



# ARCPCaC 2026

Conference program and book of abstracts

*Version 1.0*

*This document will be continuously updated to reflect any possible changes in the program*

# Preface

Welcome to the 1<sup>st</sup> ARCPaC Conference, to be held in Aarhus, Denmark, from 25-29 May 2026. With 118 registered participants and 99 scientific abstracts, the input from the Arctic paleo research community has exceeded our expectations and enabled us to put together a strong and exciting conference program.

We kindly ask all conference participants to read through and adhere to our code of conduct, which can be found right after the table of contents.

This document is intended to complement and provide an offline alternative to our conference program online at [arcpac.au.dk](http://arcpac.au.dk). If there are differences between the two sources of information, the information on the website prevails.

We wish you all a great conference and stay in Aarhus!

Kind regards,

The local organizing committee

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## Code of Conduct

We are delighted to host the 1<sup>st</sup> ARCPaC Conference in Aarhus. We want every participant to feel welcome, included, and safe. Our intention is to create a conference environment that is respectful and welcoming to participants of all genders, races, ethnicities, ages, abilities, religions, and sexual orientation.

During the conference, if anything occurs that makes you or someone you know feel unsafe or excluded, we ask you to contact either Christof Pearce ([christof.pearce@geo.au.dk](mailto:christof.pearce@geo.au.dk)) or Caroline Brand ([carbrand@geo.au.dk](mailto:carbrand@geo.au.dk)), to raise the issue. Any discussions will be dealt with in confidence.

We follow guidelines adapted from the INQUA 2019 Congress and the 2020/2023/2024 QRA Annual Discussion Meetings. These guidelines are:

1. Everyone involved with the 2026 ARCPaC conference is expected to show respect towards attendees, venue staff, the Organising Committee, volunteers, and all others participating in the meeting.
2. The open exchange of ideas and freedom of thought and expression are central to the aims and goals of the 2026 ARCPaC conference.
3. The 2026 ARCPaC conference will be an environment that recognises the inherent worth of every person and group, that fosters dignity, understanding, and mutual respect, and that embraces diversity.
4. We will do our best to accommodate specific needs such as accessibility and dietary requirements.
5. We expect all interactions between attendees to be respectful and constructive, including interactions during the formal programme.
6. Unacceptable behaviour will not be tolerated at the 2026 ARCPaC conference. Examples of unacceptable behaviour include but are not limited to bullying, intimidation, inappropriate physical contact or unwelcome sexual attention, continuous disruption of events or interference with participation or opportunity for participation of other people attending the meeting.
7. The 2026 ARCPaC conference prohibits recording/photographing as well as online posting of conference materials, talks, questions, etc., without consent.
8. We require attendees to follow this code of conduct during the entire 2026 ARCPaC conference, including the field trip, and in all online interactions associated with the meeting (including social media and any other online facilities) and related social activities.

## Acknowledgements

We are grateful to the Aarhus Institute of Advanced Studies AIAS who have let us use their buildings and meeting facilities as our conference venue. We acknowledge both the Geological Survey of Denmark and Greenland, GEUS, and the Department of Geoscience, AU, for their general support and allocation of resources to the organization of the ARCPaC conference.

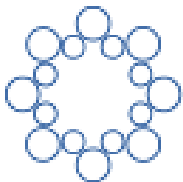
The 2026 ARCPaC conference has received financial support from the Carlsberg Foundation, AU's Interdisciplinary Cluster for Climate Change iClimate, the International Arctic Scientific Committee IASC, and the Geological Society of Denmark DGF.



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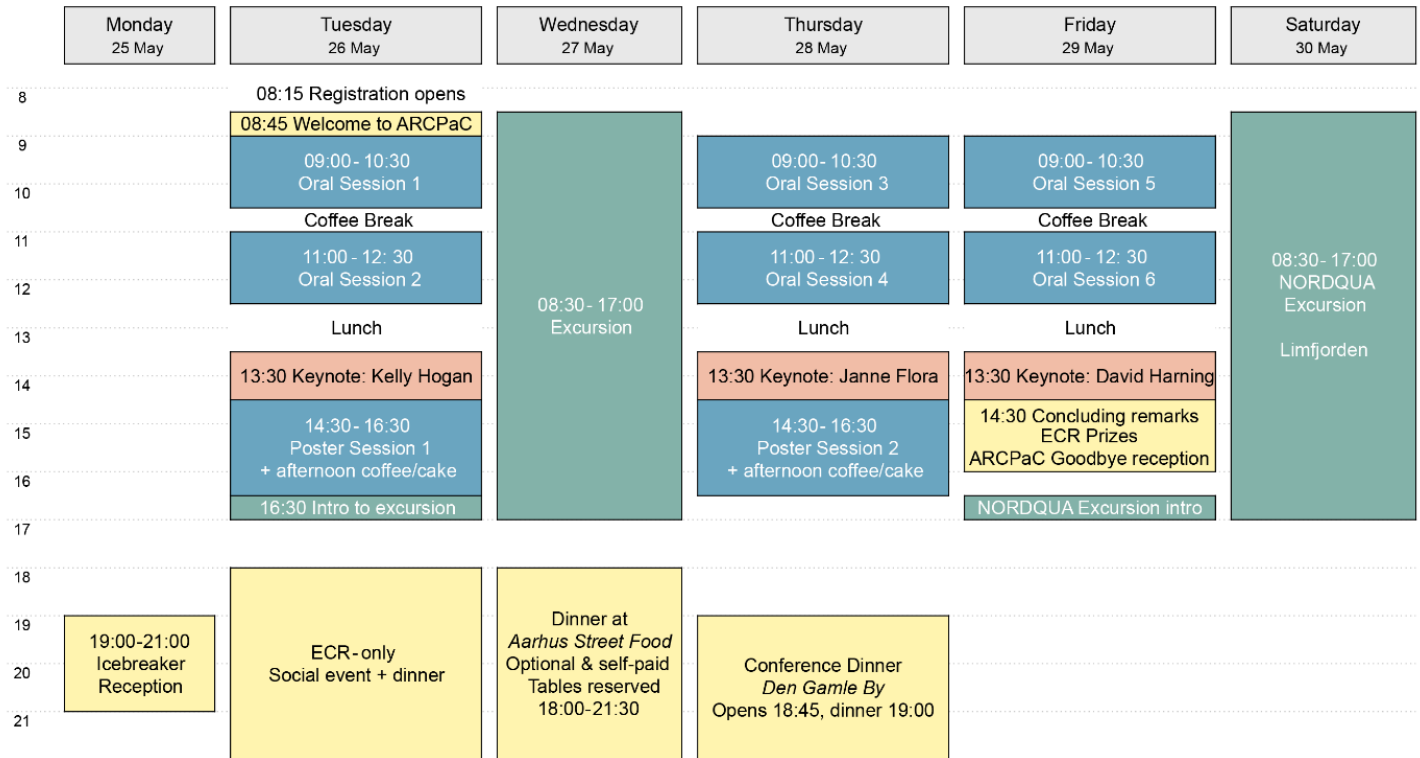


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# Program

The conference will start on Monday evening with an icebreaker reception at the Department of Geoscience of Aarhus University. The rest of the conference, including all presentation will take place at the Aarhus Institute for Advanced Studies. On Wednesday, buses will take us to various sites on the Djursland Peninsula for the mid-conference excursion.

## Week overview



## Excursion

Information on the excursion will be published in a separate booklet and posted directly on the conference website.

## Abstracts

All abstracts, organized by session

### Keynote speakers

Tuesday 13:30, convener: Anna Hughes

**Kelly Hogan** Off the shelf: Greenland's past, our future?

Wednesday 13:30, convener:

**Janne Flora** Collaboration in Practice: Lessons from Greenland on Listening, Learning, and Asking Questions

Thursday 13:30, convener: Jochen Knies

**David Harning** Holocene carbon burial in the Arctic: Lessons and motivations from Iceland

# Off the shelf: Greenland's past, our future?

Hogan, K.<sup>1\*</sup>, O Cofaigh, C.<sup>2</sup>, Hunt, M.<sup>2</sup>, Roberts, D.<sup>2</sup>, Lane, T.<sup>3</sup> Howe, J.<sup>4</sup>, Malmierca-Vallet, I.<sup>1</sup>, Tarasov, L.<sup>5</sup>, Jakobsson, M.<sup>6</sup>, Jennings, A.<sup>7</sup>, Mayer, L.<sup>8</sup>, Dowdeswell, J.<sup>9</sup>, & the KANGGLAC team

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Mass loss from glaciers and the Greenland and Antarctic ice sheets now contribute more to sealevel rise than thermal expansion of the ocean. Yet many questions remain about how this mass loss will progress in the future. A key unknown is how marine-terminating glaciers will retreat as inflows of relatively warm subsurface waters drive enhanced ice melting and iceberg calving in both Polar Regions. One way to understand such ocean-forced dynamics is to look at the record of past marine glaciation that is held on high-latitude continental shelves. The great benefit of using the marine geological and geophysical records from the shelves can record not only the retreat of ice but how this retreat occurred – via calving or melting or both – plus the ocean temperature at the time. Importantly, the records from glacial landforms and marine sediment cores also provide information over 100s-1000s years, thus extending our knowledge of rapid glacier retreat beyond what we have witnessed in the satellite era (the last ~50 years). In this talk, I will use examples from different parts of the Greenland continental shelf to discuss what we have learned about the retreat of Greenland's marine glaciers, what the potential drivers of retreat have been, where the chronology is different (or similar!), and which questions remain open.

# Collaboration in Practice: Lessons from Greenland on Listening, Learning, and Asking Questions

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Collaboration and co-creation are increasingly presented as requirements in scientific research, especially when working with Indigenous communities. At the same time, these terms can feel abstract, even intimidating, and are sometimes used to check boxes or to avoid difficult questions rather than to open up for genuine engagement.

If you are looking for a method or a formula for how to collaborate, this talk will likely be disappointing. There is no single correct way to do collaboration. There is no gold standard to reach. And even if there were, it would not travel well across contexts. Instead, I want to focus on what collaboration looks like in practice. Not as an ideal, but as something that unfolds in specific places, with specific people, under specific conditions.

The reflections I share are drawn from ongoing work with hunters in Greenland, particularly through the *Piniariarneq* projects in Northwest and East Greenland. Hunters documented their movements, catches, and observations using GPS devices over extended periods. The resulting material brought together different forms of knowledge, but the process itself did not follow a single model. Rather, the collaborations unfolded differently in each community, shaped by local routines, priorities, and concerns. Dialogue and openness were important, but they were not enough in themselves. Participation depended on whether the project was seen as meaningful and worthwhile.

These moments are important to take seriously. They remind us that collaboration is not something we can assume or secure in advance. It is something that has to be negotiated, again and again. What follows from this is not a set of guidelines, but a shift in attention. Rather than asking how to apply the right method, we might ask different questions. Who defines what matters in a project? When are people invited into the process? What counts as participation? And what does it mean to listen in ways that actually shape the research?

Co-creation, then, is not a stable model. It is an aspiration. Something we move toward, without expecting to arrive. What seems to matter more in practice is the quality of the engagement. Starting conversations early. Being willing to adjust questions. Accepting that not everyone will participate, and that this also says something important. Collaboration does not work as something you implement. It is a set of relationships that take time to build, and that remain uneven and unfinished.

This keynote is an invitation to reflect on what collaboration can entail when it is locally grounded, shaped by those involved, and responsive to the realities in which research takes place. Not as a fixed model, but as an ongoing process that changes the questions we ask, the relationships we build, and the knowledge we produce.

# Holocene carbon burial in the Arctic: Lessons and motivations from Iceland

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The burial of organic carbon (OC) in sediments is a fundamental component of the global carbon cycle. However, geologic constraints on sedimentary burial rates and the forcings that drive these patterns are geographically limited, particularly in the Arctic. This information is vital to inform carbon-climate feedbacks, conservation efforts, and emerging climate dioxide removal strategies. Fortunately, a wealth of information derived from existing paleoclimate records is available to address this problem. In this talk, I focus on Iceland as a case study, where I have compiled new and existing datasets to constrain Holocene OC burial rates ( $\text{g m}^{-2} \text{yr}^{-1}$ ) across terrestrial and marine archives and their possible driving mechanisms. First, the data show that Icelandic lakes are substantially more efficient at sequestering OC than any other sedimentary archive. The latter include fjord, marine shelf, and peat sediments that are highly cited as relevant sinks of high-latitude OC and highlight that Arctic lakes may therefore have an outsized role in climate regulation across glacier-interglacial timescales. Second, I demonstrate the value of leveraging new molecular toolsets, such as lipid-based redox potential proxies, DNA-based vegetation assemblages and radiocarbon, to understand the influence of water column and landscape dynamics on OC burial (and methane cycling) through different climate states. Third, and finally, I envision how we can move forward as an Arctic community to better understand sedimentary carbon cycling through the generation of new databases, proxy innovation, and interdisciplinary collaboration.

## Oral Session 1

Tuesday 09:00 - 10:30

Conveners: tbd

- |       |                           |   |
|-------|---------------------------|---|
| 09:00 | <b>Joanna Davies</b>      | Atmospheric warming drove breakup of the Last Glacial Maximum Northeast Greenland ice shelf   |
| 09:15 | <b>David Roberts</b>      | Holocene environmental change at the grounding line of the Northeast Greenland ice stream   |
| 09:30 | <b>Holly Jenkins</b>      | A palaeo-reconstruction of 20th century ice shelf dynamics in northeast Greenland, through epishelf lake sediments                        |
| 09:45 | <b>Clara Lery</b>         | New constraints on Late-glacial and Holocene ice-margin fluctuations in Scoresby Sund (Kangertittivaq), East-Central Greenland            |
| 10:00 | <b>Shannon Klotsko</b>    | A Massive Grounded Ice Shelf in Baffin Bay Buttressed the Greenland, Laurentide, and Innuitian Ice Sheets During the Last Glacial Maximum |
| 10:15 | <b>Anna Bang Kvorning</b> | From Ice Shelf to Open Water: Holocene Cryosphere and Ecosystem Change in Melville Bay, NW Greenland                                      |

# Atmospheric warming drove breakup of the Last Glacial Maximum Northeast Greenland ice shelf

Davies<sup>1</sup>, J.<sup>1\*</sup> D'Andrea, W. J.<sup>1</sup>, Stoltenberg, M.<sup>2</sup>, Huntsman, C.<sup>1</sup>, Böttner, C.<sup>3</sup>, Pearce, C.<sup>2</sup>, López-Quirós, A.<sup>4</sup>, Seidenkrantz, M.-S<sup>2</sup>, Reilly, B.<sup>1</sup>

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Ice shelves are floating platforms of ice that form along marine-terminating glaciers that fringe ice sheets. They are critical for ice sheet buttressing and their removal, potentially via catastrophic collapse, can lead to significant mass loss. Despite their importance in projections of future sea level rise, the mechanisms of ice shelf collapse are not yet fully understood. The melting and weakening of ice shelves can be driven by both ocean and atmospheric forcings. The rapid collapse of Larsen B (2002) ice shelf is a dramatic recent example of ice shelf breakup. The leading explanation for its collapse is that atmospheric warming drove surface melt, resulting in hydrofracturing. In contrast, breakup of the Jakobshavn Ice Shelf, West Greenland, was a more gradual process that took decades. This has been attributed to oceanic warming that caused ice shelf thinning and eventual breakup. As there are relatively few instances of ice shelf collapse within the satellite era, the question still persists: what environmental conditions does it take to destroy an ice shelf? Here we present evidence from marine sediment cores documenting the retreat of the Northeast Greenland Ice Stream and the collapse of its ice shelf during the last deglaciation.

The Northeast Greenland ice stream comprises three marine-terminating glaciers and contains 1.1 m of sea-level equivalent. During the Last Glacial Maximum, it extended ~450 kms from its current position to the continental shelf break of the Belgica Trough. Existing records show that its initial retreat (ca. 22.1 ka BP) was driven by the incursion of warm Atlantic Water, whilst cold atmospheric temperatures persisted. Following ~100 km of retreat, the formation of a large grounding zone wedge indicates that the ice stream stabilised by 15.6 ka BP for at least 1 kyr. During this time, the ice stream terminated in a floating ice shelf, inferred from geomorphological and proxy evidence preserved in marine sediment cores.

We constrain the drivers of breakup of the deglacial Northeast Greenland ice shelf using proxies for salinity ( $\delta^{18}\text{O}$  of planktic and benthic foraminifera,  $\delta^2\text{H}$  of the  $\text{C}_{18:0}$  short chain fatty acid ( $\delta^2\text{H}_{\text{C}_{18:0}}$ )) and iceberg rafting (ice rafted debris (IRD) counts), preserved in sediment core DA17ST12-135G (135G; 501 m water depth) and supplemented by previously published data from nearby core PS100-144GC (144G; 496 m water depth). Whilst the incursion of warm water caused grounding line retreat following the Last Glacial Maximum, we show that abrupt warming of summer air temperatures at the onset of the Bølling–Allerød (14.7–12.9 ka) ultimately drove collapse of the ice shelf, likely via hydrofracture. The removal of the ice shelf buttress resulted in accelerated mass loss, via enhanced meltwater discharge and iceberg rafting, that persisted until ~11 ka. These results document the important role of atmospheric forcing in the deglaciation of this large ice stream.

# Holocene environmental change at the grounding line of the Northeast Greenland ice stream

Roberts, D.H.<sup>1\*</sup>, McClymont, E.L.<sup>1</sup>, Sánchez-Montes, M.L.<sup>2</sup>, Langdon, P.G.<sup>3</sup>, Langdon, C.T.<sup>3</sup>, Lane, T.P.<sup>4</sup>, Darvill, C.M.<sup>5</sup>, Callard, S.L.<sup>6</sup>, Smith, J.A.<sup>7</sup>, Bentley, M.J.<sup>1</sup>, Jamieson, S.S.R.<sup>1</sup>, Lloyd, J.M.<sup>1</sup>, Rea, B.R.<sup>8</sup>, Ó Cofaigh, C.<sup>1</sup>, Gulliver, P.<sup>9</sup>, Jones, R.S.<sup>10</sup>, Tunstall, N.<sup>1</sup>, Longley, C.<sup>1</sup>, Taylor, J.<sup>1</sup>, Jenkins, H.<sup>1</sup>

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A lake sediment core from 2.3 Mile Lake in NE Greenland provides a record of environmental change throughout the Holocene. The lake, situated close to the present-day grounding line of the Northeast Greenland Ice Stream (NEGIS), provides evidence for Early Holocene warmth and the transition into the Neoglacial as the 79N ice shelf reformed in response to northern Hemispheric cooling.

The lowest minerogenic sediments in the lake (LF1) relate to local deglaciation which is constrained to ~ 8.6 cal. kyr BP. The geogenic signal is dominated by Fe and Si released via subglacial erosion of the underlying Neoproterozoic Rivieradal Group rocks, and low lipid biomarker and pigment concentrations demonstrate that lake productivity was limited upon deglaciation. Laminated sediments (LF2) denote a transition to a lake shortly after deglaciation. Increases in TOC and Uk<sub>37</sub> show an increase in spring air temperature as the lake evolved, but low pigment and n-alkanes concentrations suggest terrestrial productivity remained low. Based on increase in chironomid head capsule concentrations, the local Holocene Thermal Maximum occurs between 8.6 and 7.2 cal. kyr BP, with UK<sub>37</sub> calibrated air temperatures of up to 8.5°C and chironomid-derived air temperatures up to 6.3°C.

The development of an organic-rich gyttja (LF3a) corresponds to a fall in July air temperatures between ~ 7.2 – 6.4 cal. kyr BP, however, pigments, TOC and n-alkane concentrations point to increased Holocene lake productivity. This may be associated with higher spring temperatures, earlier melt of lake ice and lengthening the growing season. The uppermost sedimentary unit in the core (LF 3b) marks the onset of the Neoglacial. Between 5.6 and 3.9 cal. kyr BP air temperatures fell to 3.4°C; the lowest in this Holocene record and coincident with ice shelf regrowth in Nioghalvfjerdingsfjorden. From ~ 1.2 to 0.7 cal. kyr BP there is evidence for warming during the Medieval Climate Anomaly recorded by an increase in pigments, n-alkanes and chironomids. A final phase of lower atmospheric and lake temperatures between 0.7 and 0 cal. kyr BP coincides with the timing of the Little Ice Age maximum.

The environmental record in 2.3 Mile Lake shows broad phase relationships with insolation-controlled JJA summer air temperatures and sub-surface ocean temperatures. The NEGIS and 79N ice shelf responded to both during the Holocene Thermal Maximum and the lake records warm and cooler, productive phases of sedimentation. The advance of the 79N ice shelf in Nioghalvfjerdingsfjorden from 4.4 – 4.0 cal. kyr BP buffered 2.3 Mile Lake from influence of Return Atlantic Water, which was critical in the development of local peak, cold-phase conditions during the Neoglacial. However, the distinctive warm peak of the Medieval Climate Anomaly demonstrates that North Atlantic atmospheric circulation still impacted this High Arctic environment despite increased ice sheet proximity.

# A palaeo-reconstruction of 20<sup>th</sup> century ice shelf dynamics in northeast Greenland, through epishelf lake sediments

Jenkins, H.N<sup>\*1</sup>, Roberts, D.H<sup>1</sup>, Lloyd, J.M<sup>1</sup>, Smith, J.A<sup>2</sup>, Callard, L<sup>3</sup>, Bentley, M.J<sup>1</sup>.

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79°N (Nioghalvfjærdsbrae) is the largest marine terminating glacier in the northeast Greenland ice sheet (NEGIS). The NEGIS drains the northeast sector of the Greenland ice Sheet (GrIS) and contains approximately 1.2 m sea-level equivalent. Its future stability is pivotal not only to future mass balance of the GrIS but also the freshwater flux to the northeast Atlantic and specifically, to the North Atlantic Deep Water overturning circulation. Epishelf lakes are freshwater or stratified lakes that form along the margins of ice shelves, where the ice dams the mouth of a fjord or marginal embayment, either partially or wholly denying the inflow of marine water. Epishelf lake sediments hold the potential to record the presence and absence of an ice shelf through time and work as indicators for ice shelf loss. Palaeo records suggest that epishelf lake Blåsø has remained isolated from the marine system for the past 4,000. However, marine water has been detected below depths of 125 m in Blåsø's East basin in 2017. To understand the formation of this modern marine waterbody, we adopt a multiproxy approach in order to reconstruct recent changes to the 79°N ice shelf through three short sediment cores from epishelf lake Blåsø. Sediments were analysed using XRF (InBr, InSi and Mn/Fe), foraminifera, and  $\delta^{13}\text{C}$ , which act as indicators for the ungrounding of the ice shelf through the detection of inflowing marine water. Based on a  $^{210}\text{Pb}$  chronology, our reconstruction suggests that modern marine water first entered the East basin in 1950 and continued to develop and mix through the lake through to present day.

# New constraints on Late-glacial and Holocene ice-margin fluctuations in Scoresby Sund (Kangertittivaq), East-Central Greenland

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In the present work, we explore past glacier fluctuations in Scoresby Sund (Kangertittivaq; East-Central Greenland) based on marine sediment cores (PS1718-1 and PS1728-1), and multiple core-top samples, using sedimentological (sedimentary facies and grain-size analyses) and geochemical (XRF, bulk and clay mineralogy, and neodymium radiogenic isotopes) approaches. We identify three major sediment sources (1) the Tertiary basalts of the Geikie Plateau (smectite-rich; high  $\epsilon_{\text{Nd}}$  end-member), (2) the Caledonian basement of the inner fjord and Liverpool Land (chlorite/illite-rich; low  $\epsilon_{\text{Nd}}$  end-member), and (3) the Upper Paleozoic-Mesozoic sedimentary rocks of Jameson Land (kaolinite-rich; intermediate  $\epsilon_{\text{Nd}}$  end-member). These results, along with the sedimentary facies successions at PS1718-1 and PS1728-1, suggest that the ice-sheet margin was close to the site PS1718-1 (while covering site PS1728-1) during the Late glacial period (radiocarbon dating in progress). Subsequently, the grounding line retreated further west, and the study sites became located beneath an ice shelf, allowing fine, IRD-free laminated sediments to be deposited. During the Holocene Thermal Maximum, the glacier on the Geikie Plateau likely retreated to a landterminating position, whereas the subsequent neoglaciation saw a significant readvance to a marine-terminating position. These glacier fluctuations and associated glaciological constraints will be discussed in the light of coming chronological data and dinoflagellate cyst assemblages (work in progress), and from recently documented terrestrial moraine records (Anderson et al., 2025, <https://doi.org/10.5194/cp-21-2263-2025>).

# **A Massive Grounded Ice Shelf in Baffin Bay Buttressed the Greenland, Laurentide, and Inuitian Ice Sheets During the Last Glacial Maximum**

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Ice shelf buttressing plays a critical role in the stabilization of marine-terminating ice streams and promotes upstream ice thickening in continental scale ice sheets. The removal of ice shelves can trigger acceleration and thinning of grounded ice streams which can lead to rapid ice margin retreat and increases in global mean sea level. Here we synthesize geomorphic evidence for a ~1400–2000 m thick, northern fed, extensive Baffin Bay Ice Shelf (BBIS) that spanned the Canadian to Greenlandic margins, buttressing the Laurentide, Inuitian, and Greenland Ice Sheets around the end of the Last Glacial Maximum (LGM). The BBIS was delineated by a newly identified geomorphic boundary, that indicates the deepest extent of a paleo ice shelf, termed the Ice Contact Boundary (ICB). We identify the ICB encircling most of Baffin Bay, preserved in water up to 1800 m deep on the continental slope. The ice shelf, Antarctic-like in area (150,000 km<sup>2</sup>), would have stabilized and promoted thickening of the three adjacent ice sheets. Ice shelf collapse triggered rapid embayment-scale deglaciation and provides a processlevel mechanism linking glacial ice-shelf dynamics to abrupt Northern Hemisphere ice sheet instability.

# From Ice Shelf to Open Water: Holocene Cryosphere and Ecosystem Change in Melville Bay, NW Greenland

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Warming in the Arctic is driving the retreat of the Greenland Ice Sheet, glacier recession, and the loss of sea ice, increasing the delivery of meltwater to the ocean. One region receiving substantial meltwater discharge is the marine wildlife sanctuary Qimusseriarsuaq (Melville Bay) in northwest Greenland. To reconstruct past ice-sheet and glacier dynamics, sea-ice variability, and ecosystem responses, we applied a multi-proxy approach to a marine sediment core, that includes lipid biomarkers (highly branched isoprenoids (HBIs) and phytosterols), bulk biogeochemistry, and microfossil analyses. The record spans more than ~12.3 thousand years, capturing the deglaciation and Holocene epoch for the first time in this region. We identify the first direct sedimentary evidence of a former ice shelf, previously inferred only from seismic data. Following ice-shelf collapse, the region received high meltwater discharge relative to later periods, dynamic sea-ice conditions, and enhanced primary production from both sympagic and pelagic sources. From ~7.9 cal ka BP, we observe a shift toward more open-water conditions and a dominance of pelagic primary production, peaking between 5 and 3 cal ka BP when the ice sheet reached a minimum extent. Despite this shift in production sources, total primary productivity declined during the late Holocene, underscoring the important role of sympagic production in sustaining overall marine productivity in the region. Our findings highlight the sensitivity of Arctic primary productivity to ongoing cryosphere change.

## Oral Session 2

Tuesday 11:00 - 12:30

Conveners: Joseph Licciardi

- 11:00 **Darrell Kaufman** Holocene glacier expansions based on radiocarbon-dated ancient plants at retreating ice margins, Brooks Range, Arctic Alaska
- 11:15 **Aleksandra Osika** Holocene glacial history of southern Spitsbergen: known knowns and known unknowns
- 11:30 **Kristian Svennevig** Recent and past tsunamigenic landslides in Greenland and what they tell us about the impact of climate change
- 11:45 **ÍvarÖrn Benediktsson** The age and formation of the Skessugarður blocky end moraine, east Iceland
- 12:00 **Henrik Rasmussen** Storegga tsunami run-up reconstruction from the outer coast of Troms, northern Norway, including a 10 m surprise find
- 12:15 **Katrine Juul Andresen** Buried glacial landscapes in Kalø Bay, south-western Kattegat, Denmark

# Holocene glacier expansions based on radiocarbon-dated ancient plants at retreating ice margins, Brooks Range, Arctic Alaska

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One of the most direct methods for reconstructing episodes of past glacier expansion involves radiocarbon dating of tundra plants killed and entombed by expanding glaciers. These plants, preserved beneath glaciers for centuries to millennia, are now reemerging as ice retreats due to recent warming. Their radiocarbon ages precisely date the timing of past glacier advances beyond present-day margins. When combined across multiple glaciers, regional clusters of ages are interpreted as periods of sustained glacier growth on century scales. Although this approach has been widely applied across the North Atlantic Arctic, no comparable dataset exists from western North America. Here we report new radiocarbon ages from in-situ moss exposed at the margins of multiple retreating glaciers in the Brooks Range, Arctic Alaska — the first such dataset from western North America. Radiocarbon analyses are ongoing, and the latest available results will be presented. Preliminary findings based on 64 radiocarbon ages from multiple glaciers indicate that glacier growth began 9.1–8.5 cal ka, with a major increase in dated plant frequencies at  $5.0 \pm 0.2$  cal ka marking the onset of sustained Neoglacial expansion. These results place recent glacier recession in long-term context, indicating that current ice extent is smaller than at any time in the last 3–5 millennia. Once exposed, the fragile dead plants are vulnerable to removal by meltwater and other processes, or in some cases, the plants can spring back to life and thereby reset the radiocarbon content. This study underscores both the scientific significance and urgency of collecting these rapidly disappearing paleoclimate archives.

# Holocene glacial history of southern Spitsbergen: known knowns and known unknowns

Osika, A.<sup>1\*</sup>, Jania, J.<sup>1</sup>, Piotrowska, N.<sup>2</sup>, Tikhomirov, D.<sup>3</sup>, Szafraniec, J.E.<sup>1</sup>, Devendra, D.<sup>4</sup>, Christl, M.<sup>5</sup>, Egli, M.<sup>3</sup>, Vieli, A.<sup>3</sup>

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Climate warming is leading to the rapid recession of Svalbard glaciers, which has accelerated since the 1990s. Low-elevated, mostly tidewater glaciers of southern Spitsbergen are particularly sensitive to atmospheric warming and sea-surface temperature rise compared to the rest of Svalbard. Today, glaciers in southern Spitsbergen have one of the most negative mass balances in the archipelago, and their subglacial topography with extensive overdeepenings below sea level will promote further recession when the calving fronts retreat into deeper water. Reconstructing glacier fluctuations in the past is vital for predicting the consequences of ongoing climate warming of the Arctic. However, knowledge of Holocene glacier changes in southern Spitsbergen remains limited compared to that in well-investigated central, western and northern Svalbard.

Here, we reconstruct the Holocene fluctuations of selected glaciers around Hornsund (Hansbreen, Hornbreen, Werenskioldbreen, Vestre Torellbreen) combining geomorphological, geochronological and historical data. New and published <sup>14</sup>C ages of mollusc shells representing suspension-feeding species (*Mya truncata*, *Hiatella arctica*, *Astarte borealis*, *Chlamys islandica*) indicate glacier recession in the Early Holocene and during the Medieval Warm Period, which allowed colonization of new branches of Hornsund by benthic fauna. As a result, Hornsund was a strait between the Greenland Sea and the Barents Sea until glacier advances in the second half of the Late Holocene. Subsequent re-opening of the strait occurred around 1.5 cal ka BP until glacier advances c. 0.7 ± 0.3 ka. The ages of molluscs suggest that glacier extents in the first half of the Late Holocene were reduced compared to their Little Ice Age maxima. Geomorphological data and historical photographs from Spitsbergen expeditions in 1872 and 1918 indicate that the maximum extents in the Little Ice Age directly corresponded to glacier surges, preceded by mass accumulation due to climate cooling. Hence, glacier fluctuations in southern Spitsbergen reflect both climatic changes and their dynamics, including surges.

# Recent and past tsunamigenic landslides in Greenland and what they tell us about the impact of climate change

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In June 2017, a catastrophic rock avalanche in Greenland's Karrat Fjord triggered a tsunami that devastated a nearby village, destroying 11 houses and resulting in four fatalities (Gauthier et al. 2018; Svennevig et al. 2020). This disaster underscored a significant knowledge gap regarding tsunamigenic landslide hazards in Greenland and the broader Arctic, prompting a focused risk assessment (2018-2022) led by the Geological Survey of Denmark and Greenland (GEUS).

As part of this work nine recent (post-1952), large-scale ( $>2 \times 10^6$  m<sup>3</sup>) landslides were analysed across Greenland (Svennevig et al. 2020, 2022, 2023, 2024a, 2025). These investigations revealed a consistent pattern of climate-driven preconditioning: four landslides can be linked to permafrost degradation, three others likely to relate to similar processes, and two events correlate with glacial thinning and debuitressing. All these processes are ultimately linked to Arctic warming. Despite the relatively small dataset, these events collectively indicate an acceleration of landslide activity, supported by the absence of visible fresh landslides in the earliest systematic photographic record from 1949.

Furthermore, the identification of several giga-scale ( $>1$  km<sup>3</sup>) post-glacial ( $<11$  ka BP) landslide deposits in central West Greenland (Svennevig et al. 2024b) and South Greenland (Pedersen et al. 2026) and early Holocene deposits of giant landslide tsunamis with up to 70 m runup found in central West Greenland (Korsgaard et al. 2024) hints at the potential for even larger future events under ongoing climate warming scenarios.

Across the Arctic and high alpine areas multiple similar cases of past and historic landslides highlights that this is not a problem confined to Greenland but of relevance to everywhere where the cryosphere is degrading (e.g. Shugar et al. 2021, 2026; Kuhn et al. 2025).

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Korsgaard NJ, Svennevig K, Søndergaard AS, et al (2024) Evidence of Middle Holocene landslide-generated tsunamis recorded in lake sediments from Saqqaq, West Greenland. *Nat Hazards Earth Syst Sci* 24:757–772. <https://doi.org/10.5194/nhess-24-757-2024>

Kuhn D, Hermanns RL, Fuchs M, et al (2025) Warming-induced destabilization of polar coastal rock cliffs and the role of thermokarst: A case study of Forkastningsfjellet on Svalbard. *Sci Total Environ* 968:178807. <https://doi.org/10.1016/j.scitotenv.2025.178807>

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Shugar DH, Jacquemart M, Shean D, et al (2021) A massive rock and ice avalanche caused the 2021 disaster at Chamoli, Indian Himalaya. *Science* 373:300–306. <https://doi.org/10.1126/science.abh4455>

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- Svennevig K, Hicks SP, Forbriger T, et al (2024a) A rockslide-generated tsunami in a Greenland fjord rang Earth for 9 days. *Science* 385:1196–1205. <https://doi.org/10.1126/science.adm9247>
- Svennevig K, Keiding M, Korsgaard NJ, et al (2023) Uncovering a 70-year-old permafrost degradation induced disaster in the Arctic, the 1952 Niiortuut landslide-tsunami in central West Greenland. *Sci Total Environ* 859:11. <https://doi.org/10.1016/j.scitotenv.2022.160110>
- Svennevig K, Keiding M, Sørensen EV, et al (2025) Two similar permafrost degradation landslides at Paatuut, West Greenland, caused tsunamis of substantially different magnitudes. *Landslides*. <https://doi.org/10.1007/s10346-02402439-x>
- Svennevig K, Owen MJ, Citterio M, et al (2024b) Holocene gigascale rock avalanches in Vaigat strait, West Greenland— Implications for geohazard. *Geology*. <https://doi.org/10.1130/G51234.1>

# The age and formation of the Skessugarður blocky end moraine, east Iceland

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The Skessugarður end moraine is located in the highlands of eastern Iceland in the middle of a palaeo-ice stream flow-set that extends from the interior highlands north of the present Vatnajökull ice cap towards the coast in Vopnafjörður. The total length of the moraine is 1.8 km across a north-south orientated streamlined bedrock hill. It can be traced across sediment/lake filled depressions to the east and west, giving this ice-marginal position a total length of *c.* 4 km. A 600-m long segment of the moraine is unique in that it consists almost entirely of boulders. Here, the moraine ridge is around 7-m high and 10-m wide with a slightly steeper up-ice slope. Boulders are abundant on the bedrock hill, though seemingly less inside the moraine. The aims of this study are twofold: 1) to provide an age of the moraine with <sup>36</sup>Cl cosmogenic exposure dating, and 2) examine clast morphology within the moraine to shed light on its mechanism of formation and glacial processes operating during the deglaciation of the Iceland Ice Sheet. Four preliminary <sup>36</sup>Cl exposure ages cluster remarkably well with an average of 11.1±0.1 ka BP, indicating a substantial readvance during an overall recession of the Iceland Ice Sheet from its Younger Dryas and Preboreal positions. The clast morphological analysis involved measuring the a-, b-, and c-axis of boulders within as well as inside and outside the moraine both in the field and, for comparison, on a high-resolution DEM built from drone images. The comparison indicates that the high-resolution DEM can be used for analyzing the morphology of stacked boulders that are well exposed within the moraine. In contrast, this method shall be used with caution where boulders are partly buried inside and outside the moraine. A working hypothesis of the mechanism of formation involves initial hydraulic jacking of blocks from the bedrock, subsequent glacial ripping of the loose blocks and downglacier transport, and finally deposition at the ice margin.

# **Storegga tsunami run-up reconstruction from the outer coast of Troms, northern Norway, including a 10 m surprise find**

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The Storegga Tsunami, triggered off of the Norwegian shelf some  $8140 \pm 55$  years ago, left deposits identified at coastal sites around the North Sea and Norwegian Sea, including Denmark in the SE, Scotland in the SW, Greenland in the NW and Russia in the NE. Precise vertical run-up heights of prehistoric tsunami are notoriously difficult to determine, and model estimates of tsunami run-up, versus field-study-based reconstructions of the tsunami sediment run-up, often differ by metres. Here we present a detailed study of local Storegga tsunami sediment run-up.

During recent studies of Holocene sea-level changes in NW-Troms, Northern Norway, we have reconstructed the development from the Early Holocene regression minimum, sea-level lowstand, to the Early-Mid Holocene Transgression (EMHT) maximum, sea-level high-stand, ca. 7600 a. BP. From these reconstructions, we can interpolate the regional shoreline contemporaneous to the Storegga tsunami. This then forms our baseline from which minimum run-up heights can be calculated.

By coring 6 sites within a ca. 190x55 m elongated basin in Rakkfjorden on Kvaløya, an island forming the outer coast west of the town of Tromsø, we found a laterally tapering out, normal graded bed of gravel-silt, resting on an erosional unconformity, cut into shallow marine sandy, clay-silt. Terrestrial plant leaves and seeds from 2-10 cm above the gravel bed were radiocarbon dated to  $7770 \pm 45$  a BP. These are all characteristics of Storegga tsunami deposits. The basin is located on a bedrock saddle between an enclosed bay and a sound towards the open ocean. The surprising find is that the gravel-silt bed tapers and fines towards the open ocean, not inland towards the bay. Thus, the closed-end bay must have been brimful when the highest tsunami wave hit, to the point of spilling over the bay-end threshold into our studied basin, yet potential tsunami run-up over the ocean-end threshold seemingly left no sediments within the basin.

Probing the now peat covered thresholds in both ends of the basin, we found the ocean-end threshold to be ca. 50 cm higher than that of the bay-end, at  $20.85 \pm 0.15$  and  $20.35 \pm 0.15$  m a.s.l., respectively. From a neighbouring isolation basin, which was in a phase of basin ingression during the EMHT when the Storegga tsunami struck, we have reconstructed the sea-level at Storegga tsunami time to  $11 \pm 0.15$  m a.s.l. The local minimum sediment run-up must therefore have been  $9.35 \pm 0.3$  m, plus the tidal range uncertainty, at present  $\pm 0.96$  m, MHWS-MLWS. Reconstructions from sedimentary basins in a mid-fjord setting in Sørleangen, Lyngen some 40 km further E, show sediment run-up of 6-7 m. The local erosion and deposition of gravels into the outer coastal basin in Rakkfjorden, indicate that true Storegga tsunami run-up into the bay-end of the basin exceeded 10 m.

# Buried glacial landscapes in Kalø Bay, south-western Kattegat, Denmark

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Formerly glaciated areas such as the northern European continental margin represent important geological archives for studying glacial processes. Glacial landforms and morphologies formed under the influence of past ice sheets can be studied using high-resolution geophysical data combined with geotechnical and geological borehole information. In present-day shallow water marine settings, such as the North Sea region and the inner Danish waters, the glacial landscapes from the last glaciation are often buried below a deglaciation and post-glacial succession reflecting the gradually flooding of the areas during the Holocene Transgression. The burial and flooding mean that the geological record of the glacial and deglaciation processes in some cases is well-preserved and available for imaging in high detail by marine shallow seismic methods such as subbottom profiling.

Kalø Bay is a coastal embayment in the south-western Kattegat, in the northernmost Aarhus Bay region in Denmark. This shallow embayment was influenced by sea-level changes governed by global sea-level rise and glacio-isostatic rebound from the Scandinavian Ice Sheet during the latest Pleistocene and Holocene. Due to the bay's sheltered position, former glacial features are preserved in the bay showing evidence of subglacial, ice-marginal and proglacial depositional and erosional processes.

Observations of a depositional succession with glacio-lacustrine deposits occurring below recessional moraines and eskers suggest that the bay comprised a proglacial lake, which was later overridden by the Young Baltic Ice Advance at around 17 ka BP. During ice retreat, recessional moraines and eskers formed in the central parts of the bay. The deglaciation sequence in the bay is limited and constrained to thin glacio-fluvial deposits in the deepest parts of the bay. When the sea inundated the bay at around 9-8.5 kyrs BP, coastal features including migrating bars and wave-ravinement surfaces formed in the deeper parts of the bay, while lacustrine and terrestrial settings prevailed in the shallower inner parts of the bay. With continued sea-level rise, the bay became fully submerged with maximum relative sea-level at around 6 kyrs BP. The deposits in the bay reversed to more coastal facies during a relative sealevel fall in the Mid- and Late Holocene.

The study highlights the potential of studying glacial landforms and processes in present day shallow marine environments and demonstrates how well-preserved glacial morphologies can help elucidate glacial dynamics and in turn improve our knowledge of geological processes in formerly glaciated margins. Furthermore, the study highlights how former glacial landscapes and coastal deposits are differently affected by sea-level rise in terms of erosion and preservation. This is important for understanding impacts of future accelerating sea-level rise, assessing geoarchaeological potential and offshore aggregate distribution, and for identifying geotechnical challenges on offshore constructions such as wind farms.

### Oral Session 3

Thursday 09:00 - 10:30

Conveners: Wesley Farnsworth & tbd

- 09:00 **Jochen Knies**      Antarctification of Greenland ice sheet following the Mid Pleistocene Transition
- 09:15 **Chris Larson**      Meteoric beryllium-10 in Camp Century subglacial sediment suggests the ice sheet was absent from NW Greenland for at least 8000 years during MIS 11
- 09:30 **Caroline Brand**      Quantifying Quaternary Glacial Sediment Deposits Associated with Erosion by the Greenland Ice Sheet
- 09:45 **Frances Butcher**      A new 25-stage reconstruction of the flow pattern evolution of the Scandinavian Ice Sheet based on the subglacial lineation record.
- 10:00 **Lasse Tésik Prins**      Last Glacial Maximum ice extent in the western Danish North Sea – landscape development and glacial tectonics
- 10:15 **Mark Furze**      Revised Holocene Emergence Histories in Isfjorden, Svalbard

# ***Antarctification of Greenland ice sheet following the Mid Pleistocene Transition***

Knies, J.<sup>1,2\*</sup>, Patton, H.<sup>1</sup>, Lyså, A.<sup>2</sup>, Nowaczyk, N.<sup>3</sup>, Gebhardt, C.<sup>4</sup>, de Schepper, S.<sup>5,6</sup>, Giertzuch, P.-L.<sup>1</sup>, Vogt, C.<sup>7</sup>, and the i2B Arctic Ocean Expedition 2025 Scientific Party

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Determining the full geometry of Northern Hemisphere ice sheets during the Quaternary remains a fundamental unresolved problem in Earth history. Here, we present marine geophysical and sedimentological evidence showing that the Greenland ice sheet advanced beyond its modern continental shelf during the Pleistocene. Ice-shelf moraines identified on Morris Jesup Rise at ~800 m water depth formed within an extensive North American glacial complex fed by fast-flowing ice streams. Sediment core records indicate that a grounding-line advance past the shelf break occurred at least twice within the last 750,000 years and was probably restricted to peak glacial conditions during Marine Isotope Stage 16 (MIS) (~620,000 years ago) and MIS 12 (~420,000 years ago). Collectively, these results substantiate the presence of a Laurentide–Greenland ice sheet larger than today following the Mid-Pleistocene Transition (MPT) and demonstrate that it expanded sufficiently to generate an ice shelf reaching into the central Arctic Ocean, implying an Antarctic-like configuration of Greenland under extreme glacial climates.

# Meteoric beryllium-10 in Camp Century subglacial sediment suggests the ice sheet was absent from NW Greenland for at least 8000 years during MIS 11

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In 1966, US Army drillers recovered 3.44 meters of subglacial material from below 1.35 km of ice at Camp Century, Greenland. The upper material was last exposed to sunlight 416 ± 38 ka, during MIS 11, a long-lasting interglacial characterized by temperatures similar to the present. The duration of this ice-free period at Camp Century is not known but is important for understanding the cryospheric impacts of a warming climate. Here, we use the inventory of meteoric beryllium-10 (<sup>10</sup>Be<sub>met</sub>), an atmospherically produced cosmogenic nuclide that binds to the surface of sediment grains, as an exposure chronometer. We measured <sup>10</sup>Be<sub>met</sub> in 63-125 μm grains from 23 samples of Camp Century subglacial sediment to estimate better the duration of interglacial exposure. <sup>10</sup>Be<sub>met</sub> concentrations range from 0.2-4.5 × 10<sup>7</sup> atoms g<sup>-1</sup>. Concentrations in the deepest samples, weathered till deposited between 1.8 and 3.2 Ma, are low and uniform. Sediment in the ice-rich layer above the till contains the highest concentration of <sup>10</sup>Be<sub>met</sub>; however, this material may not have originated from the till below and may be of aeolian origin. Based on geochemical similarities, we assume that water-lain sediment above the ice layer was reworked from the till below. We use the decay-corrected (416 ka) concentrations in the till to correct for inherited <sup>10</sup>Be<sub>met</sub> concentrations in the upper samples at the time of deposition. Using the Eemian (MIS 5e) interglacial delivery rate of <sup>10</sup>Be<sub>met</sub> (4.2 × 10<sup>5</sup> atoms cm<sup>-2</sup> yr<sup>-1</sup>) from the NEEM ice core, and assuming full <sup>10</sup>Be<sub>met</sub> retention and no erosion, we compute the <sup>10</sup>Be<sub>met</sub> inventory (3.4 × 10<sup>9</sup> atoms cm<sup>-2</sup>) in the water-lain sediment section of the core and calculate that Camp Century was exposed for at least 8000 years during MIS 11. Such a long period of exposure during an interglacial with warmth similar to that experienced today suggests that the Greenland Ice Sheet was not stable during MIS 11, making it vulnerable to melt in the context of current and future warming.

# Quantifying Quaternary Glacial Sediment Deposits Associated with Erosion by the Greenland Ice Sheet

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Glacially derived, marine sediments preserve a record of the timing, extent, and dynamics of shelf glaciation. In addition, these deposits can provide constraints on glacial erosion rates and offer insights into landscape evolution. However, erosion and deposition patterns of large ice sheet such as the Greenland Ice Sheet are poorly constrained on million-year time scales, with implications for our understanding of long-term landscape evolution in the region. To address this, we present a first quantification of Quaternary glacial sediment thicknesses around Greenland based on interpretations of available marine seismic data with age constraints where scientific boreholes are available. As the seismic surveys do not cover the whole Greenlandic continental margin, we use an artificial neural network to predict Quaternary sediment thicknesses in areas with little to no data. This approach allows us to obtain a glacial sediment thickness map, thereby constraining the total volumes of glacial deposition. Our estimates reveal regional variations in glacial deposition volumes and sediment thicknesses around Greenland. On the southern and parts of the northern Greenlandic continental slope, Quaternary sediments are thin, whereas in west and east Greenland, larger sediment deposits have led to a greater shelf progradation throughout the Quaternary. These patterns demonstrate a diverse influence of (paleo-)climatic, oceanographic, and orographic processes on glacial dynamics and the source-to-sink sediment transport. Finally, we compare our estimates of Quaternary offshore deposition with estimates of onshore glacial erosion inferred from paleo-topographic reconstructions and erosion potentials of the present ice sheet, based on ice sliding velocities. This provides insights into the temporal and spatial variability of erosion around Greenland, advancing our understanding of the long-term landscape evolution in glaciated regions.

# **A new 25-stage reconstruction of the flow pattern evolution of the Scandinavian Ice Sheet based on the subglacial lineation record.**

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The Scandinavian Ice Sheet (SIS) reached its maximum extent over Fennoscandia and NW Europe ~21 000–20 000 years ago, forming the largest component of the Eurasian Ice Sheet Complex along with the British-Irish and Barents-Kara ice sheets. We present a new 25-stage reconstruction of changing ice flow directions of the SIS based on systematic mapping of ~240000 subglacial bedforms (including drumlins, mega-scale glacial lineations, crag-and-tails, and roche moutonnées) across Norway, Sweden, Finland, and parts of NW Russia. Such empirical reconstructions provide valuable insights into how ice sheets evolve over time and adjust their internal dynamics in response to climate changes.

Of the 25 stages in our reconstruction, 23 depict ice-flow evolution during advance and retreat of the SIS through Marine Isotope Stage (MIS) 2. Two additional stages likely represent flow patterns of an earlier ice sheet (potentially MIS 4 or older). Our reconstruction was enabled by the recent revolution in the availability of high-resolution (1–2 m) digital terrain models. It is based on 611 flowsets which summarise discrete ice-flow patterns recorded by subglacial lineations, and are individually categorised by their glaciodynamic contexts. The reconstruction honours the relative-age chronology of flowsets indicated by cross-cutting relationships of the subglacial lineations.

We reconstruct the changing ice-sheet flow patterns and the migration of ice divides starting with ice-sheet inception, through advance and subsequent deglaciation, and ultimately the fragmentation into independent ice masses. The primary ice divide migrated up to 500 km and developed a branched configuration during deglaciation. The reconstruction of SIS flow patterns we present is the most detailed and comprehensive to date, and the fact that we independently verify many properties of the ice sheet invoked by earlier workers is testament to the quality, rigour, and enduring legacies of those studies.

Alongside our reconstruction, we have released the flowsets, relative chronology, and flowpattern data along with a dataset of ~58000 lineation linkages which summarise our detailed landform mapping and were invaluable for reconstructing ice-flow patterns at the ice-sheetscale. In releasing these data, we intend for them to serve as useful inputs or comparative data for future studies in palaeoglaciology. This includes, for example, approaches combining flow pattern information with numerical ice sheet modelling to improve representations of ice sheet behaviour. Such improvements should yield increased robustness of information on timevarying glacio-isostatic loading by the ice sheet, relevant for sea-level forecasting. Our datasets also have wide utility for applications beyond palaeoglaciology, such as for mineral exploration.

The next stages of our analyses are now underway; integrating our flowsets with others across the wider ice sheet domain, and combining them with ice marginal landforms and dates to yield a fully integrated reconstruction of ice sheet growth and decay.

# **Last Glacial Maximum ice extent in the western Danish North Sea – landscape development and glacial tectonics**

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The Weichselian ice sheet extent has been described and discussed in detail for the onshore areas of northern Europe. For the Danish area, the North Sea area has never been described in the same detail. With offshore wind on the rise and moving to deeper waters, understanding the shallow subsurface and the lithological and geological variations in the Danish North Sea has become more important than ever. The Last Glacial Maximum (LGM) ice extent and the associated geological processes are the main focus of this work

Regional high resolution seismic mapping combined with conventional and high-resolution vintage seismic data has revealed glaciotectonic thrusting in glacio-lacustrine deposits in the western part of the Danish North Sea, indicating NNW-SSE ice flow direction. During ice advance a large proglacial lake formed and the glaciolacustrine sediments were subsequently deformed by the ice sheet.

During deglaciation, the ice sheet had at least three readvances or periods of stagnation indicated by troughs that grow progressively younger towards the north.

The drainage of the glacial lake is recorded in the sediments as erosional channels, which appear to drain through a prominent landscape feature known as the Elbe Palaeo valley.

This study presents the landscape development in the area from the LGM to the Early Holocene.

# Revised Holocene Emergence Histories in Isfjorden, Svalbard

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Determining the complex pattern of crustal rebound and glacioisostatic sea level change in formerly glaciated areas is vital for understanding the extent, thickness, and duration of former ice sheets and reconstructing ice sheet dynamics in response to external and internal forcing mechanisms. However, despite close to a century of work, the deglacial to postglacial sea level history of Isfjorden, a major 100 km long and 20 km wide fjord in the Svalbard archipelago, has hitherto remained poorly constrained. Whilst Twentieth Century researchers such as Rolf Feyling-Hanssen, Otto Salvigsen, and Troy Péwé, made significant advances in clarifying the glacioisostatically-driven pattern of emergence, historic sea level curves were often based on limited numbers of uncalibrated sea level index points (SLIPs; dated elevations of estimated former sea level), poor elevational control, and assumed histories of Holocene emergence imported from mainland Norway. The application of affordable modern dating methods, detailed altimetry, and digital elevation models from UAV surveys permits the development of high-resolution emergence curves, facilitating a more nuanced picture of Postglacial crustal rebound and challenging earlier interpretations of Holocene sea level change.

Ongoing work on the low coastal forelands of Erdmannflya (central Isfjorden) and Blomesletta/Kapp Wijk (Nordfjorden, inner Isfjorden) has enabled us to reassess marine limit (the highest deglacial shoreline) and the pattern and timing of Late Weichselian – Holocene sea level change in Isfjorden. Notably, our evidence suggests deglaciation earlier and under higher sea levels than previously described, especially in the central Isfjorden area. Importantly, we also show no evidence for the putative Talavera Transgression, a proposed Mid Holocene transgressive episode described by previous researchers for various coasts in Svalbard. The re-investigation of a stratigraphic site on Erdmannflya, perhaps the best documented sedimentary sequence assigned to the Talavera Transgression, shows no transgressive facies, but rather the progression of a coastal spit/tombolo system under regressive conditions. Additionally, we identify prominent relict cliff lines, common around Isfjorden, that have previously been assigned to a Mid Holocene transgression or still-stand, as predating the Last Glacial Maximum and that can potentially be assigned to the Eemian Interglacial.

Together, our developing work, along with recent high-resolution beach ridge studies from Bjonahamna (Tempelfjorden, inner Isfjorden; Strzelecki et al., 2026), shows that the coastal lowlands of Svalbard represent important archives of sea level data necessitating detailed nuanced analyses to challenge previously held assumptions of High Arctic deglacial-postglacial shoreline history. Their continuing expanded investigation promises to add further to our understanding of isostatic readjustment across Svalbard and help advance our understanding of glaciation and ice retreat across complex archipelago settings.

## Oral Session 4

Thursday 11:00 - 12:30

Conveners: Anna Pieńkowski & tbd

- 11:00 **Henning A. Bauch** Subsurface Injections of Warm Atlantic Waters into the Subarctic North Atlantic During Major Deglaciations
- 11:15 **Giulia Amaglio** Tracing Arctic Atlantification from the Little Ice Age to the present day in the Barents and Fram Strait: insights from biomarkers
- 11:30 **Anne de Vernal** Palynological records from the Southern Lomonosov Ridge document late Pleistocene to Holocene paleoclimates in the eastern Arctic
- 11:45 **Laura Bronzo** A 24-kyr multiproxy record of ocean-ice interactions off western Svalbard: insights from phytoplankton communities
- 12:00 **Mahima Pai** A Multi-Proxy Approach to Reconstructing Glaciomarine and Oceanographic Change in Hornsund, Svalbard
- 12:15 **Christoph Vogt** Central Arctic Ocean sediment records: Carbonate minerals, the importance of detrital, diagenetic, authigenic and biogenic origin

# Subsurface Injections of Warm Atlantic Waters into the Subarctic North Atlantic During Major Deglaciations

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It has been a common narrative in paleoclimate studies over the past decades that the demise of major glaciations was usually accompanied by notable climatic “hiccups”. These were triggered by the release of large amounts of meltwater into the North Atlantic Ocean - from thawing icebergs and decaying ice-sheets - thereby disturbing or even shutting down the arctic-directed transfer of surface ocean heat (so-called AMOC). We have studied in detail Termination 2 which followed upon the penultimate glacial maximum (PGM) of the Saalian.

Like during the last deglaciation, which is known for HS1 and its disruption on AMOC, early Termination 2 is accompanied by HS11 in the North Atlantic, an event generally considered far more affective on AMOC activity. Using census data from planktic foraminifer as well as dinoflagellate cysts respectively we can show that in the Nordic Seas the time after the PGM differed considerably from Termination 1. The planktic data, including stable O/C isotope results, reveal that Atlantic water was widespread in the Nordic Seas, however not necessarily nearer to the ocean surface but rather at greater depth. Furthermore, there is supporting evidence from upstream in the subpolar gyre that a large body of Atlantic water must have migrated northward during the penultimate deglaciation. We thus conclude that injections of these warm Atlantic waters entered the Nordic Seas at the subsurface during times of massive meltwater presence at the ocean surface. This process kept AMOC functioning rather than shutting it down.

# Tracing Arctic Atlantification from the Little Ice Age to the present day in the Barents and Fram Strait: insights from biomarkers

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Understanding the loss of sea-ice in pre- and early-industrial times through natural archives is essential to provide a longer-term perspective in the Arctic Ocean. In this study, we analysed high-resolution sediment cores from the Barents and Fram Strait. The cores were collected along the present-day winter sea-ice margin identified by satellite observations to reconstruct sea-ice variability over the past 300 years. Specifically, Highly Branched Isoprenoides (HBIs) and alkenones, proxies produced by diatoms and open-water coccolithophores, respectively, were used to trace the Atlantification of the Arctic Ocean focusing on sea-ice cover and temperature variability.

We integrated published data with new evidence to generate a regional dataset that constrains the timing of sea-ice retreat and temperature changes following the end of the Little Ice Age (LIA) and the onset of Industrial Revolution.

Preliminary results indicate significant changes in water masses prior to the 20<sup>th</sup> century, characterized by a warming trend of surface ocean waters associated with sea-ice retreat in the Fram Strait and Barents Sea. This poleward intensification of warm, salty Atlantic waters may reflect a rapid hydrographic reorganization following the end of the LIA when extensive seaice cover was present.

Sea-ice data obtained in this study were compared with Coupled Model Intercomparison Project Phase 6 (CMIP6) simulations to gain insights about the mechanisms driving the reconstructed sea-ice evolution and the robustness of their representation in current climate models.

# Palynological records from the Southern Lomonosov Ridge document late Pleistocene to Holocene paleoclimates in the eastern Arctic

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The palynological analyses of four deep-sea cores collected northward from the Laptev Sea shelf edge, at 79.91°N (SWR-31) to 83.8°N (PS2757, PS87-79 and PS87-70) provide information on pelagic fluxes (dinocysts) and terrestrial inputs from land vegetation (pollen and spores), freshwater runoff (e.g., *Pediastrum*), and erosion (reworked pre-Quaternary palynomorphs). The results show a decrease in palynological concentrations toward the north, indicating low offshore fluxes, where perennial sea ice restricts biogenic inputs. Higher sedimentation rates are also recorded close to the shelf edge, with about 2.5 meters of Holocene sediments in SWR-31 vs. 30 cm in PS87-70. The 4 records reveal particularly rich dinocyst concentrations in the early-middle Holocene and a drop to almost nil values in the late Holocene, likely due to perennial sea ice cover.

Lower in the sequences, very sparse palynological content is observed, especially at offshore sites, suggesting a predominance of perennial sea ice during the middle and late Pleistocene. Nevertheless, a marked dinocyst peak between 7 and 8 m in SWR-31, more tenuous at 2-3 m in PS2757, 1.5-2 m in PS87-79 and 1.2-1.5 m in PS87-70, suggests an episode of seasonal sea ice opening, with a gradient of decreasing pelagic fluxes and sedimentation rates in general, from the shelf edge to the North. This interval is tentatively correlated to core PS2138 from the shelf edge of NE Svalbard (Matthiessen et al., GPC 2001), in which a dinocyst assemblage similar to that of SWR-31 (with *O. centrocarpum*, *S. elongatus*, *B. tepikiense*) is assigned to MIS 5e based on  $d^{18}O$  stratigraphy in *N. pachyderma*. This interval could thus correspond to the last interglacial, characterized by relatively warm, seasonally sea-ice-free conditions near the shelf edge in the eastern Arctic.

In the lower part of core PS87-70 and PS2757, at 5.4-6 m and 6.2-7 m, respectively, a layer containing high concentrations of terrestrial input stands out. The pollen-rich assemblages indicate input from forest tundra vegetation, while abundant reworked palynomorphs reflect erosion of old sedimentary outcrops. This layer probably corresponds to a phase of erosion, during or, more likely, following an interglacial, characterized by dense vegetation in the surrounding lands. Based on  $^{230}Th$  data, this interval could tentatively be attributed to the transition from MIS 11 to 10.

# A 24-kyr multiproxy record of ocean-ice interactions off western Svalbard: insights from phytoplankton communities

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Influenced by Arctic and North Atlantic water masses, the western Svalbard margin is a key sentinel for climate change. Its sedimentary archives preserve evidence of past ocean current variations and the dynamics of the paleo-Svalbard Barents Sea Ice Sheet (SBSIS). Here, we present a multiproxy, high-resolution investigation of the 487 cm long *Calypso* piston core LBIRIDYA-02PC, recovered from the Bellsund Drift crest (1725 m depth) during the PRA2021IRIDYA expedition. This core provides a continuous sedimentary archive spanning the past 24 kyr, from the final part of the Last Glacial Period to the Holocene. Integrated analyses of calcareous nannofossils, biomarkers (alkenones, *n*-alkanes, highly branched isoprenoids - HBI), and XRF-derived geochemistry allow us to reconstruct oceanographic conditions, sea-ice dynamics, and phytoplankton community responses.

The sedimentary record indicates a series of meltwater events from the end of the Last Glacial Maximum through the deglaciation. The presence of an active coastal polynya off western Spitsbergen during the late Last Glacial Period, sustained by katabatic winds and water-mass instabilities, likely played a key role in modulating the regional expression of the Heinrich 2 (H2) event. By promoting the upwelling of subsurface warm Atlantic waters, this polynya also favored the occurrence of phytoplankton communities throughout the Late Glacial as attested by the concentrations of total alkenones and by overall calcareous nannofossil abundances.

At the onset of deglaciation (c.a. 20 kyr BP), the progressive decay of the SBSIS and associated meltwater release are recorded by distinct peaks in the alkenones %MeC<sub>37:4</sub> and %EtC<sub>38:4</sub>, alongside lithostratigraphic evidence like interlaminated layers and ice-rafted debris-rich intervals. These inputs, particularly pronounced during H1 and Meltwater Pulse 1A, likely triggered blooms of marginal ice zone diatoms, as indicated by elevated concentrations of HBI III and HBI IV. Concurrently, these conditions favored the proliferation of the coccolithophore *Emiliana huxleyi* (>4 μm).

With the Holocene onset, sustained retreat of the sea-ice margin and reduced sea-ice thickness and extent occurred along the margin. This shift led to increased coccolithophore populations and high total alkenone concentrations, likely reflecting strengthened Atlantic Water advection. During this interval, the dominant coccolithophore species included *E. huxleyi* (<4μm) and *Coccolithus pelagicus* subsp. *pelagicus*. The latter reached maximum abundance during the mid-Holocene, probably when cool Arctic waters carried by the East Spitsbergen Current were most vigorous.

By integrating biological and micropaleontological proxies, this study offers a comprehensive perspective on how major climatic episodes influenced surface-water conditions and modulated phytoplankton community composition and productivity throughout the Last Glacial-Interglacial transition.



# A Multi-Proxy Approach to Reconstructing Glaciomarine and Oceanographic Change in Hornsund, Svalbard

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High-resolution studies of climate variability are essential in cold and temperate regions. Fjords are one such environments. They serve as ideal archives of past conditions because of their rapid sediment accumulation rates and fine glaciomarine clays that effectively preserve a diverse range of climatic and oceanographic proxies. This study presents a comprehensive, multi-proxy paleoclimatic reconstruction of Hornsund Fjord, Svalbard, for the past 1700 years focusing on the environmental shifts across the Dark Ages Cold Period (DACP), the Medieval Warm Period (MWP), and the Little Ice Age (LIA).

By integrating fossil foraminiferal assemblages with geochemical data such as elemental ratios (Fe/Ca, Ti/Ca, and Zr/Rb), Ice-Rafted Debris (IRD) fluxes, carbon data (Organic Carbon concentrations), grainsize analysis and stable isotopes ( $\delta^{13}\text{C}$  and  $\delta^{18}\text{O}$ ) from foraminifera tests, we characterize the interplay between climatic forcing and benthic ecosystem dynamics. Our results highlight a clear shift in marine conditions. The MWP indicates consistent Atlantic Water inflow, reduced sea-ice cover, and increased productivity and biodiversity. An increased Atlantic Water (AW) inflow was observed just before the beginning of LIA, supporting the theory that AW partially contributed to the LIA in the Nordic Seas region. The transition into the LIA reveals expanding glaciers as evidenced by the dominance of cold-water, glacioproximal foraminifera like *Criboelphidium clavatum* and *Cassidulina reniformis*.

This research demonstrates how multi-proxy integration resolves the sensitivity of specific indicators to glaciomarine shifts. By differentiating regional variability, we offer a robust framework for interpreting environmental change in high-latitude fjord systems. To further enrich the record, results from *sedaDNA* analysis will be used. These findings are essential for future paleo-reconstructions, providing a vital baseline for understanding how rapidly changing Arctic environments respond to climate change.

This research is supported by National Science Centre of Poland grant no 2024/53/B/ST10/02821

# Central Arctic Ocean sediment records: Carbonate minerals, the importance of detrital, diagenetic, authigenic and biogenic origin

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Carbonate minerals in central Arctic Ocean sediments are of vital sedimentological and stratigraphical use. While elemental analysis (in particular the often used XRF Scanning) can only determine Ca contents, the mineralogical investigation can differentiate between aragonite, calcite, Mg-rich calcite, dolomite, ankerite, siderite and rarer phases like ikaite. Therefore, a basic elemental Ca or CaCO<sub>3</sub> record can be interpreted in more detail. Here, we will illustrate the use of different carbonate minerals in many sediment cores of the central Arctic Ocean as stratigraphic tracer, indicator for early changes in the sediment, tracer of biogenic input aka microorganism shells and how we can differentiate between these processes. First results from the i2B 2025 research cruise shall be included.

## Oral Session 5

Friday 09:00 - 10:30

Conveners: Karen Gariboldi & Julie Lattaud

- 09:00 **Kasia Śliwińska** Defining states and variability of the terrestrial cryosphere of the Greenland Ice Sheet by marine-ice core integration: Past-to-Future (P2F) project contribution
- 09:15 **Meri Mäkelä** Dinoflagellate cyst as indicators of sea-ice conditions: Implications of machine learning techniques and regional surface sediment dataset
- 09:30 **Sami Cargill** Regional Paleomagnetic-Lithostratigraphic Framework for the Last 50kyr in Northeast Baffin Bay
- 09:45 **Megh Kanvinde** Extending the central Arctic “Globigerina” exumbilicata (*Turborotalita egelida*) biohorizon to the North Atlantic
- 10:00 **Mohammad Javad (Mehrddad) Razmjooei** Reassessing Radiocarbon Chronologies in Arctic Ocean Sediments Using Calcareous Nannofossil Bioevents
- 10:15 **Robert Spielhagen** Arctic Ocean surface sediment ages, sedimentation rates and the impacts of bioturbation and bottom currents

# **Defining states and variability of the terrestrial cryosphere of the Greenland Ice Sheet by marine-ice core integration: Past-to-Future (P2F) project contribution**

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Understanding how the terrestrial cryosphere responds to and interacts with climate variability is essential for assessing Earth's sensitivity to past and future change. Within the Horizon Europe-funded P2F project, WP9 defines the states and variability of the Arctic terrestrial cryosphere. We generate and synthesize paleoclimate data that will enhance Earth System Models (ESMs) under extreme, non-analog conditions and better capture climate transition pathways.

A key WP9 objective is to assemble data for constraining past dynamics of the Greenland Ice Sheet through complementary perspectives from marine sedimentary successions and ice cores.

As part of this effort, we analyze sediment cores recovered during IODP Expedition 400 on the northwest Greenland margin (Baffin Bay). The expedition recovered high-accumulation-rate Neogene to Quaternary successions associated with contourite drifts and trough-mouth fan deposits. For P2F, our focus is on Sites U1604 and U1608, which contain high-resolution (centennial-scale) Pleistocene and Pliocene sequences capturing warm interglacial periods under different CO<sub>2</sub> forcing scenarios. Specifically, we employ microCT imaging and complementary analyses (SEM, XRD) to characterize grain morphometry and texture of the silt and sand fraction, revealing changes in weathering regimes and source-sink transportation.

In parallel, we compile and analyze ice core records to reconstruct spatial patterns of late Pleistocene climate variability across the polar regions at annual-to-decadal resolution. Continuous Flow Analysis (CFA) provides unprecedented annual-resolution, multi-proxy data informing on aridity (insoluble dust, Ca<sup>2+</sup>), sea ice extent (Na<sup>+</sup>, bromine), and land surface processes such as forest fires (NH<sub>4</sub><sup>+</sup>) and ice accumulation.

A key target interval for our work is the Eemian (MIS 5) and the penultimate Glacial/Interglacial Transition, enabling direct comparison between marine and terrestrial ice records. Furthermore, by targeted analyses of late Pliocene and Mid-Pleistocene Transition intervals, we aim to elucidate ice-ocean dynamics associated with more pronounced deglaciation of Greenland. Ultimately, these Arctic paleo-data constraints will strengthen next-generation Earth System climate models.

# Dinoflagellate cyst as indicators of sea-ice conditions: Implications of machine learning techniques and regional surface sediment dataset

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Analysing dinoflagellate cysts (dinocysts) species abundances in sea-floor sediments is a widely used method for quantitative reconstructions of past sea-surface conditions. The rapid retreat of sea ice has increased efforts to study past sea-ice changes using a growing number of proxies, including dinocysts. One advantage of dinocyst-based reconstruction compared with many other sea-ice proxies is that the calibration dataset combining surface sediment dinocyst samples and modern environmental parameters is particularly large with 1968 data points. However, there is evidence that calibrating the dinocyst dataset regionally can increase the reliability of reconstructions, as primary environmental factors driving dinoflagellate assemblages may vary between regions. Recent studies have also shown that all environmental parameters that seem to significantly affect dinocyst species distribution in surface sediments may not always be reliably reconstructed from downcore samples.

Here, we studied a regional subset ( $n = 572$ ) of the full dinocyst calibration dataset ( $n = 1968$ ) including samples from the Arctic Atlantic and the surrounding seas. We analysed which environmental variables are primarily driving dinocysts distribution in this region and how strongly sea-ice concentration here influences the species assemblages in the surface sediment. We also compared a range of quantitative algorithms including traditional methods such as the modern analogue technique (MAT) and Weighted Averaging (WA), and newer machine learning methods like boosted regression trees (BRT) for producing sea-ice reconstructions based on the regional dinocyst dataset. Furthermore, we tested the best performing model for sediment core samples from Young Sound fjord, Northeast Greenland and conducted a quantitative palaeoreconstruction of sea-ice concentration.

Our results show that the environmental parameters included in the analysis (summer seasurface temperature, summer sea-surface salinity, annual primary production, water depth, distance to coast, dissolved oxygen, and sea-ice cover) together explained relatively small amount (approx. 16%) of the total inertia in the regionally calibrated dinocyst dataset and large portion of the variance remained unconstrained. None of the individual environmental variables significantly explained the species distribution, but a group of parameters related to cold conditions (sea-surface temperature, dissolved oxygen, and sea-ice concentration) explained the largest share (10%) of the variation. The modern machine learning method BRT performed better in h-block cross-validation than traditional methods, but overall we did not achieve strongly performing calibration models for sea-ice concentration. However, BRT identified taxa that were strictly related to sea ice, and which are known to be characteristic of environments with seasonal sea ice. Thus, we argue that in some regions the use of indicator species and qualitative approaches instead of quantitative algorithms may produce more reliable dinocystbased sea-ice reconstructions.

# Regional Paleomagnetic-Lithostratigraphic Framework for the Last 50kyr in Northeast Baffin Bay

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Sediments from Baffin Bay—located between Greenland and the northern Canadian Arctic— have the potential to constrain the behavior of three surrounding ice sheets, if they can be dated. Long-standing chronological challenges, resulting from poor biogenic preservation and likely non-linear accumulation rates, have, however, precluded a clear understanding of Baffin Bay sediment records. Utilizing marine sediment cores from the northwest Greenland margin, we propose an integrated paleomagnetic-lithostratigraphic framework for records in northern Baffin Bay. Two sediment cores were collected on the lower slope of Melville Bugt in 2019: LK19-1G (73.0003°N, 63.0048°W, water depth 1,800 m) and LK19-3G (73.1154°N, 63.7912°W, water depth 1,992 m). We compare our Melville Bugt cores with another core retrieved from the northern Uummannaq trough mouth fan in 2000: HE0006-2PC (71.2194°N, 61.4921°W, water depth 1,829 m). We correlate these records using paleomagnetic secular variation (PSV; changes in geomagnetic field directions and intensity), visual description and x-ray computed tomography (CT) imagery, and geochemical properties from x-ray fluorescence (XRF). Elevated Ca/Sr values from XRF were used to identify detrital carbonate events to take advantage of a growing Baffin Bay Detrital Carbonate (BBDC) event stratigraphy. Based on two radiocarbon ages and the integrated paleomagnetic-lithostratigraphic framework, these cores span the last ~50kyr. Our correlation and comparison to other regional records suggests that BBDC events 0-5 are recorded in northeastern Baffin Bay. Integration of the paleomagnetic secular variation and BBDC event stratigraphy has implications for the timing of ice shelves and oceanographic conditions in Baffin Bay, and may help to unravel age-depth relations of longer Pleistocene records such as those drilled during IODP Expedition 400: NW Greenland margin.

# Extending the central Arctic “*Globigerina*” *exumbilicata* (*Turborotalita egelida*) biohorizon to the North Atlantic

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Unravelling the Quaternary palaeoclimate history of the central Arctic Ocean (CAO) requires improved age–depth models. Fossil bioevents, including nannofossil, dinocyst and foraminiferal events, provide important relative and age-calibrated stratigraphic tie-points. Today, amplified warming allows the subpolar planktonic foraminifera *Turborotalita quinqueloba* to expand northward into the CAO, normally dominated by the sea-ice adapted *Neogloboquadrina pachyderma*. The Quaternary sediment record preserves several past ‘subpolar’ invasions, including younger *T. quinqueloba* events and an older interval associated with the enigmatic, presumed extinct spinose species “*Globigerina*” *exumbilicata* (*T. egelida*). This species has strong potential as an older biostratigraphic and palaeoclimatic marker but its taxonomic affinity, evolutionary range, biogeographic origin, and environmental significance remain poorly constrained, in part due to a lack of records outside the CAO.

Here we report the first evidence for “*G.*” *exumbilicata* outside the CAO, from two northern North Atlantic sites: DSDP Site 409 (Reykjanes Ridge) and ODP Site 647 (southern Labrador Sea). These records provide independent constraints on its temporal range and ecology. At Site 409, three major abundance peaks occur within a 26 m interval above the 2.3 Ma basaltic basement. The earliest peak, reaching 83% of the assemblage, occurs immediately prior to the ~1.7 Ma transition from the warmer-water *N. incompta* to the polar *N. pachyderma*, a shift widely recognised across the North Atlantic. At Site 647, a peak abundance of 44% coincides with the same neogloboquadrinid transition at ~1.7 Ma. These perspectives suggest that “*G.*” *exumbilicata* may have occupied the CAO between ~1.2 and 1.8 Ma. Evidence from the Atlantic-Arctic gateway regions could further constrain this.

To better understand its ecological role during this interval, we examined stable isotope signatures of “*G.*” *exumbilicata* and co-occurring species at DSDP Site 409. Interspecies  $\delta^{18}\text{O}$  differences are small, consistent with weak upper-ocean thermal stratification and strong seasonality.  $\delta^{13}\text{C}$  values, however, show pronounced interspecies offsets with “*G.*” *exumbilicata* exhibiting strong  $^{13}\text{C}$  depletion (–1.80 to –1.77‰), likely reflecting a metabolic vital effect. Similarly depleted  $\delta^{13}\text{C}$  signatures in CAO “*G.*” *exumbilicata* samples (–1.54 to –0.92‰) suggests a comparable ecology. This, together with its acme behaviour and temporary competition with *N. pachyderma*, suggests an opportunistic ecological strategy.

# Reassessing Radiocarbon Chronologies in Arctic Ocean Sediments Using Calcareous Nannofossil Bioevents

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**Key words:** Radiocarbon dating, biostratigraphy, nanoplankton biochronology, Arctic Ocean

Radiocarbon chronologies for Arctic Ocean sediments remain widely debated due to low sedimentation rates, bioturbation, poorly constrained marine reservoir ages, and the presence of authigenic carbonate that can bias radiocarbon measurements. This debate is particularly critical for sediments overlying a regionally extensive glaciomarine diamict in the central Arctic Ocean, where radiocarbon ages approach the practical dating limit and interpretations range from Marine Isotope Stage (MIS) 3 to MIS 5.

Here we assess the reliability of Arctic radiocarbon chronologies by integrating new and published calcareous nannofossil assemblage data from the North Atlantic, Nordic Seas, and central Arctic Ocean with existing radiocarbon and oxygen isotope constraints. We focus on two key nannofossil bioevents: (i) the transition from assemblages dominated by *Gephyrocapsa* spp. to dominance by *Gephyrocapsa huxleyi*, and (ii) the Holocene abundance peak of *Coccolithus pelagicus*. These assemblage-based events are defined by relative abundance changes rather than first or last occurrences, making them less sensitive to sediment mixing over centimeter scales.

Our results show that the timing and stratigraphic ordering of these bioevents are broadly consistent across sub-Arctic and Arctic sites when evaluated against independent age controls. In particular, the *Gephyrocapsa* spp.–*G. huxleyi* transition occurs in sediments younger than MIS 4 in well-dated Nordic Seas records and is consistently observed above the Arctic last diamict interval, supporting a post-MIS 5 age for overlying sediments. While radiocarbon ages in Arctic cores display considerable scatter, likely reflecting mixing and diagenetic effects, the agreement between biostratigraphic markers and radiocarbon-based age estimates in multiple cores indicates that radiocarbon chronologies retain substantial utility when interpreted alongside independent stratigraphic constraints.

This study highlights the value of combining radiocarbon dating with calcareous nannofossil biostratigraphy to improve confidence in Arctic sediment chronologies and provides a refined framework for interpreting late Pleistocene and Holocene paleoceanographic records from the Arctic Ocean.

# Arctic Ocean surface sediment ages, sedimentation rates and the impacts of bioturbation and bottom currents

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Radiocarbon dating of biogenic components in surface sediments from the Arctic Ocean gave highly variable ages of the uppermost sediment layer in areas beyond the shelf break. We show a large collection of published and unpublished data to reveal systematics in the age distribution and investigate the potential influence of bioturbation and bottom currents. Along the western continental margin off Svalbard and on the Eurasian margin of the Arctic Ocean proper, ages are often relatively low (<1 ka) and suggest comparatively high sedimentation rates. Results from the margin off Alaska and NW Canada show the same picture (cf. Polyak et al., 2009; Global Planet. Change). In the deep-sea basins, however, sediment surface ages are mostly in the range of 2-4 ka. These ages may appear surprisingly high, considering that downcore age determinations from the Eurasian Basin reveal average sedimentation rates of ~1 cm/ka in the Holocene. A unique sediment sequence obtained at site PS2192 in the Amundsen Basin (88,3°N, 4375 m water depth) gives insight into the role of bioturbation on surface sediment ages. At this site, a surficial layer of 1 cm hemipelagic foraminifer-rich sediment is underlain by homogeneous soft clay classified as a distal turbidite. Microfossil counts reveal a quasi-logarithmic downcore decrease to <5 planktic foraminifers/g at 7 cm and determine the bioturbation depth for sand-sized particles in deep Arctic basins. Since no older foraminifers were admixed to the uppermost 1 centimeter (the turbidite is otherwise barren of microfossils), its age of 420 years (reservoir corrected) constrains the average sedimentation rate of ~1cm/ka in the late Holocene. At other sites in the deep basins, radiocarbon ages of 2-4 ka for foraminifer samples from the sediment surface (up to 8 ka in areas with very low sedimentation rates) must be considered the result of significant mixing of recently deposited specimens and those from previous millennia. Taking into account the rapidly changing Arctic under global warming, it seems unjustified to relate the composition of Arctic deep-sea surface sediments exclusively to the modern sedimentary environment.

A second factor comes into play off NE Greenland on the ridges of submarine highs and along the continental margin. Sediment surface ages are extremely variable and range between 2 and 25 ka. While ages of 2-3 ka may be explained by bioturbation, it is noticeable that the higher ages come from surface sediments with an extraordinary amount of coarse fraction (up to 50%). In some cases, a gravel-rich layer is found at the surface, likely constituting a lag deposit. We propose that strong bottom currents over the ridges and along the continental margin often prevent the deposition of finer-grained materials or even lead to the erosion of older sediments. Based on our findings we recommend particular care when sedimentation rates are calculated for Arctic sediment cores with only few radiocarbon ages available.

## Oral Session 6

Friday 11:00 - 12:30

Conveners: tbd

11:00 **Lucy Roberts**

Environmental and habitat controls on non-marine ostracod distribution in Arctic lakes

11:15 **Caroline Planche**

Early Holocene vegetation and environmental responses to abrupt climate variability in the Icelandic highlands

11:30 **Inda Brinkmann**

Sedimentary ancient DNA records climate change and permafrost thaw effects on Arctic coastal ecosystems in the Mackenzie Delta, Canada

11:45 **Ujjaini Basu**

Benthic Foraminiferal Responses to Atlantification along a Hydrographic Gradient in Krossfjorden, Svalbard

12:00 **Sarah Ferrandin**

Environmental controls on organic carbon sequestration on the Northeast Greenland shelf since deglaciation

12:15 **Subhadip Mukherjee**

A High-Resolution Ichnological Approach to Arctic Palaeoenvironmental Reconstruction

# Environmental and habitat controls on non-marine ostracod distribution in Arctic lakes

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The Arctic is warming almost four times faster than the global average. Lakes in the Arctic are a prominent feature of the landscape and are consequently undergoing limnological and ecological change such as shifts in algal productivity, water column mixing depths, and ice persistence. Most recently, the nutrient-colour paradigm has been associated with extensive loss of benthic habitat. Ostracods (small aquatic crustaceans) are a significant contributor to the benthic biomass of shallow to mid-depth lakes (<20 m) and there is great potential to use fossil ostracods to reconstruct past environmental change and predict future ecosystem states in these lake-rich regions. However, relative to mid-latitude regions, little is known of the ecological traits of ostracods in the Arctic. Here we present the first systematic survey of ostracod species and ecological preferences for the Kangerlussuaq region of southwest Greenland, the largest ice-free margin of Greenland. Twenty-four lakes (<16 m deep) were surveyed in July 2021 in a SW-NE gradient from the Greenland Ice Sheet. Electrical conductivity in the lakes ranged from 0.01 to 4.1 mS cm<sup>-1</sup>. All lakes were ultra-oligotrophic to mesotrophic; soluble reactive phosphorus ranged 1.9 to 49.7 µg L<sup>-1</sup> and nitrate concentrations were below detection limit to 12.3 µg L<sup>-1</sup>. In total, thirteen species of ostracods were recorded across the study lakes. *Candona candida* is a generalist species in the Kangerlussuaq region, being present in deeper lakes and at the higher end of the bioavailable soluble reactive phosphorus and nitrate gradients. These traits suggest that *C. candida* will become abundant in the Greenlandic ostracod fauna, and potentially across the Arctic. For some species, particularly *Cypris pubera*, bioavailable nutrient concentrations are a dominant control on distribution. Nutrient status of water appears to be a significant control on ostracod presence and abundance and should be included in future ecological studies globally.

# Early Holocene vegetation and environmental responses to abrupt climate variability in the Icelandic highlands

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North Atlantic climate is strongly regulated by the strength of the Atlantic Meridional Overturning Circulation (AMOC). At present, the stability of this circulation is increasingly questioned, as enhanced freshwater input from accelerated Arctic warming is freshening the North Atlantic and potentially weakening deep-water formation. High-resolution palaeoarchives from Iceland provide a valuable long-term perspective on past AMOC variability and associated climate tipping points, given Iceland's strategic location within the North Atlantic climate system.

The Early Holocene (11.7–8.2 ka BP) climate in the North Atlantic was characterized by a thermal maximum interrupted by rapid, short-lived cooling events linked to AMOC instability. The Icelandic highlands are likely among the most sensitive environments to external disturbances such as climate change and volcanic activity, yet their long-term ecological trajectories remain poorly constrained. This study investigates how vegetation and environmental conditions in the Icelandic highlands responded to Early Holocene warming and abrupt climatic fluctuations associated with AMOC variability.

A multi-proxies approach was applied to lake sediment sequences from the Arnarvatnsheiði region, Iceland. Vegetation dynamics were reconstructed using pollen analysis. Loss-on-ignition, organic carbon and nitrogen contents (C/N ratios), stable carbon and nitrogen isotopes, and elemental geochemistry derived from XRF scanning were used to assess soil erosion processes and landscape stability. Tephrochronology and radiocarbon dating provided robust chronological control, enabling analysis of climate–ecosystem interactions at centennial to millennial timescales.

By identifying past regime shifts and ecosystem persistence under rapid climate perturbations, this study advances theoretical understanding of ecosystem resilience.

# **Sedimentary ancient DNA records climate change and permafrost thaw effects on Arctic coastal ecosystems in the Mackenzie Delta, Canada**

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Unprecedented rates of warming are shaping Arctic ecosystems and landscapes. Impacts in the Canadian Arctic are closely connected to accelerated permafrost thaw, coastal erosion and increasing river discharge to the coastal zone. Significant shifts in biodiversity and environments are evident today, but an understanding of long-term ecosystem responses is crucial for discerning the effects of Holocene climate variability and accelerating rates of change in the 21<sup>st</sup> century.

Here we explore ancient DNA records from sediment records taken in Tuktoyaktuk harbor (Northwest Territories, Canada), and additional sites in the coastal Beaufort Sea in front of the Mackenzie Delta. We applied plant and animal metabarcoding, together with shotgun metagenomics. The 4500-year harbor record reflects the region's terrestrial and marine biodiversity at multi-decadal resolution, with distinct community shifts in particular in response to sea level rise. The identification of woolly mammoth DNA in surface sediments suggests reworking of formerly buried material from mainland permafrost into coastal sediments. We hypothesize that 'modern' signals of extinct megafauna may act as a proxy for accelerated permafrost thaw in response to recent warming.

Our study offers new perspectives on Arctic ecosystem sensitivity to climate change across the land-sea interface, and a framework for the interpretation of sedimentary ancient DNA in a rapidly warming Arctic landscape.

# Benthic Foraminiferal Responses to Atlantification along a Hydrographic Gradient in Krossfjorden, Svalbard

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Krossfjorden, a north–south oriented High Arctic fjord in western Svalbard, serves as a sensitive system for examining the regional impacts of rapid Arctic climate change. In recent years, the fjord has exhibited increasing environmental heterogeneity driven by shifts in Atlantic water inflow, glacial discharge, sediment redox conditions, and nutrient availability. These processes influence bottom water oxygenation, sedimentation patterns, and primary productivity, ultimately reshaping benthic ecosystems.

Our study integrates biological proxies, particularly benthic foraminiferal assemblages, with sediment grain size characteristics and hydrographic parameters including salinity, temperature, dissolved oxygen, and turbidity, providing a multiproxy perspective on environmental change in this High Arctic fjord system. The sample strategy consists spatial transect across Krossfjorden, extending from the inner and central fjord basins to the outer fjord, including the fjord mouth and adjoining shelf. Eight surface sediment samples (0–2 cm) were collected along this gradient and stained with Rose Bengal to distinguish living from non-living forms. The results reveal strong variability in Total Foraminiferal Number (TFN) and living benthic foraminiferal abundance across Krossfjorden. The highest values occur in the inner and outer fjord sectors, whereas the central fjord region is characterized by markedly lower abundances. Calcareous taxa dominate the inner fjord but progressively decline toward the mid-fjord, where agglutinated forms begin to increase. This pattern culminates in the outer fjord, where calcareous taxa reach their lowest abundance and agglutinated assemblages peak, indicating a transition from carbonate-favouring inner fjord conditions to more environmentally stressed outer fjord settings. The spatial distribution of angular asymmetric foraminifera shows a pronounced seaward increase across Krossfjorden. These forms are rare in the inner fjord but increase progressively through the mid-fjord and reach their highest abundance in the outer fjord. This pattern suggests a preference for environmentally stressed conditions, where ecological instability favours more tolerant forms.

Foraminiferal assemblages across the fjord transect display clear ecological zonation along the fjord gradient, with *Cassidulina reniforme*, *Elphidium clavatum*, and *Stainforthia* spp. dominating glacial-proximal settings, transitional assemblages including *Islandiella* spp. and *Lobatula lobatula* characterizing the mid-fjord, and *Bolivina pseudopunctata* together with *Textularia* spp. prevailing in glacial-distal sectors. Notably, *Nonionellina labradorica* occurs throughout the transect and reaches maximum abundance in the mid-fjord, underscoring its broad ecological tolerance across varying hydrographic conditions.

Variations in species composition and abundance across environmental zones reflect ongoing changes in bottom-water oxygenation, nutrient dynamics, and glacial–marine interactions, highlighting Krossfjorden as a key natural observatory for tracking the ecological consequences of Atlantification over decadal timescales.

# Environmental controls on organic carbon sequestration on the Northeast Greenland shelf since deglaciation

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The Arctic Ocean plays an increasingly important role in the global carbon cycle, yet the fate of organic carbon (OC) in Arctic marine sediments under ongoing climate change remains poorly understood. Since 1979, the Arctic has warmed nearly four-times faster than the global average, leading to rapid sea-ice decline, glacier retreat, and major changes in ocean circulation and primary productivity. These changes are expected to strongly influence the Arctic's "blue carbon" potential and associated carbon sequestration. In marine environments, OC sequestration refers to the long-term burial and storage of organic matter that effectively removes CO<sub>2</sub> from the atmosphere over extended periods. However, whether declining sea-ice and increased productivity will enhance long-term OC sequestration, or instead promote remineralisation and carbon recycling, remains uncertain.

Here, we investigate the factors affecting OC sequestration along the Northeast Greenland shelf using a Holocene sediment record spanning the last 12,000 years. The studied gravity core (DA17-NG-ST14-171G) was collected 30 km offshore the Young Sound-Tyrolerfjord system, close to the modern Sirius Water Polynya. The site is located outside the main troughs that channel Atlantic Intermediate Water onto the shelf and is distal from major marine-terminating glaciers, making it particularly sensitive to changes in shelf circulation, sea-ice conditions, and sediment supply. A multi-proxy approach combining bulk geochemistry ( $\delta^{15}\text{N}$ ,  $\delta^{13}\text{C}_{\text{org}}$ ,  $\text{C}_{\text{org}}:\text{N}$ ), pyrolysis-derived organic matter characterisation, lipid biomarkers including highly branched isoprenoids and *n*-alkanes, biogenic silica and benthic foraminifera fluxes, and CT-derived sediment density was used to reconstruct environmental conditions and quantify OC flux and sequestration.

The record captures four major environmental transitions from the final stages of deglaciation through the Holocene. The earliest interval represents a glacially influenced environment dominated by high sediment input and reworked terrestrial organic matter. Although OC fluxes were relatively high during this phase, sequestration efficiency remained low because most buried OC consisted of degraded allochthonous material. During the Early Holocene, declining glacial influence and seasonal sea-ice conditions coincided with rising marine productivity and a growing contribution of fresh organic matter to the sedimentary carbon pool. The following interval, corresponding to the Holocene Thermal Maximum, marks a period of maximum OC sequestration, associated with elevated productivity and seasonal sea-ice conditions consistent with enhanced marginal-ice-zone productivity and the development of a polynya-like environment on the shelf. In contrast, the Mid- to Late Holocene is characterised by a pronounced decline in OC flux and sequestration following the retreat of local glaciers onto land, with reduced sediment delivery to the shelf leading to markedly lower sedimentation rates.

Overall, the results indicate that OC flux and sequestration depend largely on sediment delivery linked to glacier dynamics, and are further moderated by local climate conditions and marine productivity.

# A High-Resolution Ichnological Approach to Arctic Palaeoenvironmental Reconstruction

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Groups of trace fossils, or ichnoassemblages in marine sediments provide an in-situ record of benthic ecosystems, and can be used to validate, constrain, and add crucial ecological details to interpretations derived from geochemical and micropalaeontological methods. The distribution, morphology, and diversity of an ichnofauna are direct responses to a specific suite of environmental parameters such as food availability, bottom water oxygenation, and substrate consistency. Important ichnologic criteria useful for environmental analyses include the penetration depth of burrows, the number and vertical extension of tiers, the size or diameter of specific trace fossils, and the overall degree and diversity of bioturbation.

Compared to other proxies in palaeoceanography, trace fossils in unconsolidated marine sediments are often understudied due to challenges in imaging and segmentation, and the general low resolution of available data. Current work has focused mainly on identifying and describing trace fossils in hard rock or consolidated sediments. Work done on trace fossils on unconsolidated sediments has only involved qualitative descriptions in two dimensions, or some basic three-dimensional (3D) image segmentation analysis on sediment core sections.

In our work we have used X-ray Computed Tomography (X-ray CT) scans from a 6-metre sediment core (DA17-ST08-92G, abbreviated as 92G) off the coast of North-East Greenland. Trace fossils were segmented with a machine-learning approach using the U-net neural network algorithm, complemented by manual inputs and corrections. Virtual three-dimensional reconstructions of the traces recognized from the CT scans visualises these biogenic structures, their morphology and distribution throughout the sediment core in a unique way. Additionally, the traces reconstructed in three dimensions, offer a means to describe them qualitatively and quantitatively. The traces were classified into two ethological groups made by a) chemosynthetic feeders and b) deposit feeders, each representing a specific type of palaeoenvironmental condition. The concentration and diversity of the main ichnotaxa throughout 92G were compared with known palaeoenvironmental reconstructions and benthic foraminiferal assemblages from the same core. Preliminary results suggest a good correlation between the type of ichnotaxa and their diversity with the palaeoenvironmental reconstruction of the core and offer a novel method in three dimensions to visualize, describe and use these biogenic structures as a quantitative palaeoenvironmental proxy in (sub)recent sediments.

## Poster Presentations

Tuesday & Thursday afternoon

All 59 poster presentations will be organized into two main sessions, but are here listed in alphabetical order

- Aisling O'Brien** The Abundance of Diatoms in Sediments from the Greenland Sea
- Alessandro Sartini** Paleo-ecological impact of meltwater events on the Arctic marine ecosystem: a study of changes in biodiversity and biogeochemistry in the Fram Strait: some preliminary analysis
- Alice Carter-Champion** Linking Fram Strait marine sediment cores using tephrostratigraphy: a pilot study spanning the Last Glacial-Interglacial Transition
- Amalie Krogholm Arildslund** Holocene variability of Atlantic Water inflow to Narsaq Sound, Southwest Greenland, reconstructed from benthic foraminifera
- Amy McGuire** Towards a pan-Arctic marine tephrostratigraphy
- Andreas Duus Petersen** Flooding of glacial paleolandscapes - high-resolution mapping of erosion and deposition processes in the eastern North Sea
- Anna Hughes** Ice streams of the Eurasian Ice Sheet Complex
- Anna Pieńkowski** Late-summer ice-edge productivity recorded by extreme diatom biomarker enrichment in the Barents Sea
- Aylin de Campo** Cosmogenic chlorine-36 constraints on Holocene glacier change in Iceland
- Brendan Reilly** Plio-Pleistocene Magnetostratigraphy of Eastern Fram Strait Drifts (IODP Exp. 403)
- Caixia Dong** Asynchronous sea-ice responses driven by Atlantic Water inflow over the past 14,600 years, Svalbard
- Carl Regnéll** Northern Swedish rivers – carved by glacial floods
- Christine Tømmervik Kollsgård** Moraines in the southern Norwegian North Sea
- Cuong Ngo** Refining Arctic Plant Diversity Dynamics
- Eleonora Santucci** Late Holocene Sea-Ice Variability and Water-Mass Dynamics in Edisto Inlet (Antarctica): A High-Resolution Multi-Proxy Approach for Bipolar Comparisons
- Erin Gregory** Dynamic post-LGM ice sheet retreat after loss of ice shelf buttress in Melville Bugt, west Greenland

<b>Frances Butcher</b>	A candidate subglacial palaeolake basin associated with regionally widespread eskers and debris-covered glaciers on Mars
<b>Gregor Luetzenburg</b>	Re-evaluating Holocene relative sea-level change in central western Greenland using remote sensing geomorphology
<b>Henrieka Detlef</b>	Holocene sea-ice and ecosystem dynamics north of Greenland – from the Arctic’s Last Ice Area to the North Water Polynya
<b>Jakob Hamann</b>	The geomorphic signature of Late Weichselian ice shelves and deglacial dynamics along the Isfjorden Coast, Svalbard
<b>Jakob Reif</b>	Asynchronous glacial response during the Younger Dryas in Troms, Norway, influenced by internal ice-sheet dynamics and local topographic controls
<b>Jesper Nørgaard</b>	Dating DK: Cosmogenic $^{10}\text{Be}$ depth profiling of glacial outwash plains in Denmark
<b>Jingyuan Zhang</b>	Diagenetic Overprint and Magnetostratigraphic Fidelity in Central Arctic Ocean Sediments
<b>Joachim Jepsen</b>	Size variability of the centric diatom <i>Coscinodiscus centralis</i> in northern Baffin Bay throughout the Holocene
<b>Jonas Damsgård</b>	Estimating fjord sediment volumes and subglacial erosion rates in Greenland from fjord morphology
<b>Joshua Williams</b>	An Ancient Giant Post-Glacial Landslide Hidden in a Danish Tunnel Valley
<b>Julia Garcia-Oteyza Ciria</b>	Multiproxy Perspectives on Glacial Oscillations and Climate Variability in Northeast Greenland
<b>Katherine Stelling</b>	Evidence for a dynamic marine-terminating western margin of the Greenland Ice Sheet during Marine Isotope Stage 3
<b>Keito Aonuma</b>	Changes in Water Dynamics of the Arctic Ocean: Insights from $^{226}\text{Ra}$ during the 2024 Polarstern PS144 Cruise
<b>Kristaps Lamsters</b>	Glacial geomorphology of palaeo-ice lobe beds in Latvia
<b>Kwangkyu Park</b>	Refining Quaternary chronostratigraphy in the western Arctic Ocean using multiproxy sediment records
<b>Lara Pérez</b>	Northeast Greenland Glaciated Margin: an IODP3 Proposal
<b>Lara Pérez</b>	Understanding Greenlandic landslide risk in a warming climate
<b>Lena Anders</b>	Exploring Arctic Ocean Conditions Beyond the Last Interglacial Period: A Multi-Proxy Approach

- Letizia Roscelli** Holocene environmental evolution in Tuktoyaktuk Harbor revealed by organic biomarkers
- Lindsey Monito** Reconstructing Timing of western Greenland Ice Sheet Dynamics at the Last Deglacial Using Paleomagnetic Secular Variation
- Maciej Telesiński** The 6.8 ka BP event in the Nordic Seas and its worldwide impacts
- Maija Heikkilä** Reconstructing Holocene algal biodiversity in a high-latitude lake with sedimentary ancient DNA and pigments
- Marie Winther** Previously unrecognized giant paleo-landslides in Denmark: towards a national inventory
- Mathia Sabino** Frozen Archives: Reconstructing Ancient Greenland Ecosystems and Environments from Basal Ice
- Matthew Hunt** Deglacial Retreat of the palaeo-Kangerlussuaq Ice Stream, South-East Greenland
- Maureen Walczak** The Role of the Pacific Ocean and Adjacent Cryosphere in Past Abrupt Climate Oscillations
- Monika Mikler** The geochemical and paleoenvironmental significance of the enhanced biosynthesis of a tri-unsaturated highly branched isoprenoid during late Heinrich Stadial 1 in Baffin Bay
- Nathan Stansell** Fennoscandian Ice Sheet and Baltic Ice Lake Connections to Abrupt Global Climate Changes During the Last Deglaciation
- Paulina Romel** Early postglacial paleoceanography of the western Canadian Arctic Archipelago: preliminary multiproxy evidence from the Beaufort Sea and M'Clure Strait
- Petra Hus** Preliminary Results of High-Resolution Micropaleontological Analysis in Rijpfjorden, Northern Svalbard
- Ricardo Monedero-Contreras** D. Greenland Ice Sheet dynamics and weathering regimes during past warm intervals: Evidence from micro-CT analysis of ice-rafted debris
- Robyn Granger** Water mass changes in North Greenland fjords during the Holocene
- Rujian Wang** Size-dependent  $\delta^{18}\text{O}$  and  $\delta^{13}\text{C}$  variations in a planktic foraminiferal *Neogloboquadrina pachyderma* (sinistral) record from Chukchi Plateau: implications for (sub)surface water conditions in the western Arctic Ocean over the past ~50 ka

- Sine Kirstine Kabel** Flooding of tidal estuaries – A study from the central Danish North Sea
- Stine Detjens** Mapping the Drowned North – Legacy Data Perspectives on the Eastern Sector of Doggerland
- Tine Rasmussen** L. Deep water exchange through the western Fram Strait during marine isotope stages (MIS) 10 to 1, last 345 ka
- Tjördis Störling** Greenland Ice Sheet responses to past warm climate intervals: Provenance insights from North-East Baffin Bay
- Tommaso Tesi** Using long-chain diols to resolve input of nutrients and river-derived carbon to the Arctic Ocean
- Vårin Trælvik Eilertsen** Iverryggen – Hill-hole pair on the Norwegian continental shelf odd Mid-Norway
- Walter Geibert** Freshwater in the glacial Arctic Ocean – the evolution of findings in the last five years
- Wenshen Xiao** Surface sediment composition off northern Greenland
- Wesley Farnsworth** The Nordic Palaeo Alliance (NORPALL) – a NordForsk Network for Early Career Quaternary Researchers
- Xiaotong Xiao** Ice sheet - ocean interaction in the central Canadian Arctic Archipelago area during the final deglacial-Holocene transition

# The Abundance of Diatoms in Sediments from the Greenland Sea

Aisling O'Brien<sup>1</sup>, Alice Carter-Champion<sup>2</sup>, Oliver S. Hansen<sup>1</sup>, Mads Ramsgaard Stoltenberg<sup>1</sup>,  
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Diatoms are a dominant microscopic phytoplankton in marine, brackish and freshwater environments. They play an important role in the carbon and silica cycles, and are the basis of many oceanic ecosystems.

Diatoms have specific requirements for light, oxygen, temperature, salinity, pH and nutrients. In terms of Arctic marine diatoms, sea-ice variability is one of the main drivers of their distribution.

Because of these environmental preferences fossil diatoms can be employed advantageously as paleoenvironmental tools but their use in paleoreconstructions is dependent on their preservation. On the shallow shelf area offshore Northeast Greenland, several marine sediment cores were analyzed for diatom content, but no fossil diatoms were found to be preserved, except in the upper 0-1cm. This indicates poor preservation of the siliceous frustules, since other studies have indicated the presence of diatoms in modern water samples and organic biomarkers have been used to indicate the presence of diatoms in the past.

The aim of this study is to investigate surface and downcore sediments from the Greenland Sea, that span the last glacial cycle, to assess the preservation of diatoms at different water depths and in different environmental settings.

Qualitative and quantitative assessments of diatom assemblages and preservation were conducted in 11 cores from 10 different sites that show variable degrees of preservation and abundance, especially when compared to cores from the Northeast Greenland shelf.

Surface sediment samples of marine sediment cores from the Greenland Sea showed diatoms present at water depths ranging from 847-2893m and abundant at 847-1555m, with locations here being south of the Jan Mayen Current. Downcore sampling from one core showed diatoms present in samples from the Last Glacial Maximum. In general, the core sites that have a higher concentration of diatoms show a south-westerly trend. This indicates a potential link between presence and abundance of diatoms with deep ocean nutrient cycles and ocean dynamics.

# **Paleo-ecological impact of meltwater events on the Arctic marine ecosystem: a study of changes in biodiversity and biogeochemistry in the Fram Strait: some preliminary analysis**

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Throughout Earth's history, a cyclical alternation of glacial and interglacial periods had caused massive ice-sheet decay and, as a result, a rapid and significant global sea-level rise, also known as Meltwater Pulses. Studying how past marine environments responded to these natural events is essential for understanding the complex relationship between the climate, ocean and cryosphere, as this information will facilitate the development of more accurate predictive models regarding future impacts, especially in the light of modern, human-induced climate change.

Highly sensitive to climate shifts, the Svalbard region once hosted the paleo Svalbard-Barents Sea Ice Sheet, which is considered the best analogue for understanding the modern West Antarctic Ice Sheet dynamics. To investigate the climatic history of this area, this project analyses sedimentary records of the Hole U1623 collected during the IODP Expedition 403, located on the Bellsund drift in the Eastern Fram Strait. Specifically, this PhD project focuses on high-resolution marine sediments deposited during the transitions between the Marine Isotope Stage (MIS) 32 and 31. Preliminary micropaleontological analyses of planktonic and benthic foraminiferal microfossil assemblages, combined with sedimentological data, provide the first evidence of the impact of meltwater events on the marine biological environment.

# Linking Fram Strait marine sediment cores using tephrostratigraphy: a pilot study spanning the Last Glacial-Interglacial Transition

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The Arctic Ocean plays a critical role in global climate via its influence on freshwater export, and sea-ice dynamics. However, reconstructions of palaeoceanographic change in the Arctic remain limited by low sedimentation rates, sparse chronological control, and large uncertainties associated with radiocarbon dating in sea-ice influenced environments. This pilot investigation of four marine sediment cores recovered from the Fram Strait (MSM5/5712, PS2837-5 and IODP Expedition 403-U1623) and Beaufort Sea regions (HLY1302JPC15)—key gateways connecting the Arctic Ocean to the North Atlantic and representing an important pathway for freshwater discharge associated with the northern routing of meltwater from the Laurentide Ice Sheet, which likely occurred at the onset of the Younger Dryas. These locations provide valuable archives for examining Arctic environmental change during the Last Glacial-Interglacial Transition (LGIT), a period marked by rapid reorganisation of ocean circulation, ice-sheet dynamics, and climate. To address chronological uncertainties in Arctic marine records, this study evaluates the potential for cryptotephra preservation within high-sedimentation-rate intervals of these cores. Cryptotephra layers—microscopic volcanic ash transported over long distances—offer the possibility of establishing isochronous marker horizons that can link marine records across the Arctic and North Atlantic. Through systematic cryptotephra extraction and ice-rafted debris quantification, this work assesses whether discrete primary volcanic horizons are preserved within these Arctic sequences and whether they can be correlated to known eruptions. Geochemical analyses are presented to confirm the correlation between archives and identification of several known eruptions during the LGIT.

Preliminary findings indicate that high-sedimentation-rate intervals within the studied cores preserve detectable cryptotephra horizons that may provide new chronological tie-points for Arctic palaeoceanographic records. The identification of the Vedde Ash in several of these records provides new chronological information which enables a new examination of the timing of paleoceanographic changes within the Younger Dryas at the Fram Strait, as well within the North Atlantic more broadly, particularly as these records can be directly linked to the Greenland Ice cores via this tephra identification. Several additional tephra layers were also identified in the Bølling-Allerød interval and will be presented as potential tie-points for additional records, although they were not identified within the Greenland Ice cores. This study demonstrates the potential of tephrostratigraphy to improve chronological frameworks in Arctic marine sediments and highlights the value of high-sedimentation archives for resolving rapid climate transitions. Establishing tephra-based correlations across the Arctic basin can enhance our ability to synchronise records and evaluate the timing and propagation of climatic shifts between the Arctic and the wider Atlantic system.

# Holocene variability of Atlantic Water inflow to Narsaq Sound, Southwest Greenland, reconstructed from benthic foraminifera

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The oceanography and cryosphere along the western coast of Greenland is largely influenced by the West Greenland Current, which transports Atlantic Water northward. The inflow of warmer waters affects marine terminating glaciers, the coastal climate, and the marine ecosystems. The influence of Atlantic sourced waters on the shelf and in fjords along West Greenland varies over time linked to large-scale mechanisms including the Atlantic Meridional Overturning Circulation, the strength of the subpolar gyre, and the North Atlantic Oscillation (NAO).

Narsaq Sound in Southwest Greenland is connected to the shelf through Ikersuaq Fjord and directly influenced by Atlantic Water due to the absence of a sill. Previous studies from Narsaq Sound have shown shifts in the regional hydroclimate, iceberg rafting, and glacier margin positions throughout the Middle and Late Holocene (Nørgaard-Pedersen and Mikkelsen, 2009; Faust et al., in review). During the last 2,000 years BP Southwest Greenland has been strongly influenced by the dominant NAO state. A positive NAO state, such as during the Medieval Warm Period (MWP) results in a colder climate with more precipitation in Southwest Greenland (Faust et al., in review). These changes have been linked to glacier margin positions during the Middle and Late Holocene but not yet to changing water mass influence and the benthic fauna.

As water masses influence benthic systems, benthic foraminifera assemblages are a useful proxy for reconstructing fluctuations in oceanography over time. Here we use benthic foraminiferal assemblages from the gravity core GeoB25206-2 (Narsaq Sound, 60°56.200'N, 46°9.300'W; 285 m) to reconstruct past oceanographic variability during the Holocene. The core is well dated and captures continuous sedimentation throughout the last 12,000 years. Preliminary results reveal that species such as *Cassidulina reniforme* and *Elphidium clavatum*, which are indicators of cold-water conditions, are dominant in the assemblage before 1,000 years BP, whereafter they almost disappear. During the MWP and the beginning of the Little Ice Age *Islandiella helenae* became the most important species. This indicates that the fjord might have been less influenced by marine-terminating glaciers and more by seasonal sea ice. Sea ice and cold-water conditions during the MWP align with the concurrent positive NAO state. Associated strengthening of the subpolar gyre and increased transport of Arctic Water southward (Lohmann et al., 2009) can explain the presence of sea ice inferred from the benthic foraminifera assemblage in Narsaq Sound. Since ~350 years BP, the site has been more influenced by Atlantic sourced waters as suggested by the dominance of *Islandiella norcrossi* in the assemblage. The preliminary data indicates that benthic foraminiferal assemblages from Narsaq Sound record water mass variability and contribute to a broader understanding of the timing and magnitude of Atlantic Water inflow to southwest Greenland and of Holocene oceanography in the region.

Faust et al., Preprint. <https://doi.org/10.21203/rs.3.rs-7656605/v1>, Lohmann et al., 2009. <https://doi.org/10.1007/s00382-008-0467-6>, Nørgaard-Pedersen and Mikkelsen, 2009. <https://doi.org/10.1016/j.jmargeo.2009.05.004>

# Towards a pan-Arctic marine tephrostratigraphy

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Understanding how past climate changes unfolded across space and time in the highly sensitive Arctic requires integrating evidence from diverse proxy archives. Chronological uncertainties in marine sediment sequences, however, often limit robust comparison with terrestrial and ice-core records. Volcanic ash (tephra) layers, rapidly deposited and characterised by distinct geochemical signatures, offer powerful isochronous markers facilitating precise correlation. The detection of microscopic, non-visible ash particles (cryptotephra), transported over thousands of kilometres, further enhances the potential for synchronising records at intra- and, in some cases, intercontinental scales.

Despite this, Arctic tephrochronology remains restricted to a small number of isolated studies. Here, I synthesise existing tephra data to evaluate the potential for tephra-based correlations across the Arctic and beyond. I also present new cryptotephra results from IODP Site 302-3A in the central Arctic Ocean, offering new opportunities for correlation and improved age control.

Developing a coherent regional tephrostratigraphy would significantly improve correlations between marine, terrestrial, and ice-core records. It also promises enhanced age control for individual marine cores, enabling more robust integration of proxy reconstructions and new insights into the timing and mechanisms of past Arctic climate change.

# **Flooding of glacial paleolandscapes - high-resolution mapping of erosion and deposition processes in the eastern North Sea**

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Large Weichselian glaciofluvial systems and Saalian till-plains define the glacial landscape of western Denmark. This landscape, now submerged and buried below marine sediments, extends into the eastern North Sea where coarse regional mapping resolves the major landscape elements. While the onshore part of Denmark's glacial landscapes is studied in great detail, due to easier accessibility, the offshore landscapes remain understudied. This is the case not only for Denmark, but also for submerged glacial landscapes in the Arctic and the rest of the world.

The development of offshore wind farms offers a unique opportunity to study flooded glacial landscapes applying the extensive high resolution and high density geophysical and geotechnical data collected for preliminary site investigations. This study presents the interpretation and analysis of sub-bottom profiler and sparker seismic data from the North Sea 1 offshore wind farm area (2200 km<sup>2</sup>) in the Danish North Sea. This data allowed for reconstruction of the glacial paleolandscape at an unprecedented level of detail.

The morphology and subcropping sediments of the North Sea 1 paleolandscape aligns with the onshore analogies. The landscape is characterized by low reliefs and large glaciofluvial channels incised into the slightly higher elevation older till plains and glaciofluvial outwash plains. The channels are very well preserved and details can be resolved in the base and channel fill from the seismic data. Interestingly, the higher elevation elements of the landscape do not show the expected glacial morphology of older till plains known from onshore studies. Instead, they can be characterized as flat plateaus suggesting that they have been eroded and reshaped during transgression.

The transgressive evolution of the paleolandscape provides important insights into how glacial terrains develop in response to post glacial sea level rise and how they are subsequently reshaped by coastal processes. Several stages of flooding are identified ranging from low-energy conditions in sheltered settings formed during the initial inundation of channels and lowlands, to wave-dominated coastlines shaped by erosion and long-shore sediment transport. Understanding how energy increased through the transgression reveals why preservation varies within the paleolandscape and provides a framework for interpreting submerged low-relief glacial terrains.

# Ice streams of the Eurasian Ice Sheet Complex

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Accurate projection of ice sheet contribution to future sea-level rise requires uncovering the long-term dynamics of fast-flowing ice streams; the primary conduits of meltwater to the ocean. Contemporary observations of ice sheet surface velocity changes indicate that ice streams exhibit variability in speed and can switch on-and-off over time. However, such observations only cover the last few decades, insufficient time to capture all glacial processes. Further, direct observations from present-day ice stream beds are limited to spatially-restricted insights into subglacial processes and conditions influencing fast-ice flow. Geological records spanning the last glacial cycle (10,000s of years) provide evidence of the nature of, and spatial variations in, subglacial conditions and instances of fast-ice flow across former ice sheet beds. Based on varied evidence numerous fast-ice flow pathways are postulated to have existed within the former Eurasian Ice Sheet Complex (EISC), including both marine-terminating ice streams and outlet glaciers of various sizes, and terrestrially-terminating ‘ice-lobes’. These interpretations have accrued alongside changes in conceptual understanding of ice stream dynamics and development of robust criteria for identifying fast-ice flow in the geological record. At the same time increasingly widespread availability of high-resolution (1-10 m) marine and terrestrial data has facilitated digital mapping of former ice sheet beds. Here, we conduct a review of postulated fast-flow pathways of the EISC. This new digital synthesis provides i) an opportunity to examine and assess variations in geological signatures of fast-ice flow from both marine and terrestrial ice sheet sectors, ii) assessment of the prevalence of ice streaming within the overall ice flow configuration and evolution of the ice sheets comprising the EISC, and iii) updated and revised constraints on the spatial occurrence of ice streams within the EISC for palaeoglaciological modelling.

# Late-summer ice-edge productivity recorded by extreme diatom biomarker enrichment in the Barents Sea

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Reconstructing past Arctic sea-ice variability is essential for understanding climate–ocean feedbacks, yet existing biomarker approaches primarily constrain winter or spring sea-ice conditions. In particular, proxies capable of identifying the late-summer sea-ice minimum remain limited. Here we present a high-resolution biomarker record spanning the last millennium from sediment core NPAL04 recovered from the northern Barents Sea. The record includes sea-ice and pelagic highly branched isoprenoid (HBI) biomarkers (IP<sub>25</sub>, IPSO<sub>25</sub>, HBI III and HBI IV) together with phytosterols and sea-surface temperature estimates derived from the new, HBI-biomarker-based EZ<sub>25</sub> proxy.

Sea-ice biomarkers indicate persistent seasonal sea ice at the site throughout the last millennium, with expanded ice conditions during the Little Ice Age. However, the record is characterised by an exceptional enrichment of the pelagic biomarker HBI III beginning around 1710 CE and peaking during the late 19<sup>th</sup> century. Concentrations exceed those observed in modern Barents Sea surface sediments by more than an order of magnitude. These extreme values cannot be explained by spring marginal ice-zone productivity alone and coincide with historical observations placing the late-summer sea-ice margin directly over the core site during the mid- to late 19<sup>th</sup> century.

We interpret this anomalous HBI III enrichment as evidence for intense late-season ice-edge diatom blooms, likely dominated by *Rhizosolenia* spp., capable of sustaining productivity in stratified, nutrient-limited surface waters through vertical migration. Enhanced stratification and nutrient entrainment near the retreating ice margin likely promoted these blooms.

Our findings demonstrate that extreme pelagic HBI enrichments may represent a previously unrecognised sedimentary signature of late-summer ice-edge productivity. This signal offers a potential new approach for identifying the summer sea-ice minimum in Arctic palaeo-records and provides insight into seasonal ecosystem responses to past sea-ice variability in the Barents Sea.

# Cosmogenic chlorine-36 constraints on Holocene glacier change in Iceland

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Understanding temperature variability during the Holocene is critical for constraining baselines of natural climate variability. Temperate mountain glacier extent is limited most significantly by summer air temperature, thus geological records of past glacier length changes represent a useful proxy for this climatic variable. Iceland's maritime glaciers with their high sensitivity to temperature and precipitation changes serve as robust indicators of climate variability in the North Atlantic region. Previous reconstructions of Iceland's Holocene glacier and climate history have relied primarily on marine sediment cores, terrestrial geomorphological evidence, and glaciological modelling. These proxies highlight a correlation between glacier fluctuations and regional climate variability and suggest notable glacier retreats during early and midHolocene warm periods.

Here, we present cosmogenic chlorine-36 measurements from four outlet glaciers of the Vatnajökull ice cap in Iceland that test and further constrain the occurrence of past glacier minima during the Holocene. Unlike the more commonly used method of cosmogenic surface exposure dating of moraines, which constrains the timing of past glacier advances, our application targets the remnant cosmogenic signals of prehistoric exposure events preserved in freshly exposed proglacial surfaces. Our data thus tests for the occurrence and constrains the duration of past glacier retreat events and, thereby, warmer times during the Holocene. Our results support the hypothesis that Icelandic glaciers were smaller than present for several millennia during the Holocene and when combined with existing datasets of Icelandic climate, our new results allow us to reconstruct both glacier advance and retreat through the Holocene.

# Plio-Pleistocene Magnetostratigraphy of Eastern Fram Strait Drifts (IODP Exp. 403)

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International Ocean Discovery Program (IODP) Exp. 403 recovered expanded contourite sequences from the eastern Fram Strait and Svalbard Margin (76.5-79.2°N), providing new sedimentary archives of Arctic environmental evolution spanning the last ~6 Ma. Shipboard paleomagnetic measurements on discrete samples were central to developing initial chronologies and were broadly consistent with limited biostratigraphic observations. However, magnetizations in many sediments are carried by mixed magnetite (Fe<sub>3</sub>O<sub>4</sub>) and greigite (Fe<sub>3</sub>S<sub>4</sub>) assemblages, reflecting primary detrital and secondary chemical remanent magnetizations that complicate magnetostratigraphic interpretation. In particular, Pliocene sediments often contain up to centimeter-scale greigite/siderite nodules that host strong secondary magnetizations, with mineralogy confirmed by X-ray diffraction. One nodule studied in detail records reverse polarity within sediments deposited during the normal polarity Chron C2An.1n (late Gauss 2.63 Ma), demonstrating that substantial time offsets may occur between primary and secondary remanence acquisition.

Magnetic parameters, including anhysteretic remanent magnetization (ARM) and magnetic susceptibility (k), were used to distinguish greigite-dominated from magnetite-dominated intervals. At Bellsund Drift Site U1623 on the Svalbard Margin, high sedimentation rates (~22 cm/kyr over the last 1 Myr) and relatively low ARM coercivities indicate dominantly detrital magnetic assemblages and well-defined magnetizations. These records clearly identify the Matuyama–Brunhes boundary and the Jaramillo Subchron, allowing for strong constraints on proxy data like the timing of nannofossil abundance events. At eastern Fram Strait sites (U1619 and U1620), paleomagnetic data were filtered using magnetic property criteria to remove greigite-rich samples. The resulting polarity pattern indicates expanded early Pleistocene and Pliocene sequences with sedimentation rates of ~16–36 cm/kyr, highlighting the potential of these sites to resolve Arctic paleoceanographic variability at orbital to suborbital timescales.

Ongoing work has two major objectives. (1) We seek to develop high-resolution relative paleointensity (RPI) and environmental magnetic records from u-channel analyses at Bellsund Drift Site U1623 over the last ~400 kyr. Initial results from the last glacial cycle show increased fine magnetic mineral concentrations (ARM/k) during or immediately following interglacial periods, similar to observations from the Yermak Plateau. (2) We seek to improve confidence in magnetostratigraphic interpretations of Pliocene sediments using hybrid thermal and alternating-field demagnetization techniques to isolate magnetite-hosted remanences. Thermal experiments show mineral alteration beginning near ~250°C, lower than reported in previous studies where

hybrid demagnetization approaches have been successful. However, a small subset of samples retains stable magnetizations above 350°C and yields interpretable primary polarity directions. While challenges remain, the potential for well-constrained Plio-Pliocene magnetostratigraphies in these high-sedimentation-rate sites makes them attractive targets for Arctic paleoceanographic studies and for developing improved multi-proxy age models for the region.

# Asynchronous sea-ice responses driven by Atlantic Water inflow over the past 14,600 years, Svalbard

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Sea ice is a critical component in the polar system, influencing the energy budget, air-sea gas exchange, thermohaline circulation, and marine ecosystems. Under global warming, the Arctic Ocean has experienced a pronounced sea-ice decline. The Svalbard archipelago, located along the only deep-water connection between the Atlantic and Arctic oceans, has warmed by approximately 4 °C over the past century. This unprecedented condition calls for long-term studies of sea-ice variability to understand the rapid sea-ice decline in recent decades and to predict future Arctic changes. Highly branched isoprenoid (HBI) with 25 carbon atoms (IP<sub>25</sub>) is produced solely by sea-ice diatoms and has been used to reconstruct paleo-sea-ice distributions. C<sub>37:4</sub> alkenone, biosynthesized by the Isochrysidales that widely co-occurs with sea ice, also serves as a useful proxy to reconstruct millennial-scale sea-ice conditions. Here, we present biomarker data (including HBIs, brassicasterol, dinosterol, and C<sub>37</sub> alkenones) from sediment cores in distinct Svalbard fjords (HH17-1100-GC in Wijdefjorden, HH19-877-GC in Bellsund, and HH19-905-GC in Little Storfjorden). Results showed that semi-quantitative sea-ice index P(III)IP<sub>25</sub> aligned with the abundance of the C<sub>37:4</sub> alkenone (%C<sub>37:4</sub>) over the past 14.6 kyrs, quantitatively reflecting sea-ice variability since Last deglaciation. During the Bølling–Allerød (13.95–12.8 kyr BP), warm Atlantic Water (AW) inflow into Svalbard fjords increased, and glacier fronts retreated into central Wijdefjorden. PIP<sub>25</sub> in HH17-1100-GC indicated partial sea ice cover and a retreating ice edge there. The highest peaks of PIP<sub>25</sub> in HH17-1100-GC, HH19-877-GC, and HH19-905-GC occurred during the Younger Dryas (YD), indicating extensive sea ice expansion. The cooling trend and prolonged sea ice inhibited glacial activity. These peaks exhibited a centennial-scale phase lag, with changes on the southwest coast before those on the north and southeast coasts. During this period, %C<sub>37:4</sub> was low in HH17-1100-GC, likely due to extended sea ice limiting productivity, while %C<sub>37:4</sub> in HH19-877-GC and HH19-905-GC closely matched the trend of PIP<sub>25</sub>. During the early Holocene, warm AW inflow increased; PIP<sub>25</sub> and %C<sub>37:4</sub> decreased significantly after the YD termination, consistent with reduced sea ice extent and warm sea surface temperatures. The late Holocene in Svalbard was characterized by a general cooling trend and increasing sea ice extent. These findings provide a valuable paleoclimatic baseline to better constrain and predict the trajectory of Arctic cryospheric change under ongoing global warming.

## Northern Swedish rivers – carved by glacial floods

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All the largest rivers of northern Sweden have been shaped by catastrophic glacial lake outburst floods (GLOFs) during the last deglaciation of the Scandinavian Ice Sheet.

Instead of gradually evolving through progressive downcutting and meandering through finegrained sediments following post-glacial uplift and shoreline regression, large tracts of rivers in northern Sweden have remained largely static through the Holocene. This, as violent GLOFs had cleared the river valleys of finer sediments along their flood paths, hindering “common” fluvial geomorphic processes and landscape development.

Here, I show how glacial floods have produced unique river morphologies and landscapes in northern Sweden, and how traces left by these floods can also be used to reconstruct, e.g., both the last ice-sheet demise and pattern of post-glacial uplift.

# Moraines in the southern Norwegian North Sea

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Over the past few years, MAREANO ([www.mareano.no](http://www.mareano.no)) has mapped seabed areas considered for offshore wind farming in the Norwegian North Sea south of Norway. Some of these are particularly valuable and vulnerable areas for the sea (SVO). Multibeam bathymetry (1-5 m resolution), sub-bottom profiles (SBP), video transects and seafloor sediment samples have been collected as a basis for regional geological mapping. Here, we present 1:100 000 maps and descriptions of seabed sediment (grain size), sedimentary environment, landforms and genesis produced by NGU from the collected data.

The new maps add to the understanding of the glacier extent and ice sheet dynamics in the North Sea at the end of the last glaciation. Grounded ice sheets have affected the area, depositing till and forming glacial landforms that are still exposed on the sea floor. Most profound is a ~30 km long NNW-SSE oriented ridge crossing the eastern part of the study area. The ridge complex is composed of two large moraines superposed by several smaller ones and is interpreted to represent two episodes of westward ice advance during the general ice retreat of the ice margin. The eastern moraine is the largest, up to 15 m high and 2200 m wide. It overprints the western moraine, indicating that the eastern moraine is the youngest. Several smaller furrows cross the moraine in an ENE-WSW direction interpreted as glacial lineations, indicating the direction of ice flow. The SBP data show eastern-dipping internal reflectors indicating glacial push from ENE. Along the southern end of the moraine, poorly sorted glaci-fluvial deposits are interpreted to represent glacial lake outburst flood sediment from the NE of the moraine ridge complex.

Post-deglaciation, the area was submerged due to sea level rise and coastal processes (waves and currents) modified the present expression of the glacial geomorphology. Bottom currents have had a fundamental impact on the sedimentary environment since, depositing and transporting sediment and partly covering the glacial landforms at the seabed. The formation of current-related bedforms is probably also affected by the relief of the underlying glacial landforms.

Geomorphology is important for understanding glacial dynamics and the formation of the marine landscape. By mapping glacial features, we identify geological information useful for future users, e.g. for windfarms, offshore cables or fisheries. The results also support policy makers in balancing the need for energy and the protection of unique landforms and vulnerable environments.

# Refining Arctic Plant Diversity Dynamics

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The Arctic is warming four times faster than the global average, yet recent pan-Arctic analyses reveal a puzzling decoupling between stable local species richness and widespread species turnover. While current research identifies temperature and erect shrub expansion as key drivers of change, several methodological limitations – such as the exclusion of non-vascular plants and scale mismatches in snow data – hinder a complete mechanistic understanding. This work proposes a refined statistical framework to address these gaps. By implementing Compositional Data Analysis (CoDA), we account for the inherent negative correlations between functional group shifts. Furthermore, we apply spatial and temporal lag models to explicitly capture extinction and colonization dynamics often masked in standard linear approaches. Integrating high-resolution topographic proxies and functional trait data allows for a more granular assessment of community resistance and vulnerability. These refinements provide a more robust basis for predicting how climate-driven reshuffling will ultimately impact Arctic ecosystem functions and livelihoods.

# Late Holocene Sea-Ice Variability and Water-Mass Dynamics in Edisto Inlet (Antarctica): A High-Resolution Multi-Proxy Approach for Bipolar Comparisons

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High-resolution paleoenvironmental archives are essential for understanding the sensitivity of polar coastal systems to climate forcing. This study presents a multi-proxy reconstruction from Edisto Inlet (NW Ross Sea, Antarctica), a high-sedimentation-rate site ( $0.2 - 0.7 \text{ cm yr}^{-1}$ ) providing an exceptional archive of Late Holocene sea-ice dynamics. By analysing fossil diatom assemblages and geochemical proxies (including  $\text{IPSO}_{25}$ ) from core HLF17-01, we identify three distinct environmental phases over the last 2.6 ka: a seasonal phase, a transitional warm phase, and a cooler phase (post-0.7 ka BP) characterized by increased sea-ice persistence.

A key finding of this work is the decoupling of sea-ice indicators *Fragilariopsis curta* and *Fragilariopsis cylindrus*, which reflect different seasonal durations and ice conditions rather than a uniform sea-ice signal. Furthermore, the presence of *Proboscia inermis*, a species typically absent under normal summer melt conditions, is used as a proxy for modified Circumpolar Deep Water (mCDW) intrusions and suggests periods of enhanced water-column stratification.

While focused on the Ross Sea, these results offer significant synergies for Arctic research, particularly regarding the Arctic coastal sector. The high-resolution methodology and the refined use of species-specific diatom proxies provide a comparative framework for investigating similar seasonal sea-ice retreats and water-mass dynamics in Arctic coastal inlets. These results highlight the value of diatom assemblages as robust proxies for reconstructing sea-ice seasonality and oceanographic variability in polar coastal environments, providing insights relevant for understanding sea-ice–ocean interactions across polar systems.

# Dynamic post-LGM ice sheet retreat after loss of ice shelf buttress in Melville Bugt, west Greenland

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Anthropogenic climate change could cause the collapse of Earth's remaining ice sheets, particularly marine-terminating ice sheets, whose response to warming is poorly understood. To advance our understanding of ice dynamics under warming conditions and provide more accurate constraints for modelling, we can study analogous ice sheets in the geologic record. At the Last Glacial Maximum (LGM), the Greenland Ice Sheet drained through several ice streams into Baffin Bay, buttressed by the Baffin Bay Ice Shelf. This work will present an ice retreat history from the northern edge of the central Melville Bugt trough mouth fan (TMF) reconstructed using subbottom profiles, multibeam bathymetry, and sediment cores. We identify a series grounding zone wedges and iceberg takeoff plough marks on the Melville outer trough. In the embayment between the TMF and the northern inter-trough margin, termed the Melville Hook, there are a series of debris flow and meltwater-derived sediment deposits. The debris flows are inferred to have been triggered during ice stream retreat, overtaking the background meltwater drainage signal. Our findings reveal how an overthickened ice stream reacted to the loss of an ice shelf buttress and may provide supporting evidence for the contested marine ice cliff instability hypothesis.

We further detail the evolution of ice within the Melville Hook after ice stream retreat, which includes the interplay of ice shelf evolution and ice drainage from the inter-trough bank. Our results highlight the importance of such hooks formed by the extension of TMFs beyond the adjacent margin in overall ice sheet stability and growth. In the Melville Hook, the western Greenland Ice Sheet extended onto the continental slope and was grounded deeper than previously thought, which has implications for total ice volume at the LGM.

# A candidate subglacial palaeolake basin associated with regionally widespread eskers and debris-covered glaciers on Mars

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Our neighbouring planet, Mars, is thought to have been extremely cold and hyperarid for the last 3 Gyr, with an extremely limited role of liquid water. Mars' mid-latitude regions host thousands of debris-covered glaciers, which formed within the last 10s-100s Myr (during the mid-to-late 'Amazonian' period). These glaciers are thought to have been deposited by snowfall during cyclical Martian ice ages driven by variations in Mars' orbital obliquity. It has long been assumed that they have remained predominantly cold-based under cold Amazonian climate conditions. A small number of eskers (ridges of glaciofluvial sediment deposited in ice-confined meltwater tunnels) extending from glaciers in the Phlegra Montes and Tempe Terra regions of the northern mid latitudes have been attributed to rare, spatially restricted subglacial melting of their parent glaciers, driven by transient, localized geothermal heating events. This is consistent with their locations within glaciated tectonic grabens in (or near to) major volcano-tectonic provinces.

Here, we present two key advances. First, we identify additional eskers associated with glaciers in Tempe Terra, which indicate regionally widespread occurrences of

Amazonian subglacial melting distributed along a 650 km long mountain chain in the Tempe Terra region. They likely necessitate a much more spatially extensive heat source (e.g., a geothermal hotspot and/or regional climate change) than previously expected.

Second, and perhaps most tantalizingly, two of the newly identified eskers are associated with a landsystem consistent with meltwater drainage into a subglacial palaeolake. The landsystem comprises landforms interpreted as eskers, subglacial channels, an eskerterminal fan, and a medial moraine. Together, they suggest that formerly thicker and more extensive Amazonian mid-latitude ice masses, of which mid-latitude debris-covered glaciers are thought to be retreated remnants, were capable of supporting subglacial lakes. This should motivate an extensive search for glacial paleolake deposits across Mars' mid latitudes.

Glaciers in Mars' mid latitudes are prime targets for next-generation missions aiming to search for life, reconstruct environmental change on Mars, and characterize potential in situ water resources for eventual human exploration. Subglacial paleolake deposits proximal to these glaciers would represent high-priority science targets because on subglacial lakes on Earth support microbial ecosystems under extreme conditions, while paleolake deposits have high potential for preserving biosignatures in the geologic record.

# Re-evaluating Holocene relative sea-level change in central western Greenland using remote sensing geomorphology

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Reconstructions of Holocene relative sea-level (RSL) change in Greenland are essential for constraining past Greenland Ice Sheet (GrIS) mass balance, ice extent, and glacial isostatic adjustment (GIA). Isolation basins represent the highest-quality RSL archives available in Greenland and have been widely used to calibrate icesheet and GIA models (Long et al., 2011). However, in several regions of central western Greenland, low-lying basins only contain freshwater deposits throughout their sediment records, with no evidence of a marine phase. These observations have typically been interpreted as indicating minimal Holocene RSL change, with significant implications for regional ice-sheet thickness reconstructions and GIA model calibration.

We propose an alternative explanation. Fjord systems of central western Greenland in places have steep, unstable slopes and widespread evidence for large landslides (Dai et al., 2025). Comparable Arctic environments have experienced landslide-generated tsunamis capable of remobilising sediments and scouring shallow basins (Korsgaard et al., 2024). We hypothesise that paleo-tsunamis could have removed or severely disturbed marine sediments in low-lying basins in central western Greenland, producing freshwater-dominated records that mimic a signal of negligible RSL change, an artefact of archive loss rather than genuine sea-level stability.

To test this hypothesis, we employ high-resolution satellite imagery (Sentinel-2, SPOT 6/7) and digital elevation models (ArcticDEM) to systematically map raised beach ridges, wave-cut terraces, and other coastal geomorphological features that record former sea-level positions independently of basin sediment archives. We further investigate landslide scars and coastal features like wash-over deposits indicative of high-energy inundation, evaluating their spatial relationship with low-lying basins. Local observations are integrated with a newly developed Greenland-wide RSL and marine limit database to assess regional coherence.

This project delivers the first systematic assessment of whether geomorphological evidence supports a Holocene RSL history in central western Greenland that is inconsistent with isolation basin interpretations and establishes remote sensing geomorphology as a tool for reconstructing RSL where sedimentary archives are compromised.

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# **Holocene sea-ice and ecosystem dynamics north of Greenland – from the Arctic’s Last Ice Area to the North Water Polynya**

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The northern coastline of Greenland, spanning from the Lincoln Sea to northern Baffin Bay via the Nares Strait, is a unique sea-ice regime. Under future climate warming, the Lincoln Sea is expected to remain the final refuge of multi-year sea ice in the Arctic, important for sea-ice dependent ecosystems. However, prolonged periods of open water during recent years raise concerns about its long-term stability. Nares Strait connects the perennially sea-ice covered Lincoln Sea to the Pikiarsorsuaq or North Water Polynya (NOW), the Arctic’s largest and most productive polynya. The annual formation of the NOW is aided by ice arches in the narrow passages of Nares Strait. Recurrent failure of ice arches in Nares Strait during recent years influence the extent, ice cover, and stratification of the NOW and with it, its ecosystem.

Using a transect of marine sediment cores spanning from the Lincoln Sea to northern Baffin Bay, we can investigate the regional sea-ice and ecosystem dynamics during the Holocene. Reduced sea-ice extent during the earliest (~10-11 ka) Holocene is associated with maximum regional atmospheric temperatures. This is followed by the re-establishment of a perennial sea-ice cover in the Lincoln Sea and variable sea-ice cover in the Nares Strait and NOW region during the mid-to-late Holocene (<6 ka). In combination with previously published records, two intervals of stable polynya conditions (~3.8-5.5 ka, <1 ka) are recognized. These are associated with different sea-ice regimes and ecosystem dynamics, potentially a result of varying boundary conditions across the mid-to-late Holocene. These are interrupted by a period (~3.8-1 ka) characterized by an unstable southern ice arch in Nares Strait and time-transgressive contraction of the polynya. This pattern suggests that the formation of a southern ice arch in Nares Strait played a key role in controlling the extent of the NOW during the Holocene, with an unstable ice arch making the region more vulnerable to changes in atmospheric and oceanic forcing.

# The geomorphic signature of Late Weichselian ice shelves and deglacial dynamics along the Isfjorden Coast, Svalbard

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The last deglaciation of the Svalbard-Barents Sea Ice Sheet remains poorly constrained, particularly regarding glacier dynamics in Svalbard's major outlet fjords. This study presents new geomorphological and sedimentological evidence from the southern Isfjorden coast, revealing a previously unrecognized ~4.6 km-long ice-marginal moraine complex. Geomorphological characteristics indicate deposition by an advancing ice shelf during deglaciation, representing the first terrestrial paleo-ice-shelf moraine identified in Svalbard. The moraine's steady elevation directly at the local marine limit during deglaciation (~70 m a.s.l.), its coast-parallel lobate geomorphology, and the presence of erratics from northeastern Isfjorden suggest a southwestward-flowing ice stream that became buoyant in central Isfjorden, where water depths would have supported the formation of an ice shelf prior to rapid isostatic uplift. These findings support recent evidence indicating that glacier activity in Svalbard during the Late Weichselian was more dynamic than long recognized. Both the moraine complex and postglacial landscape assemblage provide insights into deglacial dynamics and Holocene landscape evolution in Isfjorden - offering a paleo-analogue to processes observed in parts of Greenland and West Antarctica today.

# **Asynchronous glacial response during the Younger Dryas in Troms, Norway, influenced by internal ice-sheet dynamics and local topographic controls**

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We present a revised chronology that constrains ice-margin retreat and re-advance dynamics of the Fennoscandian Ice Sheet in Troms, northern Norway. The prominent Tromsø–Lyngen (TL) moraines, which form part of a Scandinavia-wide moraine belt, have been attributed to a major ice-margin re-advance culminating in the Younger Dryas stadial. Despite decades of research, substantial uncertainties persist regarding both the timing and duration of the TL event in northern Norway, primarily owing to the limited availability and spatial coverage of geochronological data. Proglacial threshold lakes register minerogenic-rich sediment accumulation during maximum ice re-advance, followed by a transition to organic-rich lacustrine or peat deposition upon ice-margin retreat. Radiocarbon dating of the minerogenic– organic sedimentary boundary constrains the timing of local ice-margin recession and thus provides minimum ages for the re-advance.

To constrain the onset, duration, termination, and spatial variability of the TL event in Troms— an area characterized by pronounced topographic heterogeneity but subjected to broadly similar regional climatic forcing during deglaciation—we: (i) identified and dated five new sites proximal to the TL moraine complex, comprising four proglacial threshold lakes and one outcrop of ice-dammed lake sediments; (ii) compiled a comprehensive database of all available TL-related chronological information and critically evaluated the reliability of each age determination using strict quality criteria; and (iii) integrated the robust legacy ages together with the new age determinations into a unified chronological framework using Bayesian sequence models in OxCal, which synthesize reliable radiocarbon ages within their stratigraphic contexts to produce a coherent, regionally comparable chronology.

The resulting model substantially increases chronological precision and reveals asynchronous glacier responses across catchment boundaries and fjord systems. It supports earlier evidence that the TL event was a major late Allerød re-advance following a short period of largely icefree fjords, and that the ice margin then remained broadly stable through the Younger Dryas. The new ages imply a more prolonged ice-margin residence into the Early Holocene in eastern Troms, where the hinterland is dominated by high plateau topography, and an earlier, more rapid retreat in western Troms, where deeply incised fjords intersect high mountain topography.

These spatially variable patterns demonstrate that the re-advance cannot be attributed to external climate forcing alone, highlighting the importance of internal ice-sheet dynamics and local topographic controls in governing ice-margin oscillations, while nevertheless affirming the overarching influence of late-glacial climatic changes.

# Dating DK: Cosmogenic $^{10}\text{Be}$ depth profiling of glacial outwash plains in Denmark

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During the Quaternary period the Fennoscandian ice sheet reached far into Europe on several occasions. Especially the last two ice sheet expansions, the Saalian and Weichselian, left many marks on the Danish land surface and shaped the landscape, leaving behind outwash plains, terminal moraines, tunnel valleys, and other glacial landforms. Although, there is general consensus regarding which ice advances resulted in which landscape features, most correlations have not yet been verified by absolute dating. To improve constraints on the ice cover history of the Danish area, we have carried out  $^{10}\text{Be}$  profiling on several outwash plains across Denmark. These outwash plains have been chosen (i) to constrain the timing of the overall ice margin retreat across Denmark, and (ii) to decipher whether the northern part of the prominent 90-degree landform (the “Main Stationary line”) belongs to the Last Glacial Maximum advance (~20.000 years ago) or a previous ice advance, such as the Kattegat advance (~30.000 years ago). Denmark is located right at the foothills of the Fennoscandian ice sheet, and we expect our results to have strong implications on the understanding of ice sheet dynamics at play during advance-retreat cycles of continental sized ice sheets, as well as to improve the understanding of the glacial history of Northern Europe. At ARCPaC some of the preliminary results from this investigation will be presented.

$^{10}\text{Be}$  profiling is a technique which involves sampling sediment from several depths below the surface at a specific location. Interpretation of the  $^{10}\text{Be}$  concentrations can lead to age estimation of the sampled deposit, since the concentrations will depend on the cosmogenic exposure history of the sediment package. A set of samples from different depths are needed to separate the pre- and post-burial  $^{10}\text{Be}$  nuclide concentrations or to draw attention to  $^{10}\text{Be}$  irregularities throughout the profile indicating asynchronous deposition. The numerical modelling of nuclide concentrations carried out in this study serves as proof of concept and highlights the applicability of the  $^{10}\text{Be}$  profiling approach. Hence, alongside the preliminary results of the study, our novel MATLAB implementations for interpreting  $^{10}\text{Be}$  profiles will also be showcased.

# Diagenetic Overprint and Magnetostratigraphic Fidelity in Central Arctic Ocean Sediments

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The frequent geomagnetic reversals in central Arctic sediments have been widely questioned as faithful recording of changes in Earth's magnetic field. Paleomagnetic and rock magnetic parameters from two gravity cores collected from the Alpha and Mendeleev ridges, western Arctic Ocean, have been analyzed to examine the preservation and alteration mechanisms of magnetostratigraphic signals. Paleomagnetic results indicate that the remanence records in the upper sections of the cores are poorly preserved, whereas the lower part contains a recognizable inclination reversal section that allow for regional correlation. Rock magnetic analyses reveal significant diagenesis, with distinct differences in composition of magnetic minerals between the upper and lower part of the cores. Age constraints established based on biostratigraphy and manganese cycles suggest that the variations in magnetic minerals appear to correlate more strongly with core depth than with age. The primary remanent magnetization in the upper parts of the cores is likely obscured by a strong, inseparable chemical remanent magnetization (CRM) resulting from intense diagenesis. Variations in the redox environment of Arctic Ocean Bottom Water could be a crucial factor contributing to the CRM changes in magnetic minerals within sediments, ultimately leading to anomalous magnetic inclination signals.

# Size variability of the centric diatom *Coscinodiscus centralis* in northern Baffin Bay throughout the Holocene

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Diatoms are unicellular algae, and as primary producers, they form the base of the food web in many aquatic ecosystems. They are highly sensitive to environmental parameters including temperature, salinity, nutrients and sea ice, and their abundance and preservation in sediments make them ideal micropaleontological proxies in paleoceanography. Additionally, they play an important role in the marine carbon cycle.

To gain a more mechanistic insight into the response of diatoms to environmental changes during the Holocene, this study focuses on the size variability of a single species of diatom, *Coscinodiscus centralis*, rather than studying the full diatom assemblage. This relatively large centric diatom, which ranges from 50 to 400  $\mu\text{m}$  in diameter, is highly abundant in the Baffin Bay, and specifically in the North Water Polynya offshore northwestern Greenland.

Here we show size variations of *C. centralis* in gravity core LK19-ST6-6G (632 meters water depth, 76.5627, -73.3341), centrally located in the North Water Polynya. The core covers the past  $\sim 12$  kyr BP, with *C. centralis* being present since  $\sim 8$  kyr BP, likely related to the opening of Nares Strait. Results show size variability of *C. centralis* ranging from 122  $\mu\text{m}$  to 372  $\mu\text{m}$ , with median values between 175  $\mu\text{m}$  and 230  $\mu\text{m}$ . A significant reduction in median size, on the order of  $\sim 60$   $\mu\text{m}$ , occurred between  $\sim 5$ -4 ka, suggesting that *C. centralis* sizes sensitively responded to environmental and ecosystem changes at this time, likely related to polynya dynamics.

# Estimating fjord sediment volumes and subglacial erosion rates in Greenland from fjord morphology

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Greenland's fjords host major sediment depocenters that preserve long-term records of subglacial erosion and sediment transport from the Greenland Ice Sheet. Yet, sediment thicknesses and volumes remain poorly constrained in most fjords due to sparse seismic coverage and limited core penetration, hindering our ability to quantify past erosion rates and reconstruct ice-dynamics in a source-to-sink framework. To address this gap, we develop a geomorphology-based reconstruction method that estimates first-order sediment infill by fitting idealized parabolic bedrock geometries to fjord cross-sections, calibrated using seismically surveyed fjords. This approach exploits the growing high-resolution bathymetry coverage in Greenland to infer fjord sediment thicknesses based on deviations from U-shaped profiles.

Applying this method to 28 Greenlandic fjords, we generate spatially continuous sediment-thickness maps revealing pronounced across-fjord and along-fjord variability, with several basins containing more than 500 m of inferred sediment infill and volumes exceeding 10 km<sup>3</sup>. Integrating these volumes with ice-catchment areas and deglaciation chronologies, we estimate minimum catchment-averaged erosion rates of ~0.01–1.38 mm yr<sup>-1</sup> over deglacial–Holocene timescales. To further assess spatial and temporal patterns of subglacial erosion, we employ the coupled ice-flow and erosion model iSOSIA, driven by paleoclimate forcing, to simulate erosion beneath marine-terminating outlet glaciers during the last deglaciation. Modeled sediment outputs are compared with our fjord-infill estimates, enabling calibration of erosion model parameters and investigation of transient changes in subglacial erosion patterns.

Our combined observational–modeling results show that deglacial erosion rates vary markedly through time and space: fast-flowing, topographically constrained outlet glaciers can exceed 10 mm yr<sup>-1</sup>, whereas slower interior regions erode at <0.1 mm yr<sup>-1</sup>. Sediment volumes scale moderately with fjord and catchment area and are likely influenced by regional parameters like precipitation, basin morphology and ice-flow dynamics.

This work provides new first-order constraints on the amount and distribution of glacially derived sediment stored in Greenland's fjords and demonstrates the value of combining geomorphological reconstructions, marine sediment archives, and numerical modeling to refine estimates of subglacial erosion. The approach offers a versatile tool for quantifying fjord sediment budgets in data-sparse regions and for improving reconstructions of past ice-sheet behavior and predictions of future sediment fluxes under continued ice-sheet retreat.

# An Ancient Giant Post-Glacial Landslide Hidden in a Danish Tunnel Valley

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Denmark is a low-relief landscape generally considered stable since deglaciation despite increasing national focus on modern slope instability (Svennevig et al., 2020). Here, we present the first geomorphic and subsurface characterization of a giant paraglacial paleo-landslide on the southern flank of the Vejle Ådal tunnel valley, informally named the Nørre Vilstrup Landslide, in eastern Jutland. Geomorphic mapping using high-resolution (0.4 m) national LiDAR reveals a ~11.1 km<sup>2</sup> lobate deformation complex that protrudes ~0.5 km northward into the valley and appears to deform the valley floor. The feature is defined by (i) a ~1 km<sup>2</sup> proximal depression, (ii) a main lobate body with ~12 valley-parallel deformation fabrics expressed as ~east-west ridges and troughs, and (iii) a distal band of convex “stands” that are buttressed against the northern valley wall and mirror the landslide morphology across the valley. This morphology is consistent with large-scale translation and frontal toe thrusting.

Transient Electromagnetic (TEM) surveys combined with borehole stratigraphy from the national Danish borehole database provide subsurface characterization. Preliminary results indicate that the subsurface clay and sand units appear disrupted in a pattern that mirrors the lobate surface morphology. Ongoing interpretation evaluates whether the subsurface structures support the landslide hypothesis, specifically examining evidence for thrusting and potential upward intrusion of clay during landsliding beneath the proximal depression.

Remnant curvilinear lineations preserved on the plateau and within the complex indicate inherited subglacial morphology, possibly formed by meltwater erosion (Adamczyk et al., 2022; Lesemann et al., 2010) or subglacial landsliding (Clark & Livingstone, 2018). The landslide likely developed within a dynamically evolving post-/paraglacial landscape shaped by deglacial unloading, groundwater reorganization, and fluvial incision along the tunnel valley margin.

We reconstruct the geomorphic evolution in four relative time steps: (1) subglacial excavation of the Vejle Ådal tunnel valley beneath the Scandinavian Ice Sheet. Curvilinear lineations preserved on the plateau predate the landslide complex; (2) postglacial drainage reorganization and gully incision along the valley flanks; (3) large-scale translational failure that displaced the southern valley flank northward, forming the lobate deformation complex, proximal depression, and distal toe thrust; and (4) post-failure fluvial reworking modified the landslide toe and reorganized valley-floor drainage.

Possible alternate formative processes include subglacial meltwater erosion capable of producing complex valley-side morphologies governed by hydraulic potential gradients beneath ice sheets (Hooke & Jennings, 2006; Kehew et al., 2012) and paraglacial fluvial incision and sediment remobilization during early post-glacial landscape adjustment that can modify tunnel valley margins and generate lobate depositional complexes along valley sides (Ballantyne, 2002). However, none of these hypotheses explain the overall morphology described in the study area.

Our working hypothesis is that the Nørre Vilstrup structure is a landslide and represents one of the largest paleo-landslides in Denmark and suggests that deep (~100 m scale) mass movements may play a more significant role in the paraglacial landscape adjustment than previously recognized. Similar mass-wasting

processes have been documented within buried tunnel valleys of the central North Sea (Kirkham et al., 2024) and many other potential paleolandslides are present in the Danish landscape.

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# Multiproxy Perspectives on Glacial Oscillations and Climate Variability in Northeast Greenland

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Multidisciplinary research on past climatic and environmental dynamics is crucial for improving our understanding of the complex interactions among Earth system components. The Arctic, a key element of the global climate system, hosts some of the most climate-sensitive environments on the planet and preserves a variety of natural archives that provide valuable information about past, present, and potential future environmental conditions. In this context, the remote ice-free coastal sectors of Northeast Greenland National Park constitute an exceptional natural setting for investigating geomorphological processes associated with cold climates and the climatic conditions that drive them.

This contribution presents new proxy evidence derived from two complementary natural archives: the geomorphological record, including glacial deposits and erosional landforms, and lacustrine sediment sequences from which geochemical and biological proxies were obtained. Our study focuses on four valleys where detailed geomorphological mapping was combined with <sup>10</sup>Be cosmogenic nuclide exposure dating. These data were integrated with a multiproxy analysis of lake sediment records and <sup>14</sup>C chronologies in order to reconstruct patterns of Holocene climate variability.

The results indicate that glacier retreat initiated after the Younger Dryas and accelerated into the Early Holocene, likely in response to warmer and drier climatic conditions. Lake sediment records reveal a progressive long-term reduction in precipitation, which likely contributed to continued glacier recession. During the Holocene Thermal Maximum, widespread glacier retreat occurred across the region, consistent with warmer conditions throughout Greenland. Around 3 ka cal BP, a transition toward wetter conditions is inferred, which promoted renewed glacial advances during the Late Holocene. A further phase of glacier expansion is documented around 1.3 ka, corresponding to the period commonly referred to as the Dark Ages. This interval was followed by relatively warmer conditions during the Medieval Warm Period before another glacial phase developed.

The subsequent Little Ice Age (LIA) was characterized by significant glacier advances that reached maximum extents at approximately 0.6 and 0.3 ka. Multiproxy lake records suggest that these advances were driven by a combination of increased precipitation and lower temperatures. The termination of the LIA was marked by a shift toward decreasing precipitation and rising temperatures.

Overall, this multidisciplinary reconstruction offers new insights into the environmental evolution of the High Arctic, emphasizing the strong coupling between climate variability, geomorphological processes, and glacier dynamics over millennial timescales. Integrative approaches such as this are fundamental for improving our understanding of Arctic environmental sensitivity and for anticipating the potential impacts of ongoing climate change in polar regions.

# Evidence for a dynamic marine-terminating western margin of the Greenland Ice Sheet during Marine Isotope Stage 3

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Constraining the extent and behavior of the Greenland Ice Sheet (GIS) on glacial timescales provides context for its influence on global climate as a major freshwater source to the North Atlantic Ocean, as a contributor to global sea level, and as an analog for ice sheet behavior during periods of abrupt climate change. However, GIS configuration during Marine Isotope Stage 3 (MIS 3; ~57-29 ka), when global ice volume was between glacial and interglacial conditions and climate was characterized by abrupt millennial-scale oscillations, remains poorly resolved due to sparse observations. Jumbo piston core AR2307-89JC - recovered in Baffin Bay from a water depth of 1,178 m on the northern slope of the Disko trough mouth fan

- contains hemipelagic sediments deposited over the past ~45 - 50 kyr that reflect the behavior of the GIS and adjacent oceanographic conditions from mid-MIS 3, through the Last Glacial Maximum, the deglaciation, and the Holocene. Here we present a radiocarbon-based chronology, X-ray fluorescence analysis, and computed tomography-aided lithologic interpretation that reveal relatively high sedimentation rates and the presence of ice proximal facies, including ice rafting events that are likely Greenland-sourced, indicating a dynamic, marine-terminating GIS during MIS 3.

# Changes in Water Dynamics of the Arctic Ocean: Insights from $^{226}\text{Ra}$ during the 2024 Polarstern PS144 Cruise

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The Arctic Ocean is considered one of the ocean regions most vulnerable to climate change. Both changes in the hydrological cycle and the storage of fresh water near the surface, forced by increasing continental runoff, and the positive trend in the temperature of the warm Atlantic Water (AW) inflow have through the Fram Strait and the Barents Sea have been observed and are likely to increase further in the future. These changes are expected to alter the stratification of the Arctic Ocean, potentially leading to increased vertical heat fluxes with impacts on the regional sea ice. However, observations are sparse and future projections of stratification in the Arctic Ocean basins uncertain.

To address these problems,  $^{226}\text{Ra}$  is an ideal tracer. With a half-life of approximately 1600 years,  $^{226}\text{Ra}$  is produced by the radioactive decay of  $^{230}\text{Th}$  in the solid Earth. In the Arctic Ocean,  $^{226}\text{Ra}$  is supplied through three primary pathways: (1) riverine and shelf-water inputs to the surface layer, (2) inflow of AW subducted to form a subsurface layer, and (3) diffusion and release from deep-sea sediments. The first two pathways are closely connected to ongoing climate-driven changes in the Arctic Ocean, whereas the third pathway, along with the vertical gradient of  $^{226}\text{Ra}$  in the water column, provides a means to evaluate deep Arctic ventilation. Such ventilation reflects the strength of deep Arctic circulation and large-scale overturning processes. Therefore,  $^{226}\text{Ra}$  serves as a valuable proxy for assessing the impacts of ongoing system changes in the Arctic Ocean.

In this study, we analyzed seawater samples collected from the central Arctic Ocean during the Polarstern cruise PS144 (Project: ARCWATCH-2), conducted from 9 August to 13 October 2024. The sampling area was primarily located on the Eurasian side of the Arctic Ocean, covering the Nansen Basin, Amundsen Basin, and Makarov Basin. This region is strongly influenced by freshwater input and its redistribution via the Transpolar Drift (TPD), as well as by Atlantic Water (AW) inflow through the Fram Strait and the Barents Sea.

Samples were collected in pre-cleaned 1 L bottles at multiple depths from the sea surface to the seafloor, with 10–15 samples obtained at each station. Radium was separated using column chromatography with AG50W-X8 and Sr-Spec resins. The extracted  $^{226}\text{Ra}$  was measured using High-Resolution Inductively Coupled Plasma Mass Spectrometry (HR-ICP-MS; Element XR) at AWI Bremerhaven.

This dataset provides full-depth water-column profiles from multiple stations, allowing us to constrain large-scale water-mass distribution and deep-basin circulation dynamics. Utilizing this data, this study aims to quantify the ongoing transformations within the Arctic Ocean by comparing our new dataset with historical conditions. Our analysis focuses on characterizing the effect of the evolving surface freshwater distribution, the subsurface influence of AW inflow, and the resulting changes in vertical exchange intensity, ultimately providing new insights into the response of the Arctic system to climate change.

# Glacial geomorphology of palaeo-ice lobe beds in Latvia

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The contemporary landscape of Latvia was shaped mainly by the advance and deglaciation of the southeastern sector of the Last Scandinavian Ice Sheet (SIS). The retreat of the extensively lobate ice margin during the Old Dryas was characterised by asynchronous readvances and even surges of ice lobes and tongues. As a result, landform assemblages consisting of subglacial, proglacial, supraglacial and dead-ice features were created. Here, we report on the results of nationwide geomorphological mapping performed using a 1-m-resolution digital terrain model made from airborne laser scanning data (LiDAR). The morphological diversity is related to the dynamics of ice lobes influenced by bedrock topography and composition, thickness and lithology of pre-existing Quaternary sediments, thermal and hydrological conditions at the ice/bed interface, which governs the ice flow pattern and velocity.

Unique glacial landscape systems may be attributed, for example, to surging ice lobes, rapid ice streaming and dead-ice-dominated processes. In general, low elevations and topographically controlled ice streaming allowed fast-flowing and/or surging lobes to create landscapes dominated by streamlined subglacial bedforms, tunnel valleys and eskers, in surging situations – mega-scale glacial lineations overlain by crevasse-squeeze ridges. On the other hand, interstream/interlobate elevated areas (uplands and complex interlobate ridges) developed diverse glacial landscapes comprising glaciotectonic composite ridges and massifs, morainic plateaus and hills, glaciolacustrine plateau hills, supraglacial crevasse fills and various hummocky topography. A superimposed nature of streamlined bedforms is encountered in places, suggesting dynamic and oscillatory retreat of the ice margin often imposed by repeated advances. Widespread geometrical ridge networks interpreted as crevasse fields attest to surging and following ice stream shutdown behaviour. On the contrary, a large number of esker ridges at other sites, sometimes found in tunnel valleys indicates on active soft and wet bed deglaciation facilitated by meltwater availability, especially in the later phases of the deglaciation. The variability of glacial landsystems enables reconstructions of the dynamic nature of deglaciation of the SE sector of the SIS.

A preliminary database already includes several tens of thousands of glacial landforms and is also used to train machine learning models. The development of an unsupervised segmentation for glacial landform mapping is ongoing, providing near-future potential for automated landform mapping in the Baltics.

This research is funded by the Latvian Council of Science, project “Reconstruction of ice stream dynamics and deglaciation of the SE sector of the Scandinavian Ice Sheet in Latvia”, project No. lzp-2024/1-0193.

# Refining Quaternary chronostratigraphy in the western Arctic Ocean using multiproxy sediment records

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Establishing reliable chronostratigraphy for Arctic Ocean sediments remains challenging because of extremely low sedimentation rates, limited microfossil preservation, and complex depositional processes. These limitations hinder the reconstruction of long-term paleoenvironmental and cryospheric evolution in the Arctic Ocean. Here we investigate a sediment core retrieved from the Makarov Basin in the western Arctic Ocean to improve regional chronostratigraphic constraints and to explore sediment provenance changes since the early Pleistocene. The age framework is evaluated using multiproxy stratigraphic approaches, including manganese variability, lithologic cyclicity, and correlations with global paleoclimate reference records. This integrated framework allows us to examine orbital-scale environmental variability recorded in Arctic deep-sea sediments. Bulk mineral assemblages derived from quantitative X-ray diffraction analyses reveal spatially mixed sediment sources associated with the Siberian margin and northern North America. Variations in specific provenance-sensitive minerals provide insights into sediment transport processes linked to sea-ice drift, ice-rafted debris supply, and large-scale cryospheric dynamics in the circum-Arctic region. Our results highlight the importance of improved chronostratigraphic frameworks for interpreting Arctic sedimentary records and provide new perspectives on the coupling between ice-sheet evolution, sediment transport pathways, and paleoceanographic variability during the Quaternary.

# Northeast Greenland Glaciated Margin: an IODP3 Proposal

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The Greenland Ice Sheet is identified as a tipping point element within the Earth's climate system, which under the current trend of CO<sub>2</sub> emissions is at risk of becoming unstable, possibly leading to a complete meltdown. Its contribution to global sea-level rise over the past centuries has preceded the accelerating ice-sheet runoff now intensified by polar amplification. Thus, understanding the long-term stability of the Greenland Ice Sheet is critical for anticipating future climate and sea-level scenarios. While coupling between the ice sheet, ocean and sea ice is readily observable today in Northeast Greenland, geological records of past conditions and ice sheet dynamics for illuminating long-term trends are lacking. Deep ocean records from the Nordic Seas have previously provided insights into the Cenozoic ice-ocean-tectonic evolution of the northern North Atlantic. There are, however, outstanding questions related to the past evolution and dynamics of the Greenland Ice Sheet, where the Northeast Greenland continental margin forms a missing piece of the puzzle. NorthGreen aims to cover this knowledge gap by drilling the prograded shelf margin of Northeast Greenland which is associated with major trough-mouth fans and contourite accumulations. The scientific objectives are: (1) determine the timing and environmental conditions at the onset of glacial expansion; (2) reconstruct the dynamics of the Greenland Ice Sheet during abrupt changes in atmospheric and oceanographic conditions; and (3) assess the impact of regional tectonic and oceanographic changes on the polar cryospheric evolution. To accomplish these objectives, NorthGreen proposes to drill twelve sites (6 primary complemented by 6 alternate) along transects crossing the Northeast Greenland continental shelf and slope. The sites are located within the Norske Trough and on the glaciated bank areas immediately south of the trough. Norske Trough represents one of the main outlets of the Northeast Greenland ice stream, which currently drains 20% of the Greenland Ice Sheet. Thus, the targeted sedimentary sequences contain high-resolution information that is directly linked to the early evolution and variability of the Greenland Ice Sheet as well as the control factors of its dynamics (e.g., climate, oceanography and tectonics) and their interaction through time. The region is densely covered by seismic data and several shallow core sites exist, facilitating the identification of drilling targets and development of the experimental design.

# Understanding Greenlandic landslide risk in a warming climate

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Rising Arctic air temperatures are having dire environmental consequences beyond Greenland ice sheet retreat. Tsunami-generating landslides constitute an ever-increasing risk for Arctic communities as permafrost degrades and slopes become unstable. In particular, settlements along the steep fjords of West Greenland are facing a future with an increasing exposure to lifethreatening tsunamis. Despite the recent occurrences of destructive tsunamis (e.g. Karrat Fjord, 2017), the coastal impacts and potential reoccurrence of fjord system landslides is unknown. A rich pool of existing marine and terrestrial data, complemented by fieldwork planned for 2027/2028, constitutes a unique opportunity to reconstruct past landslide events, and to investigate the landscape changes induced by landslide and tsunami events in West Greenland. This project aims to understand the climatic influence on landslide triggering and the mechanisms of land to sea sediment transfer. Filling these knowledge gaps is expected to shed some light on the expected reoccurrences and landslide/tsunami magnitudes under the future warming scenarios projected by the Intergovernmental Panel on Climate Change (IPCC).

# Exploring Arctic Ocean Conditions Beyond the Last Interglacial Period: A Multi-Proxy Approach

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The Arctic Ocean plays a critical role in the global climate system, acting as both a driver and responder to climate changes. With the polar regions warming at an accelerated rate due to Arctic amplification, understanding past warm periods is essential for predicting future climate scenarios (IPCC6, 2021). However, our knowledge of Arctic Ocean conditions during periods beyond the last interglacial (LIG) remains limited, largely due to the scarcity of long, continuous, climate records.

This study aims to investigate past ocean conditions such as sea ice extent, sea surface temperature, and primary productivity during warm periods preceding the LIG. Using a multiproxy approach, including benthic foraminiferal assemblages, stable isotopes, and biomarkers, this research focuses on Giant Piston core KH7010-5-GCP01, collected from the northern Barents Sea margin during the i2B Arctic Ocean Expedition (KH7010, (Knies et al., 2025)): This core, at 14 meters in length, is significantly longer than its well-studied counterpart, PS2138 (Rachor & Grobe, 2007), and is expected to extend back to Marine Isotope Stage 7 (MIS 7) or older. Its shelf location ensures sufficient sediment input, providing ample material for high-resolution analysis.

Preliminary results suggest that KH7010-5 contains well-preserved calcium-rich layers with abundant foraminifera, offering potential for detailed reconstructions of past ocean conditions. Additional cores from the Lomonosov Ridge, such as KH7010-12 and KH7010-14, may further extend interpretations into the Central Arctic Ocean.

This presentation will outline the conceptual framework, preliminary findings, and methodological challenges of this doctoral research, highlighting its potential to advance our understanding of Arctic Ocean dynamics during past warm periods and their implications for future climate change.

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# Holocene environmental evolution in Tuktoyaktuk Harbor revealed by organic biomarkers

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Coastal Arctic regions are particularly sensitive to a multitude of climate-induced changes, including sea-level rise, permafrost thawing, shoreline erosion, and variations in riverine input. The Mackenzie Delta and nearby coastal areas, in particular, are experiencing rapid modifications, and future projections indicate significant geomorphological changes by the end of the century.

Here, we performed organic biomarker analyses on a ~9 m long marine sediment core from Tuktoyaktuk Harbor (Beaufort Sea, Northwest Territories, Canada), covering the past 10ka based on a well-constrained age model, to reconstruct paleoenvironmental changes experienced by this area since the onset of the Holocene. Our overarching goal was to relate modern and anticipated changes to the natural climate variability observed throughout the Holocene.

Our results show a strong correlation between accumulation rates and organic matter composition. Biomarker compositions are consistent with four possible distinct stages in the development of the Tuktoyaktuk Harbor. From the Early to Middle Holocene, the site probably resembled a productive freshwater bog characterized by biospheric terrestrial organic matter with high abundances of *Eustigmatophyceae* algae (as high concentrations of long-chain diols, C<sub>30</sub> 1,15-diol and C<sub>32</sub> 1,15-diol, seem to indicate), but with low accumulation rates (Stage I). At ca. 4400 BP, a marked increase in both accumulation rates and diatom-derived highly branched isoprenoids (HBIs) points to the development of a productive thermokarst lake or thermokarst lagoon (Stage II). Subsequently, the area experienced continued marine transgression with direct connection to the Beaufort Sea and to Mackenzie-derived inputs with possibly enhanced rates of coastal erosion. Geomorphological changes leading to the formation of the modern harbour coincided with substantially lower HBI concentrations, while the alkanebased carbon preference index (CPI) might indicate a large input of petrogenic material from the Mackenzie watershed (Stage III). Finally, since the 20th century, most biomarker-based indices depart markedly from their previous trends, potentially reflecting anthropogenic forcing (Stage IV).

Overall, this study demonstrates that high-latitude coastal regions can undergo rapid transitions due to permafrost thaw, sea-level rise, and coastal erosion, highlighting the sensitivity and vulnerability of Arctic coastal environments to ongoing climate change.

# Reconstructing Timing of western Greenland Ice Sheet Dynamics at the Last Deglacial Using Paleomagnetic Secular Variation

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The western Greenland Ice Sheet at the last deglacial transitioned from a marine-terminating margin to a primarily land-based system, providing a natural example in the geologic record of possible rates and character of collapse for marine-terminating systems. However, few existing records from this region span the Last Glacial Maximum (LGM) through the onset and evolution of retreat at the last deglacial, making links to the potential drivers of retreat difficult. The Baffin Bay Deglacial Experiment (BADEX) project in 2023 recovered a network of marine sediment cores from the upper-slope that capture this transition from shelf-edge glaciation at the LGM through the deglaciation and into post-glacial conditions along the West Greenland Margin. Using sediment cores recovered north of trough mouth fans built by paleo-ice streams in the Disko Bugt, Uummannaq, and Upernavik regions, our project aims to constrain spatiotemporal variations in retreat along the margin and understand the mechanisms driving the retreat. Proximity of grounded ice is recorded in characteristic lithofacies along the margin, and key sedimentary sequences capture evolving ice dynamics during this transition from LGM through deglaciation. Placing these sequences in time and making comparisons along the West Greenland Margin requires high-resolution age models. Historically, a lack of radiocarbon datable material in marine records of Baffin Bay has limited the ability to develop robust age models, especially in the northern systems, such as Upernavik. To address this, we turn to paleomagnetic secular variation (PSV) as a continuous, regionally synchronous, and environmentally independent way to develop high-resolution centennial-millennial scale age models. In southern Baffin Bay, PSV records are co-registered with available radiocarbon dates, which we use to develop our chronostratigraphic framework. We identify several equivalent PSV features along the margin that allow us to import our integrated PSV-radiocarbon age model from the Disko and Uummannaq regions to our northern Upernavik records. Using this approach, we explore the relative timing of sedimentary signatures of ice dynamics from LGM through post-glacial conditions.

# The 6.8 ka BP event in the Nordic Seas and its worldwide impacts

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The middle Holocene represents the warmest phase of the present interglacial in the mid- and high latitudes of the Northern Hemisphere, yet this interval was punctuated by short-lived cooling episodes. Sediment records from the Nordic Seas, particularly from their northeastern sector, reveal a pronounced subsurface cooling event at approximately 6.8 ka BP. We attribute this anomaly to a westward displacement of the main Atlantic Water inflow, which facilitated enhanced sea-ice advection into the eastern Fram Strait. The resulting increase in sea-ice cover strengthened and deepened the halocline, promoting the subduction of Atlantic Water to greater depths and weakening its northward advection.

This reorganization of water masses produced a transient cooling of subsurface waters and disrupted thermohaline circulation in the Nordic Seas, a region critical to North Atlantic ocean dynamics. Such perturbations likely propagated beyond the Arctic–North Atlantic system. Numerical climate simulations suggest that the event contributed to a temporary weakening of the Atlantic Meridional Overturning Circulation (AMOC), a reduction in Atlantic cross-equatorial ocean heat transport, and a southward displacement of the Intertropical Convergence Zone (ITCZ).

These circulation changes may explain synchronous climatic anomalies recorded in terrestrial and marine archives worldwide. Cooling signals are observed in paleoclimate records from both hemispheres, including central Greenland, inner North America, the North Atlantic region, and Antarctica. Speleothem records from China indicate a weakening of the Southeast Asian monsoon around this time that can also be traced back to the 6.8 ka BP event. Archaeological and paleoenvironmental evidence further suggests contemporaneous episodes of cooling and drought in regions including South America, the Mediterranean, the Sahara, and Iran.

In the context of ongoing climate change, the 6.8 ka BP event highlights the sensitivity of the climate system to regional oceanographic perturbations. Even during a generally warm climatic background, localized disturbances in key ocean circulation regions can trigger cascading environmental responses with global-scale impacts.

# Reconstructing Holocene algal biodiversity in a high-latitude lake with sedimentary ancient DNA and pigments

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Arctic freshwaters have sustained ecosystems and human societies for millennia—providing drinking water, food resources, cultural value, and ecological stability. Today, these lakes are increasingly vulnerable as Arctic regions warm rapidly and understanding long-term lake biodiversity is therefore critical. Primary producers and microbial communities govern ecosystem productivity, carbon cycling, and food-web resilience, forming the foundation upon which both ecological functioning and human well-being depend. Sedimentary ancient DNA (sedaDNA) offers a powerful means to reconstruct past algal communities, especially for taxonomic groups that leave few or no microscopic fossils in the sedimentary record. This study aims to reconstruct changes in the Holocene algal communities of Lake Kuutsjärvi (NE Finland). By combining sedaDNA with sedimentary algal pigment analyses and a suite of paleoenvironmental datasets, we investigate how lake algal diversity has developed over millennia and how the base of the food web has responded to climate fluctuations and landscape changes.

We analysed 150 sediment samples for algal pigments using high-performance liquid chromatography (HPLC) and 84 sediment samples for sedaDNA using robotic extraction, stringent ancient-DNA laboratory protocols, polymerase chain reactions (PCR) with 18S\_allshorts marker and high-throughput sequencing followed by bioinformatic processing with the updated OBITools4 pipeline. Taxonomic assignments were performed using both NCBI and PR2 reference databases.

In this contribution, we share our first insights into how primary producer communities have changed through time and responded to changing climate, drawing on the complementary strengths of sedaDNA and algal pigments. These proxies allow us to see both the broad patterns of ecosystem productivity and the finer details of algal diversity—including groups that rarely preserve in traditional records but emerge in the sedaDNA signal. Together, these findings contribute to our broader effort to evaluate Arctic lake biodiversity, freshwater resource capacity, and long-term ecological responses to Holocene climate variability in northern Fennoscandia.

# Previously unrecognized giant paleo-landslides in Denmark: towards a national inventory

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Giant paraglacial landslides may represent a previously unrecognized component of postglacial landscape evolution in Denmark. These features were first recognized by Schou (1949), LykkeAndersen et al. (2018) and Svennevig et al. (2020); however, they have not been systematically mapped or investigated. Here, we present the first comprehensive national inventory of potential giant paleo-landslides in Denmark. Several origins have previously been proposed for these landforms, including glacial curvilineations, kettles and kames, hummocky terrain, icemarginal hills, ice-lake hills and meltwater terraces (Smed, 1981; Lesemann et al., 2010; Houmark-Nielsen, 2021; Adamczyk et al., 2022; Jakobsen, 2022).

Potential paleo-landslides were manually mapped in a national 0.4 m LiDAR digital terrain model based on their morphology. A classification scheme was developed to assign confidence scores to the landforms using a set of defined criteria, enabling variability in interpretations to be assessed. Ongoing work includes field studies at selected sites combined with transient electromagnetic (TEM) surveys and borehole data, which enable investigation of internal deformation and support geomorphological interpretation. Preliminary results document ~200 potential paleo-landslides of up to ~20 km<sup>2</sup>. Most are concentrated along the flanks of tunnel valleys in areas formerly covered by the Weichselian Scandinavian Ice Sheet. Potential landslides are also identified on the flanks of glaciotectionic complexes.

The recognition of these landforms adds complexity to our understanding of Danish landscape evolution and highlights postglacial and paraglacial processes as important agents in landscape formation. These include glacial melting and debuitressing, changes in precipitation patterns, permafrost degradation, and fluvial or marine incision, all of which may have acted as preconditioning factors for the paleo landslides. Similar conditions are increasing today in Arctic and high-alpine regions, where rapid warming is increasing slope instability and landslide activity (Shugar et al., 2021; Svennevig et al., 2022). As such conditions are expected to intensify under ongoing climate change (Svennevig et al., 2024), the last deglaciation provides a useful analogue for better understanding future landscape responses.

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# Frozen Archives: Reconstructing Ancient Greenland Ecosystems and Environments from Basal Ice

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Ice cores retrieved over the past 50 years from the Greenland Ice Sheet have archived invaluable clues about the response of large ice caps to global climate dynamics. Evidence indicates that during past warm interglacial periods, the Greenland Ice Sheet likely experienced significant retreat and may even have collapsed entirely. However, the factors controlling the stability of the Greenland Ice Sheet, its origin, and the environmental implications of its demise are still scarcely understood.

Basal ice, namely debris-rich ice found at the base of the ice mass near the substrate, has the highest potential to preserve information that may help constrain climate conditions conducive to the demise of the ice sheet. To unfold these precious archives, we aim to develop and apply innovative organic geochemical techniques targeting fossil biomolecules entrained at the base of the Greenland Ice Sheet during its formation to reconstruct ancient ecosystems.

In this contribution, we show preliminary results on the methodology developed, including tests using artificial and natural basal ice samples. We also investigated fossil biomolecules in material (river and lake sediments; permafrost soils) collected from a modern periglacial environment at the western margin of the Greenland Ice Sheet. The comparison with the organic geochemical fingerprint preserved in basal material retrieved by deep ice core drilling will help us to reconstruct past ecosystems and ultimately gain insights into the climate and environmental conditions that existed prior to the buildup of the modern Greenland Ice Sheet.

# Deglacial Retreat of the palaeo-Kangerlussuaq Ice Stream, SouthEast Greenland

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The Greenland Ice Sheet is currently undergoing accelerated mass loss as a result of anthropogenic climate change. This retreat, together with associated oceanographic changes, poses risks across multiple spatial scales—from degradation of local marine ecosystems to potential disruption of global ocean circulation. In addition, continued ice loss threatens lowlying coastal communities worldwide through ongoing sea-level rise. Robust predictions of future ice sheet behaviour under different warming scenarios therefore require well-constrained reconstructions of past ice sheet dynamics and ice–ocean interactions.

One region of particular importance is Kangerlussuaq Glacier in south-eastern Greenland. With ice velocities exceeding  $1000 \text{ m yr}^{-1}$  near its terminus, it is among the most dynamic outlets of the Greenland Ice Sheet and represents a key location for investigating large-magnitude ice sheet variability through time. During a research cruise aboard the RRS Sir David Attenborough in the summer of 2024, forty-two gravity and piston sediment cores were recovered from the continental shelf of south-eastern Greenland. Sampling focused on the Kangerlussuaq Trough system, including sites extending seaward from Kangerlussuaq Fjord, areas in front of major glaciers to the south such as Apuliliip Apusia and Søndre Parallelgletsjer, and several fjords to the north containing Sorgenfri Gletsjer and Rosenberg Gletsjer. Combined sedimentological and geomorphological evidence from these cores indicates that the Greenland Ice Sheet advanced onto the outer continental shelf during the Last Glacial Maximum.

Radiocarbon dating of the sediment cores constrains the timing of grounded ice retreat across the continental shelf during the last deglaciation. The results indicate that grounded ice had withdrawn from the outer shelf prior to 20.8 cal. ka and had retreated to the inner shelf by 11.7 cal. ka. In addition, palaeoceanographic proxy records preserved within the sediments provide new insight into the mechanisms and environmental conditions associated with ice sheet retreat, offering important constraints on ice sheet–ocean interactions during deglaciation.

# The Role of the Pacific Ocean and Adjacent Cryosphere in Past Abrupt Climate Oscillations

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Recent years have brought new depth and dimension to our understanding of the dynamic role of the Pacific Ocean in millennial-scale climate variability. Detailed chronologies suggest that changes in North Pacific circulation occur early in the sequence of millennial events over the past 50,000 years, but the mechanisms involved remain uncertain. Here we present new radiocarbon-dated foraminiferal oxygen isotopic records derived from marine sediment cores (OC1706B-11JC, OC2006A-27JC) on the NE Pacific continental margin adjacent to the major southernmost drainages of the Cordilleran Ice Sheet – the Columbia River and Strait of Juan de Fuca. We find that discharge from these drainages over the past 21,000 years is most active when the adjacent NE Pacific is at its coldest – likely associated with an ice sheet that is advancing towards or has achieved its greatest southward extent. Available ice sheet models (e.g., GLAC-1D, ICE-6G) suggest that during periods when the Cordilleran Ice Sheet advances into the Columbia River drainage basin, >40% of the total discharge of the ice sheet may be routed through these outlets, with the drainage basin potentially crossing the continental divide if and when the ice sheet dome covers the Canadian Rockies. The Strait of Juan de Fuca and Columbia River reach the Pacific Ocean within the range of latitudes at which the northern limb of the North Pacific Subtropical Gyre (NPSG) bifurcates into the northward-flowing Alaskan Current (the eastern limb of the North Pacific Subpolar or Alaskan Gyre) and southward-flowing California Current (the eastern limb of the NPSG). Diversion of the subtropical-subpolar transition zone associated with a large ice sheet during glacial periods would likely increase return of freshwater via northward flowing Alaskan Current to the subpolar ocean, enhancing stratification and reduced overturning. However, when the ice sheet extends to its southernmost position an increased fraction of summer runoff may more readily enter the southward-flowing California Current; increased net freshwater export from the subpolar North Pacific would export buoyancy southward and favor North Pacific overturning and enhanced northward heat transport. The NE Pacific – Pacific Northwest region may thus operate as a sensitive salinity (buoyancy) flux switch to trigger abrupt changes in the North Pacific overturning system with global consequences.

# The geochemical and paleoenvironmental significance of the enhanced biosynthesis of a tri-unsaturated highly branched isoprenoid during late Heinrich Stadial 1 in Baffin Bay

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We document ‘unusually’ high concentrations of a diatom biomarker, a tri-unsaturated highly branched isoprenoid isomer in geometric *E* configuration, hereafter denoted as HBI<sub>C25:3</sub> (E), in a marine sediment core from southeastern Baffin Bay during late Heinrich Stadial 1 (HS1). This event is also associated with changes in the sedimentary abundance of archaeal membrane lipids. It coincides with the occurrence of a diatom-rich layer, with species present indicating cold surface waters and winter sea ice. The stable carbon isotopic composition ( $\delta^{13}\text{C}$ ) of the HBI<sub>C25:3</sub> (E) in this special interval ranges between -20.1 and -15.9 ‰ vs. VPDB and indicates a CO<sub>2</sub> depleted source environment, fitting well to the isotopic signature of Arctic sea-ice derived organic matter (Belt et al., 2008; Schubert and Calvert, 2001). Our literature review, however, reveals that other environments might also explain such heavy  $\delta^{13}\text{C}$  values, such as epishelf lakes (e.g., Smith et al., 2006) or, potentially, melt ponds on ice shelves.

The enhanced biosynthesis of the HBI<sub>C25:3</sub> (E), but also the increases in GDGT-2/GDGT-3 and RI-OH values, are likely due to a shift in diatom and archaeal communities, being unique to the ice-shelf collapse environment in Baffin Bay during late HS1 (Couette et al., 2022). We propose three potential source environments that might eventually explain the enhanced biosynthesis of this lipid: (1) The HBI<sub>C25:3</sub> (E) have been produced by ice algae thriving in platelet sea ice, which is a rare form of sea ice limited to ice-shelf environments (Hoppmann et al., 2020). (2) Another possible source might be from freshwater diatoms thriving in melt ponds on ice-shelf surfaces. (3)  $\delta^{13}\text{C}$  values of organic matter from an epishelf lake (Smith et al., 2006) are similar to the ones of the HBI<sub>C25:3</sub> (E), and this lipid is known to be produced by a freshwater diatom in lakes (Belt et al., 2001); thus, potentially representing the drainage of an epishelf lake. However, future studies in form of ice and sediment core, water-filter and sediment trap studies from these possible sources tied to Arctic ice shelf environments (e.g., Ward Hunt Ice Shelf off Ellesmere Island) are needed to explore the diatom assemblages, lipid composition, and carbon isotopic signatures of these special polar habitats.

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# **Fennoscandian Ice Sheet and Baltic Ice Lake Connections to Abrupt Global Climate Changes During the Last Deglaciation**

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During the last deglaciation, the retreat of the Fennoscandian Ice Sheet triggered a series of ice-damming events across the Baltic Sea basin, leading to the formation of transient proglacial lakes, most notably the Baltic Ice Lake (BIL). Episodes of rapid drainage from the BIL are hypothesized to have had significant impacts on ocean circulation and global climate during the Late Glacial and Early Holocene. However, the timing, mechanisms, and climate consequences of these draining events remain poorly understood. To address this knowledge gap, we are collecting new cosmogenic nuclide exposure-age data on ice sheet retreat and palaeo-lake development, combined with new radiometric and thermoluminescence ages from sediment cores collected in the Baltic region, to help constrain the minimum timing of local drainage events. We are also applying the Community Earth System Model to test whether BIL outburst floods could have contributed to abrupt climate anomalies, including the Inter-Allerød Cold Period and the Preboreal Oscillation. Preliminary simulations indicate that meltwater influx from BIL drainage events weakened the Atlantic Meridional Overturning Circulation (AMOC), producing regionally variable temperature and precipitation anomalies. Most notably, much of western Eurasia experienced cooling while the Intertropical Convergence Zone (ITCZ) shifted relative to pre-industrial conditions. These results suggest that climate dynamics in the Baltic region played a more influential role in shaping abrupt high-latitude climate shifts than previously recognized, underscoring the importance of incorporating regional meltwater events into assessments of past and future climate variability.

# Early postglacial paleoceanography of the western Canadian Arctic Archipelago: preliminary multiproxy evidence from the Beaufort Sea and M'Clure Strait

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The western Canadian Arctic Archipelago (CAA) is a key marine gateway connecting the Arctic Ocean with the Beaufort Sea and the broader Arctic–Atlantic–Pacific exchange system. However, the timing of the last deglaciation and the subsequent evolution of marine environments in this region remain enigmatic, particularly in its western sector. This study investigates two sediment core records from the western CAA, from the Beaufort Sea margin and from M'Clure Strait to reveal the earlier phase of environmental reorganization that followed regional deglaciation and the opening of western Arctic gateways. A multiproxy approach combines benthic and planktic foraminiferal assemblages with highly branched isoprenoid (HBI) biomarkers and geochemical indicators (total organic carbon and biogenic silica) to trace changes in water conditions, bioproductivity, and sea-ice variability. Preliminary results indicate the presence of distinct palaeoceanographic variability in the studied cores, expressed by shifts in foraminifera assemblages, supported by geochemical proxies. Changes in the abundance of calcareous and agglutinated foraminifera suggest alterations in water conditions and the changing influence of different water masses. Furthermore, the biomarker record indicates fluctuations in sea-ice cover. These records will provide new constraints on the paleoceanographic development of a still poorly studied part of the Arctic and improve our understanding of how Arctic marine systems responded to major cryospheric change in the past.

# Preliminary Results of High-Resolution Micropaleontological Analysis in Rijpfjorden, Northern Svalbard

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Keywords: foraminifera, arctic, Svalbard, ecosystem, climate change, Atlantification

Rijpfjorden, one of the true High-Arctic fjords (80°N, 22.3°E), maintaining sea-ice cover for 6–8 months per year. With its opening toward a wide, shallow shelf (100–200 m) oriented northward toward the Arctic Ocean, Rijpfjorden is influenced by the Svalbard Branch current, a part of West Spitsbergen Current, bringing Atlantic Water into the fjord. However, during the past two decades, climate change has shifted this dynamic, and the influence of Atlantic Water has become more dominant, as indicated by oceanographic studies. Here, we present the first results from a short multicore R3 (19 cm length), collected from the outer part of the fjord. The core was sampled at high resolution (1-cm intervals), sieved (63 µm), and prepared for micropaleontological (foraminiferal) analysis. Moreover, the results were compared with temperature and salinity measurements (PSU) taken during the cruise. Samples for radiocarbon dating are currently being prepared. However, previous research in Rijpfjorden (glacier dynamics and geomorphology) identified core ages between 10.6 cal ka BP (226 cm) and 11 cal ka BP (453 cm), thus suggesting a late Holocene age for core R3.

Preliminary analysis shows that the lower intervals of the core are presented by low-abundance, cold-water opportunistic agglutinated foraminifera, such as *Lagenammmina difflugiformis* and *Labrospira crassimargo*. The middle intervals (around 10–11 cm) show a *Cassidulina reniformis*-*Elphidium excavatum f. clavatum* assemblage, with increased opportunistic calcareous species and diversity. Finally, the upper intervals of the core contain a mix of Atlantic species and opportunists living in a high-energy, nutrient-rich environment (e.g., *Adercotryma glomeratum*, *Cibicides refulgens*, *C. reniformis*, and *Textularia earlandi*). This micropaleontological analysis provides crucial evidence of ongoing environmental change and serves as an indicator of Atlantification in highArctic environments. Furthermore, this research establishes a baseline for future monitoring, being one of the first high-resolution paleoenvironmental records in this area of Svalbard.

# Greenland Ice Sheet dynamics and weathering regimes during past warm intervals: Evidence from micro-CT analysis of ice-rafted debris

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Understanding the sensitivity of the Greenland Ice Sheet (GrIS)—a major reservoir of the terrestrial cryosphere—to past warm climates is critical for predicting its response to the ongoing global warming and for improving Earth System Models (ESMs), given GrIS strong influence on global ocean circulation and atmospheric patterns. In this study, we investigate GrIS variability across marine interglacial transitions using sedimentary micro-computed tomography (microCT) analyses of ice-rafted debris (IRD) from marine sediment core U1604B recovered in Baffin Bay during IODP Expedition 400 (Knutz et al., 2025). Baffin Bay represents a key high-latitude oceanographic gateway linking Arctic and North Atlantic circulation and integrating sedimentary signals from both the Greenland and North American ice sheets. Interglacial intervals corresponding to Marine Isotope Stage (MIS) 5 (Eemian) and MIS 11 (Holstein)—warm periods often considered analogues for ongoing global warming—were identified in core U1604B using X-ray fluorescence (XRF) geochemical proxies. Approximately 40–50 sediment samples spanning these intervals were selected for high-resolution micro-CT scanning ( $\sim 1.5 \mu\text{m}$  resolution) to generate quantitative three-dimensional datasets of IRD particles. This novel approach enables non-destructive quantification of grain size, sorting, morphology, and surface microtextures. The methodological workflow integrates micro-CT imaging with mineralogical characterization and microtextural analysis of sand- and silt-sized grains (38–250  $\mu\text{m}$  sieved sediments) to distinguish between glacial, glaciofluvial, fluvial, and aeolian sediment transport regimes. By combining geochemical proxy records with micro-sedimentary observations, this study aims to reconstruct variations in weathering regimes, sediment provenance, and source-to-sink transport processes associated with GrIS fluctuations during warm climate intervals. Changes in IRD fluxes and transport pathways may also reflect variations in terrigenous nutrient delivery to high-latitude marine systems, which can influence ocean productivity and climate feedback mechanisms. Furthermore, the development of this integrated micro-CT-based methodology provides a new framework for linking sedimentological processes with cryosphere dynamics and biogeochemical cycling during past interglacial periods.

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# Water mass changes in North Greenland fjords during the Holocene

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Sea ice dynamics and primary productivity in northern Greenland are influenced by the influx of warm subsurface Atlantic waters. Holocene-age sediments recently recovered from previously unexplored Sherard Osborn and Viktoria fjords of the remote northern Greenland margin have allowed for palaeoceanographic research into sea-ice dynamics and water mass circulation in the Lincoln Sea (Jakobsson et al., 2020, O'Regan et al., 2021; Cronin et al., 2022; Detlef et al., 2023). Our project aims to focus on reconstructing Holocene subsurface water mass changes in this region through a combination of biomarker- and foraminifera-based proxies, with this submission to ARCPaC 2027 presenting the project overview and initial results.

Changes to sea-ice extent and seasonality over the last 10,000 years will be tracked through the identification and quantification of the algal biomarker IP<sub>25</sub>, relative to sterols produced more ubiquitously by marine algae (Belt et al., 2007, Müller et al., 2011). Initial measurements from core-top samples have thus far added to the growing body of ground-truthing work done around northern Greenland (Detlef et al., 2023). Furthermore, we present the ongoing strategy for generating the first foraminifera-bound nitrogen isotope ratio (FB $\delta^{15}\text{N}$ ) record from this region of persistent sea ice cover. FB- $\delta^{15}\text{N}$  is a proxy for determining changes in thermocline nitrate and upper ocean biogeochemical cycling, and in comparing Holocene FB- $\delta^{15}\text{N}$  variability with modern water mass  $\delta^{15}\text{N}$  signatures (determined through a combination of published data and newly collected nitrate samples), we aim to test the suitability of the proxy to record past changes in Atlantic water intrusions into this remote Arctic environment.

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# Size-dependent $\delta^{18}\text{O}$ and $\delta^{13}\text{C}$ variations in a planktic foraminiferal *Neogloboquadrina pachyderma* (sinistral) record from Chukchi Plateau: implications for (sub)surface water conditions in the western Arctic Ocean over the past ~ 50 ka

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Oxygen and carbon stable isotopes in planktic foraminifera *Neogloboquadrina pachyderma* (sinistral) (Nps) have a promising potential for reconstructing (sub)surface water conditions in the Arctic Ocean. Size-dependent (63-154  $\mu\text{m}$ , 154-250  $\mu\text{m}$ , and >250  $\mu\text{m}$ ) Nps  $\delta^{18}\text{O}$  and  $\delta^{13}\text{C}$  were measured along with Ice Rafted Debris (IRD) and scanned XRF Ca and Mn contents in sediment core ARC3-P31 from the Chukchi Plateau (434 m water depth) representing paleoceanographic conditions during the last ~50 ka (Marine Isotope Stages 1-3). While the interval corresponding to the Last Glacial Maximum is represented by a hiatus, the following deglaciation is clearly marked by a strong depletion in both  $\delta^{18}\text{O}$  and  $\delta^{13}\text{C}$  in all Nps size fractions along with the peaks in detrital carbonate IRD and coal fragment indicative of the Canadian Arctic Archipelago provenance. This pronounced feature presumably indicates a collapse event of the northwestern Laurentide Ice Sheet, potentially linked to the rising sea level. In the overall record under study, average values of Nps  $\delta^{18}\text{O}$  and  $\delta^{13}\text{C}$  fluctuate in the range of 1.2-2.1‰ and 0.3-0.9 ‰, respectively. Mid-size Nps  $\delta^{18}\text{O}$  values (154-250  $\mu\text{m}$ ) are in average lighter by ~0.2-0.5 ‰ than those of small (63-154  $\mu\text{m}$ ) and large (>250  $\mu\text{m}$ ) Nps tests. This offset may indicate a different water-depth dwelling, possibly affected by a relatively warm subsurface Atlantic water.

# **Flooding of tidal estuaries – A study from the central Danish North Sea**

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After the last glacial maximum (MIS2), ~20 kyrs BP, the central North Sea region transitioned from a glaciofluvial landscape to a shallow marine setting. This transition was largely governed by climate-induced sea level rise, flooding the former land area, Doggerland. Flooding depended to a large degree on the existing glacial landscape and major topographical elements. In the central and eastern North Sea region, such are constituted by the Dogger Bank and the Elbe Palaeo Valley, a former ice-marginal valley that drained the Scandinavian Ice Sheet and extended from the German Elbe river mouth towards the easternmost Dogger Bank in the Danish sector of the North Sea. The role of these landscape elements during the flooding of Doggerland is still relatively poorly constrained.

Initial work on high-resolution seismic data east of the Elbe Palaeo Valley has revealed two larger submerged tributary valley systems. These valley systems comprise fluvial, tidal, estuarine and marine deposits, reflecting how the systems changed from glacio-fluvial river valleys to tidally influenced estuaries before being fully flooded at approximately ~8-5.8 kyr BP. This study presents a thorough analysis of the geomorphic and stratigraphic units in the estuaries, focusing on reconstructing their spatial and temporal evolution in relation to the Holocene sea level rise. We further assess the preservation degree of the various deposits, with emphasis on valley margins and terrestrial facies, linking preservation degree to topography and environments, and investigating processes controlling erosion and landscape preservation.

The study contributes to our geological understanding of the eastern North Sea and how flooding affected the estuaries and Doggerland. This provides essential background for further research into landscape evolution during rising sea levels and climate adaptation of lowtopography landscapes as well as assessments of geoarchaeological potential.

# Mapping the Drowned North – Legacy Data Perspectives on the Eastern Sector of Doggerland

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The North Sea covers an extensive submerged prehistoric landscape, Doggerland, whose development and subsequent flooding are central to understanding the Late Pleistocene and Early Holocene geological and archaeological record of Northern Europe. In this contribution we present ongoing efforts within the SUBNORDICA project, to synthesise a broad, cross-national wealth of legacy geophysical, geotechnical and geological data into a coherent palaeolandscape model of this vast submerged region.

The work draws on an expanding network of collaboration across research institutes and makes extensive use of open-source datasets produced for offshore windfarm development. Current data sources include the Alfred-Wegener-Institute, Senckenberg am Meer, the German Federal Maritime Hydrographic Agency (BSH, including PINTA datasets), the University of Bremen, GEUS, the Danish Energy Agency, and datasets acquired by Aarhus University (SeisLab Aarhus). We actively pursue additional partnerships, with the aim of achieving the most detailed and continuous coverage of the German and Danish sectors of the North Sea to date.

The growing data foundation enables the reconstruction of major palaeoriver systems, most prominently the Elbe Palaeo Valley and its tributaries, which structured the Doggerland landscape. These rivers acted both as connective corridors and natural boundaries, shaping human and animal mobility across a constantly changing environment, while their associated wetlands represent zones of high archaeological and palaeoenvironmental preservation potential.

The synthesis process also highlights the challenges inherent in large-scale data integration, including variable vertical datums, inconsistent tidal corrections, heterogeneous survey resolutions, and differing surface nomenclatures. Addressing these discrepancies is essential for producing consistent cross-border reconstructions.

The emerging landscape model will directly inform AI-driven analyses of human behaviour and environmental change within the wider SUBNORDICA framework and will provide a valuable foundation for future research on the Holocene Base and Late Pleistocene–Early Holocene developments in the eastern North Sea.

# Deep water exchange through the western Fram Strait during marine isotope stages (MIS) 10 to 1, last 345 ka

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Core HH12-1203GC was taken in a contourite drift on top of the East Greenland Ridge (EGR), a 300 km long submarine elevation jutting southeastwards from the North-East Greenland shelf and separating the Fram Strait from the Greenland Sea. The core is taken from 2325 m water depth and lies in the pathway of the southward flowing cold East Greenland Current (EGC). The core has been investigated for oxygen and carbon isotopes, benthic and planktic foraminiferal faunas, and content of ice rafted debris (IRD; >0.5 mm) for the last c. 345 ka (MIS 10-1). The purpose of the study was to reconstruct the flow of the EGC in relation to past climate changes on millennial and orbital time scale in high resolution. The results show millennial scale variability in surface parameters for MIS 5-1 indicating rapid variability in the flow in the upper part of the EGC and correlating with Dansgaard-Oeschger events as recorded in Greenland ice cores. This variability is not apparent in the benthic parameters, which mainly varies on orbital scale except for during the major terminations of MIS10-9 (T IV), MIS 6-5 (T II), and the MIS 4-3 transition. These are characterized by events of very low magnetic susceptibility, low  $\delta^{18}\text{O}$  values, IRD consisting primarily of sedimentary rocks, and absence of foraminifera. Terminations II and I, interglacials, and glacials show intermediate to high magnetic susceptibility values. Glacials are mainly characterized by high concentrations of crystalline IRD and generally low number of well-preserved foraminifera, while interglacials have low IRD, high abundance of foraminifera, but poorly preserved. The deep-water flow over the East Greenland Ridge was strong during all interglacial phases but weakened during the major glacials MIS 10-2. The flow was also weaker in the large stadials of MIS 9, 7 and 5, and in MIS 3. Our results suggest a decoupling of surface-intermediate water flow compared to the deep-water flow over the ridge with a likely continuous exchange through the western Fram Strait that was weakest during terminations T IV-T I, including the MIS4-3 transition. The magnetic susceptibility pattern of core HH12-1203GC from the western Fram Strait is similar to the patterns seen in cores CAGE19-3-KH-9/10GPC from the central and -/14GPC from the eastern Fram Strait and from the same water depth of c. 2300 m. This is a strong indication of closely linked environmental developments and deep-water flow patterns in the region.

# **Greenland Ice Sheet responses to past warm climate intervals: Provenance insights from North-East Baffin Bay**

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The ChronIce project (Chronicling Greenland Ice Sheet evolution through past warm climates), investigates the dynamics of the Greenland Ice Sheet to past warm climate intervals by reconstructing changes in physical weathering and past ice sheet configurations back to ~15 Ma. Constraining the response of the Greenland Ice Sheet to past warm climate intervals is essential for improving our understanding of its sensitivity to future warming and its contribution to global sea-level rise.

Focusing on sedimentary archives from North-East Baffin Bay, we analyzed marine cores recovered during International Ocean Drilling Program (IODP) Expedition 400 (Sites U1604, U1606, U1607 and U1608). Temporal variations in glacial provenance, weathering intensity, and ice sheet configurations are assessed using detrital mineral composition and multi mineral geochronology approaches. Heavy mineral fractions are characterized using Automated Quantitative Mineralogy–Scanning Electron Microscopy (AQM-SEM) and Laser Ablation– Inductively Coupled Plasma–Mass Spectrometry (LA-ICP-MS), enabling single-grain U–Pb geochronology and robust provenance fingerprinting of ice-rafted debris (IRD). We present new data from zircon, apatite and titanite grains. Preliminary zircon, titanite and apatite ages (max.~3200 Ma) from the Upper Pleistocene (130.000 – 12.000 years ago) pointing to a Greenlandic source area possible Southern-West Greenland or the Ilulissat area.

# Using long-chain diols to resolve input of nutrients and river derived carbon to the Arctic Ocean

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Long-chain alkyl diols (LCDs) are lipid biomarkers widely distributed in marine and lacustrine environments and produced by several groups of algae, including eustigmatophytes and diatoms (e.g., *Proboscia*). Since they are well preserved in sediments, LCDs have been applied as (paleo)environmental proxies to reconstruct oceanographic and climatic conditions including surface temperature, freshwater input, productivity, and nutrient availability.

Here we investigate the distribution of LCDs in modern marine surface sediments collected along the Siberian Arctic margin and adjacent basins, including the Laptev, East Siberian, Chukchi, and Beaufort seas. Our goal is to develop biomarker-based tools applicable to both modern and past sedimentary records to resolve spatial variability in nutrient supply and river-derived carbon inputs to the Arctic Ocean. We detected LCDs in all studied sediments, indicating widespread production and preservation across the Arctic shelves. However, the relative distribution of individual diols reveals regional differences. Sediments from the Chukchi Sea and the easternmost Siberian margin display a distinct LCDs fingerprint compared to those from the Laptev and East Siberian seas and previously reported data from the Kara Sea, typified by higher abundance of 1,14 diols relative to 1,13 and 1,15 diols.

We interpret these differences in homologues distribution as reflecting spatial variability in nutrient supply and phytoplankton communities across Arctic shelves. The distinctive LCDs signature in the Chukchi Sea and eastern Siberian margin likely reflects the influence of nutrient-rich Pacific waters entering the Arctic through the Bering Strait. This inflow transports substantial amounts of nutrients into the Arctic, stimulating primary productivity and influencing phytoplankton assemblages relative to the more river-influenced Siberian shelf seas. Comparison with modern oceanographic datasets supports this interpretation, showing strong correlations between LCD-based nutrient indices and nitrate ( $\text{NO}_3^-$ ) and phosphate ( $\text{PO}_4^{3-}$ ) concentrations. In addition, the high relative abundance and spatial distribution of the  $\text{C}_{32}$  1,15-diol corresponds closely with regions influenced by major Arctic rivers, supporting previous inferences indicating that it may serve as an indicator of freshwater discharge and river-derived organic carbon. Together, these results show that LCDs in Arctic surface sediments provide valuable information on nutrient supply and freshwater influence, highlighting their potential as proxies for reconstructing past changes in Arctic river discharge and productivity.

# Iverryggen – Hill-hole pair on the Norwegian continental shelf off Mid-Norway

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The multidisciplinary Norwegian seabed mapping programme MAREANO ([www.mareano.no](http://www.mareano.no)) investigates Norwegian offshore areas. Through extensive marine data collection, the programme has produced large datasets used to produce maps of bathymetry, geology, biology, nature types and environmental status.

Here, we present multi beam swath bathymetry and high-resolution TOPAS sub-bottom profiler data collected from Iverryggen, off Mid-Norway. Iverryggen rises as a ridge, or “hill”, approximately 130 m above the surrounding smooth seafloor, which deepens gently westwards from ~270 m to ~350 m. The ridge has a steep western side, whereas the eastern side slopes more gradually towards a topographic depression, or “hole”, with an irregular seafloor morphology. The ridge extends 18 km in the north–south direction and is 5 km wide. A further ridge extension, about 25 km long, 700 m wide, and up to 60 m high, runs in a southeast direction. A series of NW–SE-trending transverse ridges up to 2 m high, 15 m wide and 9 km long superimpose the lower lying parts of the ridge and the surrounding seafloor.

Iverryggen and its associated depression are interpreted as a hill–hole pair formed when sediment froze to the base of relatively slow-flowing thin ice, followed by melting and westward transport of the material. This process left a depression in the source area to the east, characterised by an irregular seafloor morphology. It was likely formed during a short, temporary ice advance characterised by high rates of erosion and transport of sediments from east to west during the last glaciation. The transverse ridges are interpreted to be retreat moraines representing shorter stillstands and re-advances of the NW–SE retreating ice front during the overall retreat.

# Freshwater in the glacial Arctic Ocean – the evolution of findings in the last five years

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Five years ago, the claim that the Arctic Ocean was filled with freshwater down to at least 2500 m depth during some peak glacials was published (Geibert et al., 2021). A controversial, yet productive debate unfolded (Spielhagen et al., 2022, Geibert et al., 2022a; Hillaire-Marcel et al., 2022, Geibert et al., 2022b, and more), which also included revisiting previous age constraints and some underlying data. In this presentation, we review the new evidence and arguments that have since been added to the debate, and we discuss if the original arguments still hold, if new aspects have to be considered, and which activities could possibly further prove or disprove that large parts of the Arctic Ocean were filled with freshwater during prolonged periods in the past.

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# Surface sediment composition off northern Greenland

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The Lincoln Sea off Northern Greenland is considered as the most resilient region for Arctic sea ice. Glacier outlets such as Ryder, Petermann, C.H. Ostenfeld, drain a considerable portion of the Greenland Ice Sheet into the Arctic Ocean. Past environmental changes here provide critical insights for future warming projections. This area receives substantial glacially derived sediments that document past ice sheet and ocean conditions. However, persistent sea ice cover has limited marine geological surveys, resulting in a lack of systematic constraints on sediment composition, transport mechanisms, and ice-ocean interactions.

This study analyzes surface sediment samples from the Ryder2019 and GEOEO2024 expeditions to the Lincoln Sea. By integrating grain size, clay mineralogy, major/trace elements and Sr-Nd isotopes, we investigate sediment composition, provenance, and spatial distribution patterns to elucidate the control of ice tongue dynamics in sedimentary processes.

Our results reveal distinct regional differences in material sources and transport mechanisms. Sediments are predominantly silt. Areas with stable ice tongues (Ryder and Petermann) show higher clay content, finer grain size, and better sorting compared to areas with active calving (C.H. Ostenfeld), which exhibit more offshore-like characteristics. Illite (avg. 74%) dominates the clay mineral assemblage, followed by chlorite (16%), kaolinite (7%) and smectite (3%). Compiled with published data, this dataset fills a gap in the pan-Arctic clay mineral distribution map. Variations in clay mineral assemblages and Sr-Nd isotopic compositions confirm spatial provenance heterogeneity. Sediments in stable ice tongue zones derive primarily from subglacial erosion, while active calving areas show mixed sources with pronounced spatial variability. Our data provide key sedimentological and geochemical constraints for reconstructing fjord ice tongue dynamics and the evolution history of the Greenland Ice Sheet.

# **The Nordic Palaeo Alliance (NORPALL) – a NordForsk Network for Early Career Quaternary Researchers**

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The Nordic Palaeo Alliance (NORPALL) is a collaborative group of early career Earth science researchers with the shared ambition of improving age constraints on glacier landforms, sediments and climate archives within the Nordics. The Nordic Lands are linked through a shared Quaternary history; however, each region hosts its own unique glacial history and climate archives. Understanding the rates and style of past deglaciation is critical for projecting future change. Palaeo-investigations which provide quantitative / geochronological constraints are increasingly important given today's (anthropogenic driven) changing climate directly effecting cryosphere and global sea level. NORPALL fosters the development of new geochronological approaches for reconstructing the past to constrain projections of the future. The primary goals of NORPALL are to i) establish and unite a community of like-minded early career researchers who will ii) target outstanding research questions facing Nordic Quaternary Science and ultimately, iii) promote and advance Quaternary research focusing on chronological tools within the Nordic countries by training future scientists. The NORPALL network is comprised of a steering committee of eight early career researchers (PhD.) from Iceland, Denmark and Sweden. This NORPALL team leads the organization of all field schools, meetings and social events. These NORPALL gatherings will be directed towards early career Quaternary researchers and graduate students from (or working in) the Nordic region. NORPALL is additionally composed of a select group of NORPALL mentors – senior researchers from (or working in) the Nordic region. NORPALL has been granted its first three years of funding by NordForsk.

# Ice sheet - ocean interaction in the central Canadian Arctic Archipelago area during the final deglacial-Holocene transition

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The Canadian Arctic Archipelago (CAA) experienced a rapid ice sheet retreat during the late stage of the last deglaciation, finally resulting in the re-opening of the Arctic-Atlantic marine passage. However, there still remains considerable uncertainty regarding the dynamics, mechanisms, and impacts of ice sheet/sea-ice/ocean interactions during the crucial final deglacial-Holocene transition. Here, we present well-dated and high-resolution records from Barrow Strait, a key location in the central part of the Arctic-Atlantic passage, capturing the rapid fluctuations in ice sheet-ocean interactions during this time interval. Multi-proxy sedimentological, geochemical and radiogenic isotope data allow to reconstruct the centennial/decadal variability of ice sheet/sea-ice/open-water productivity during the final stage of deglaciation, followed by the amelioration from permanent sea ice cover to seasonal sea-ice cover after the Arctic-Atlantic throughflow establishment. Two events of ice sheet decay at the final stage of deglaciation were identified by abrupt changes in depositional processes and marine conditions. We suggest that the oscillated penetration of warm Atlantic water contributed to ice sheet instability and further promoted the ice sheet decay, followed by the inflow of Arctic surface water that then became the dominant factor shaping the marine environment after the final disintegration of ice sheets. Our findings underline the rapid natural change and the alternating nature of coastal ice margin environment during the ongoing deglaciation, and highlight the potential influence of different ocean currents/water masses on the ice sheet melting process.