5 cm/kyr) and based mainly on radiocarbon and optical stimulated luminescence (OSL) datings, that can evaluate the age of organic remains and minerals just back to 50 and 150 ka, respectively. Both models are accepted, however the "young" model is becoming more popular. In order to refine the age of sediments and their composition we carried out an investigation of sediment core AF-0731 (78° 37' 48.9'' N, 171° 56'

52.1'' W), retrieved from water depth of 2280 m on the eastern slope of the Mendeleev Rise (355 cm long). We obtained lithological (IRD counts), geochemical (planktic $\delta^{18}O$ and $\delta^{13}C$) and microfossils (planktic and benthic foraminifers; ostracods) data. In the upper part of the core there are five abundance peaks of benthic and planktic foraminifers that correspond to each other as well as to ostracods and match the same brown clay layers, which is considered to represent interglacials. Downcore (250 and 305 cm) only planktic peaks are present. The composition of microfossil assemblages indicates that the upper 20–50 cm of sediments of the core were deposited during the late Neopleistocene–Holocene. The age control was provided by four $^{230}Th/^{234}U$ dates: 0-2 cm ~ 2.3 ± 0.3 ka; 15 cm ~ 34.3 ± 4.8 ka; 47 cm ~108 ± 15 ka; 80 cm ~ 108 ± 15 ka. Based on these datings the upper foraminiferal peak (0-15 cm) can be correlated with MIS 1-3, the second (40-50 cm) - with MIS 5; 80 cm interval doesn't bear any fauna ($^{230}Th/^{234}U$ ~ 108 ± 15 ka) and correlates with MIS 6. The base of the core was dated by Sr-isotope chemostratigraphy (performed on N. pachyderma sin). $^{87}Sr/^{86}Sr$ ratios were measured in two samples: 330-333 cm ~ 0.709151 ± 4 and 353–355 cm ~ 0.709154 ± 5. The average $^{87}Sr/^{86}Sr$ value of the samples recalculated into an age following LOWESS 4b/5 algorithm equals 670 ± 50 ka. The established SIS-age is in a good accordance with U-Th dating of organic-rich sediments that yielded the age of ~710 ka (unpublished data of F.E. Maksimov). This confirms the early Neopleistocene age of the base of the core AF-0731. Sedimentation rates were 0.5–0.6 cm/kyr during accumulation of the lower sediment units, which is close to the rate of sedimentation of the upper layers of 0.44 cm/kyr. These findings incline us to accept the "old" model for this part of the Mendeleev Rise.

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A varved ? LGM sediment record from the Polar Urals

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Counting of more than 5000 rhythmically laminated sediment layers in two cores from lake Bol. Schuchye in the Polar Urals display striking concordance to the AMS ^{14}C-chronology, suggesting that they represent annual layers or i.e. varves. The potentially varved sequence spans a time period from c. 19 – 24 ka and thus hold the potential to construct a high resolution stratigraphy constraining the timing and duration of glacial and climate variations at the time.

Continuous and high resolution lake records spanning across the Last Glacial Maximum (LGM) are notoriously rare in the Arctic due to the contemporary extensive ice sheet coverage. However, previous research around the Arctic Eurasian seaboard has revealed that almost the entire Russian Arctic, in contrast to further to the west, remained ice free throughout the LGM. Lakes within the Polar Urals were therefore targeted by the CHASE-project (Climate History along the Arctic Seaboard of Eurasia) in order to address the past climate variability in

the region and elucidate the causes behind the asynchronous east-west development.

In this study, a 24 m long sediment sequence in two parallel cores was analyzed by high resolution XRF core scanning in order to both visually and chemically distinguish potential varves. Only the lower half of the total core length was found to be rhythmically laminated. The laminations are commonly c. 2 mm thick and are easily defined both from optical images and chemically by high potassium and iron values in the winter clay layers. The resulting lamination count was successfully tested by cross correlation between two overlapping cores and comparison to the AMS ^{14}C-chronology. We therefore conclude that the laminations most likely are varves.

The combination of AMS ^{14}C-dating and varve counting in this study has provided a valuable contribution to constrain the age model for ongoing palynological-, DNA- and compound specific isotope (δ^2H, δ^{18}O) analyses also conducted within the framework of the CHASE-project. Put together, this continuous and unprecedented high resolution record will effectively supplement previous attempts to reconstruct past environmental changes based on fragmentary data from moraines and exposed strata along river banks and in coastal cliffs around the Russian Arctic.

Landscape Response of the Southern Part of the Middle Russian Upland to Climatic Fluctuations during the Pleistocene and the Holocene

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The Middle Russian Upland lies on the East European Plain. The Upland's southern part, which is our study area, is tectonically associated with the northeastern wing of the Voronezh Anteclise. Our geological and geomorphological study of the area has shown that it sits on an actively growing structure (Romanovskaya, 2015). According to recent studies, this structure's neotectonic uplift amplitude can be estimated at more than 200 m. This growth played an important role in landscape formation all around. This is demonstrated by the following: 1) recent dramatic changes in the flow directions of the rivers Don and Tikhaya Sosna as they had to bypass rising upland; 2) instances of damming up, which created numerous oxbow lakes and led to waterlogging in floodplains; 3) increase in the density of the erosion grid on the upland itself; 4) fall of the groundwater table; 5) intensification of erosion, weathering, karst and slope wash processes.

Our results of structural-geomorphologic study and modeling have exposed the presence of differently aged erosion-shaped denudational, erosion-shaped accumulational and purely accumulational surfaces on the Upland's southern segment, which were formed by neotectonic movements and also influenced by climate fluctuations. The entire landscape is a system of altitudinal steps. Each surface has its own complex of recent deposits. The highest (220 - 230 m above sea level) and oldest surface dates from the Late Miocene. A surface at about 200 m dates from the Late Miocene and the Pliocene. Surfaces at 180 m and 150 m date from the Eopleistocene and the Early Pleistocene, respectively. The latter lies on fluvioglacial deposits from the time of the maximum Dnepr (or Don) Glaciations. The fluvial terraces above the floodplains of the rivers Don and Tikhaya Sosna were formed under the influence of the Don, Dnepr, Moscow and Valdai Glaciations. Terrace IV (at about 60 m above river level) was formed in the opening half of the Middle Neopleistocene. Terrace III (40 m) was formed in the closing half of the Middle Neopleistocene. Terrace II (30 m) was formed in the opening half of the Late Neopleistocene. Terrace II (at 10 to 12 m) was formed in the closing half of the Late Neopleistocene. The floodplain (at 2 to 4 m) was formed in the Holocene.

Besides, there is a lot of pale yellow calcareous loess, loess-like loam and brownish paleosol in the Quaternary geological sections of the area. The loess of the Great European Loess Belt is eolian-glacial deposit accumulated in the area between the Fennoscandian Ice Shield and the North Atlantic Ocean. It is considered to be an ideal material to record the impact of rapid climate change (Antoine et al., 2009). Radiocarbon dating of fossils at archaeological site Divnogorie-9, located in the upper loess-like loam part of the area section (50.9649ºN, 39.3031ºE), returned 12-14 ka BP. Drilling with coring along a profile laid across a chosen relief structure was also carried out. Its results will be fully demonstrated in our presentation.

The emerging picture of the geomorphology and the Quaternary geology of the study area suggests that its landscape was formed by the work of exogenous agents and neotectonic movements and reflects climatic fluctuations during the Pleistocene and the Holocene.

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The INBIS Channel System: a unique deep-sea sediment route in the NW Barents Sea

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The INBIS Channel System is an inter-fan deep-marine channel system located on the lower reaches of the continental slope in the Norwegian-Greenland Sea, West of Bjørnøya, Barents Sea. Upslope of the INBIS Channel System a complex series of gullies and tributary canyons incise the upper parts of the continental slope; these are inferred to have originated from erosion by turbidity currents and possibly also from cascading of dense cold water from the continental shelf. These features merge and grow in dimensions down slope and converge into the deep main trunk channel, called the INBIS Channel. The formation of this channel system was possible due to its location between the Kveithola Trough Mouth Fan (TMF) and the Bjørnøya TMF. Due to this, the Inbis Channel System was protected and, in consequence, only partially fed from the massive sediment gravity flows produced by ice streams during the Last Glacial Maximum, as well as modified by the Spitsbergen Current, a northward flowing ocean current that affects the shallower parts of the channel boundaries, controlling its asymmetry. These particular conditions are rare on this part of the margin, making the INBIS Channel System a unique example in this part of the NW Barents Sea.

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Holocene Benthic Foraminifera and Ostracode Faunas from the Herald Canyon and Beaufort Sea, Arctic Ocean

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Calcareous microfossil assemblages in late-Holocene sediments on the western Arctic continental shelf provide an important baseline for evaluating the impacts of today's Artic Ocean warming. This study compares ^{14}C-dated late Holocene microfaunal assemblages of the SWERUS-L2-2-PC1 (8.2 m) core, which records the last 4200 years and was collected in a water depth of 57m in the Herald Canyon (Chukchi Sea shelf), and the HLY-1302-JPC-32 (14m), GGC-30 (3m), and MC-29 (30cm) cores which record the last 3000 years and were collected in a water depth of 60m in the Beaufort Sea shelf off the coast of Canada. Foraminiferal and ostracode assemblages present in all cores are typical for Arctic continental shelf environments. The dominant benthic foraminiferal species on the Beaufort shelf in order of abundance are *Cassidulina reniforme*, *Elphidium excavatum clavatum* and *Islandiella teretis*. In contrast, the fauna on the Chukchi shelf in order of abundance are *Elphidium excavatum clavatum*, *Buccella* spp. and *Cassidulina reniforme*. Ostracode assemblages in the JPC-32 core are dominated by *Paracyprideis pseudopunctillata* and also include *Acanthocythereis dunelmensis, Cytheropteron elaeni* and *Kotoracythere*; in 2-PC1 the dominant species are *A. dunelmensis, Kotoracythere arctoborealis, Elofsonella concinna, Normanicythere leioderma, Cytheropteron elaeni,* and *Semicytherura complanata*. Preliminary chronology of the cores indicates centennial scale variability in proportions of benthic foraminiferal species, such as *Cassidulina reniforme*. Differences in species dominance between the two sites may be due to a greater influence of nutrient-rich Pacific water in the Chukchi shelf, which is close to the Bering Strait source, compared to the more distal Beaufort self. The Holocene faunal patterns will be compared to other proxy records (δ^{18}O, Mg/Ca and organic biomarkers) to establish possible causes for temporal and spatial variability in dominant species.

Holocene deglaciation, sea-level changes and shifts in sediment supply recorded in High Arctic paraglacial coastal systems – examples from central Spitsbergen

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Understanding the mechanisms that control High Arctic coastal zone evolution is crucial to decipher landscape changes and associated shifts in sediment fluxes triggered by climate change.

The gravel-dominated barrier 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 polar coasts 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. Paraglacial processes operating on Svalbard have already reduced glacial processes to a secondary role in controlling landscape change. This change is apparent in slope, valley floor and glacier foreland systems, where glacigenic landforms are being denuded by fluvial, aeolian or mass-wasting processes that are being accelerated by permafrost degradation. However, the impact of these changes on the coastal zone is uncertain because of few studies of pre- and post-LIA coastal change.

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 several coastal studies carried out by our research team along paraglacial coast of Billefjorden and Templefjorden.

We reconstruct the evolution of coasts in central Spitsbergen to illustrate the highly variable coastal zone responses to paraglacial landscape transformation associated with glacier retreat. Our results document dramatic changes in sediment flux and coastal response under intervals characterized by a warming climate, retreating local ice masses, a shortened winter sea-ice season and melting permafrost. Our research was based on a combination of methods including aerial photogrammetric and GIS analyses, sedimentological tests of coastal deposits and field-based geomorphological mapping.
The study highlights the need for a greater understanding of the controls on High Arctic coastal sediment budgets, especially given the potential for future accelerated warming and sea-level rise.

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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Arctic Freshwater Discharge, Sea-Ice Formation, and Holocene Climate Variability – Preliminary Results of a Biomarker Approach

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Understanding Arctic sea-ice, as one of the most dynamic components of the climate system, can improve attempts of future climate predictions. During the last decade, a novel biomarker proxy (IP25; Belt et al., 2007), exclusively produced by sea-ice diatoms (Brown et al., 2014), was successfully applied to reconstruct past sea-ice variability (see Stein et al., 2017 and numerous references therein). Most recently, tri-unsaturated HBI (HBI-III) have been discovered to contain additional useful information about the vicinity of the retreating sea-ice edge or marginal ice zone (Belt at al., 2015). In our study, multiproxy biomarker measurements have been carried out to reconstruct sea-ice cover (IP25, PIP25) primary production (brassicasterol, dinosterol; HBI-III) and river runoff (ß-sitosterol, campesterol) as well as sea surface temperatures (alkenones). Furthermore, δD stable isotopes of specific biomarker will be determined for salinity estimates. Here, we present new data from a sediment core off the NE-Greenland continental margin (PS93_025) characterized by high sedimentation rates and covering the last ~10 kyrs to better constrain freshwater discharge, sea-ice variability and extent, ice-sheet history, ocean/atmosphere exchange and primary production. Our still preliminary biomarker, total organic carbon and inorganic carbon data indicate a high variability of Arctic sea-ice during the Holocene.

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Vulnerability of organic matter in thawing subsea permafrost: First results from recent drillcores in the SE Laptev Sea

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Large areas across the Arctic Ocean shelves are underlain by permafrost that accumulated when shelves were exposed during cold and dry periods in the Pleistocene, and were submerged by the marine transgression at the onset of the Holocene. Exposure to comparatively warm ocean water has promoted permafrost warming and even thaw since then, and this effect will likely intensify in the future as water temperatures rise with anthropogenic warming. Thawing of subsea permafrost is expected to stimulate the microbial decomposition of organic matter and the production of CO_2 and CH_4, and might thus add greenhouse gases to the atmosphere. We here use a set of deep drillcores (≤ 58 m length) retrieved from the Laptev Sea in 2011-2015 to assess the source and degradation state of organic matter in subsea permafrost. We will present first results from biomarker analyses (n-alkanes, n-alkanoic acids, lignin phenols) of samples taken at high depth resolution (5 cm) across the current thaw front, which thus represent a continuum from organic matter that is still frozen, to organic matter that has been thawed in recent times. Our findings will promote our understanding of organic matter stored in subsea permafrost, and its vulnerability to decomposition upon thaw due to natural and anthropogenic warming.

First high-resolution sediment record from the western Fram Strait - A multiproxy reconstruction of the Holocene water mass history off NE Greenland

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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. A new 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 changes in near-surface salinities, temperature, stratification and water masses (polar waters vs. Atlantic Water), potentially related to variations of the freshwater and sea ice export from the Arctic Ocean. The 260 cm long sedimentary record from site PS93/025 (80.5°N, 8.5°W) was investigated for sediment composition, foraminifer contents, grain size variations (sortable silt) and the isotopic composition of planktic foraminifers. Radiocarbon datings reveal an age of 10.2 cal-ka for the core base and continuous sedimentation throughout most of the Holocene.

The sediments are generally very fine-grained (<2% sand). The grain size record reveals a fining-upwards trend and sediments from <6.5 cal-ka consist of <0.5% coarse fraction. 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. Foraminifer abundances (both planktic and benthic) are high in Early Holocene sediments until ca. 7 cal-ka and decrease rapidly thereafter. This is interpreted to reflect a relatively strong advection of Atlantic Water to the NW Fram Strait, which correlates well with similar findings on the eastern side of the Arctic Gateway. Sortable silt grain sizes are high (27-32 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 20-22 µm and slight variation. Considering also the grain-size distribution curves, we propose a decline of bottom current velocities on the outer NE Greenland shelf after 7 cal-ka, related to a decrease of Atlantic Water advection. These preliminary results reveal a strong coupling of Holocene environments on both sides of the Fram Strait.