

Appendix 3

Summary of Professional Accomplishments (Autoreferat)

*Holocene palaeoceanographic changes in polar shelf seas
– a multiproxy approach*

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1. **Name:**

Anna Jadwiga Pieńkowski-Furze (publishing name: Anna J. Pieńkowski)

2. **Diplomas, degrees conferred in specific areas of science or arts, incl. the name of the institution which conferred the degree, year of degree conferment, title of the PhD dissertation:**

PhD University of Alberta, Canada, 2011

Department of Earth & Atmospheric Sciences

Dissertation title: *The deglacial to postglacial environmental evolution of the Canadian Arctic Archipelago: a marine perspective.*

Supervisor: Prof. John England

MPhil University of Wales (Bangor), Bangor, UK, 2005

School of Ocean Sciences

Dissertation title: *Dinoflagellates and their cysts from the Weddell Sea, Antarctica.*

Supervisors: Prof. David Thomas, Prof. James Scourse, Dr. Fabienne Marret

BSc University of Wales (Bangor), Bangor, UK, 2002

Marine Biology/Oceanography Joint Honours 1st Class

3. **Information on employment in research institutes or faculties/departments or school of arts:****Post-PhD:**

2021-present	Institute of Geology, Adam Mickiewicz University in Poznań, Poland Project PI & Associate Professor (Profesor uczelni)
2023-present	Department of Arctic Geology, UNIS (University Centre in Svalbard), Norway iEarth Education Chair & Associate Professor (Førsteamanuensis)
2021-2023	Department of Arctic Geology, UNIS, Norway Adjunct Associate Professor in Micropalaeontology
2019-2021	Norwegian Polar Institute, Svalbard, Norway Nansen Legacy Postdoctoral Fellow
2018-2019	Department of Arctic Geology, UNIS, Norway Visiting Researcher
2015-2018	Department of Physical Sciences, MacEwan University, Canada Assistant Professor in Biogeochemistry
2014-2015	Department of Physical Sciences, MacEwan University, Canada Sessional Instructor in Earth Sciences
2011-2014	School of Ocean Sciences, Bangor University, UK Lecturer in Marine Geology & Palaeoceanography

Pre-PhD:

2008-2010	Department of Physical Sciences, MacEwan University, Canada Laboratory Instructor
2004-2008	Department of Earth & Atmospheric Sciences, University of Alberta, Canada Teaching Assistant
2003	School of Ocean Sciences, Bangor University, UK Research Assistant
2002-2003	School of Ocean Sciences, Bangor University, UK Teaching Assistant

4. Description of the achievements, set out in art. 219 para 1 point 2 of the Act:

The scientific achievements forming the basis of this habilitation constitute a coherent and multifaceted body of accomplishments, developed over more than a decade of independent research after my PhD. These achievements extend beyond a single publication cycle and encompass original scientific contributions, methodological advances, competitive grant acquisition and leadership, international research activity, teaching and mentorship, as well as service to the scientific community.

Within this broader framework of achievements, a thematically unified cycle of six peer-reviewed publications represents the core scientific synthesis, while being integrally supported by complementary publications, externally funded projects, international collaborations, and academic leadership activities that collectively define my habilitation achievements.

Specifically, my scientific achievements that form the basis of this application for my habilitation consist of:

- i) a publication cycle within my broader achievements **[A1]-[A6]** (**Appendix 7**);
- ii) additional peer-reviewed publications **[D1]-[D14]**
- iii) major grant projects **[P1-P4]**
- iv) other achievements including:
 - international activity carried out at foreign institutions
 - teaching and mentorship
 - science communication and public engagement
 - leadership roles in international science networks
 - grant acquisition and management.

[Note that throughout this appendix, I have used conventional literature references, alongside abbreviations referring to my publications included in the scientific achievements, including: my cycle of peer-reviewed published scientific articles (**A**), other publications (**D**) and grant projects (**P**). Details of the individual items described by the above abbreviations can also be found at the end of this appendix and in **Appendix 7** of the application.]

a. Scope of the scientific achievements:

The scientific achievements presented below are realised through a combination of original publications, competitive research funding, international leadership, and sustained academic activity, with the publication cycle forming one - but not the sole - integrative component of these achievements.

Holocene palaeoceanographic changes in polar shelf seas - a multiproxy approach

*b. List of publications included in the scientific achievements in order of discussion;
(author/authors, title/titles of papers, year of publishing, name of the publishing house):*

The cycle of six peer-reviewed publications which forms part of my overall achievements was written and submitted after having received my doctoral (PhD) degree, and published in international peer-reviewed scientific journals that are listed in the Web of Science database. I am the first author on five of these articles, and the last author on one paper. My specific contribution to each individual publication is listed below and is also confirmed by my co-authors through accompanying statements (**Appendix 6**); more detailed information about these articles can be found in [Section 4c](#) of this appendix.

- [A1] [Pieńkowski, A.J., England, J.H., Furze, M.F.A., Blasco, S., Mudie, P.J., MacLean, B., 2013. 11,000 years of environmental change in the Northwest Passage: a multiproxy record from central Parry Channel. *Marine Geology*, Elsevier, vol. 341, 2013, p. 68–85; DOI: <https://doi.org/10.1016/j.margeo.2013.04.008>](#)

IF: 2.2 (Q1); MEiN₂₀₂₄: 100; Citations: 40; CiteScore Percentile: 82
Corresponding author: **Pieńkowski A.J.**

My contribution to this work encompassed conceptualisation of the study and leading and coordinating the research. This included leading laboratory work for all multiproxy analyses, including: benthic and planktic foraminifera, palynology (dinocysts and other non-pollen palynomorphs), sedimentology, and biogeochemistry; as well as selecting materials for radiocarbon dating. I also participated in age-depth model construction. I coordinated data interpretation and results discussions. Further, I wrote the manuscript which was then available for input by my co-authors.

- [A2] [Pieńkowski, A.J., Husum, K., Belt, S.T., Ninneman, U., Köseoğlu, D., Divine, D., Smik, L., Knies, J., Hogan, K., Noormets, R. 2021. Seasonal sea ice persists through the Holocene Thermal Maximum at 80°N. *Communications Earth & Environment*, Nature Publishing Group, vol. 2, article number 124; DOI: <https://doi.org/10.1038/s43247-021-00191-x>](#)

IF: 9.5 (Q1); MEiN₂₀₂₄: 20; Citations: 26; CiteScore Percentile: 95
Corresponding author: **Pieńkowski A.J.**

My contribution to this work included conceptualising the research, analysis of HBI (highly-branched isoprenoid) biomarker and foraminiferal stable isotope data, as well as giving input on age-depth model construction. I led the discussion on data interpretation. I wrote the first draft of the manuscript which was then available to co-

authors for input and feedback. This study was carried out as part of the Nansen Legacy (Arven etter Nansen) project funded by the Norwegian Research Council (Forskingsrådet) under whose auspices I conducted a postdoctoral position.

- [A3] [Pieńkowski, A.J., Szczuciński, W., Breszka, A., Chyleński, M., Juras, A., Romel, P., Rozwalak, P., Trzebny, A., Dabert, M., Belt, S.T., Jagodziński, R., Smik, L., Włodarski, W. 2024. Sedimentary ancient DNA and HBI biomarkers as sea-ice indicators: A complementary approach in Antarctic fjord environments. *Limnology & Oceanography Letters*, Wiley Blackwell, article number 10395; DOI: <https://doi.org/10.1002/lol2.10395>](#)

IF₂₀₂₄: 5.0 (Q1); MEiN₂₀₂₄: 20; Citations: 6; CiteScore Percentile: 95
Corresponding author: **Pieńkowski A.J.**

My contribution to this article consisted of conceptualising the research and coordinating all analyses, as well as previous ship-based collection of materials. I conducted HBI biomarker analyses myself and gave input to remaining proxy analyses, including selection of relevant sea-ice and bioproductivity indicator organisms for sedimentary DNA assay. I led result discussion and data interpretation. I wrote the manuscript on which the co-authors gave feedback. This research was carried out under the auspices of the POLS project CHARME (CHanging AntaRctic Marine Environments) [P1] funded by the National Science Centre and Norwegian Grants and led by myself as Principal Investigator.

- [A4] [Pieńkowski, A.J., Coulthard, R.D., Furze, M.F.A. 2023. Revised marine reservoir offset \(\$\Delta R\$ \) values for molluscs and marine mammals from Arctic North America. *Boreas*, Wiley-Blackwell, vol. 52, p. 145-167; DOI: <https://doi.org/10.1111/bor.12606>](#)

IF: 2.9 (Q1); MEiN₂₀₂₄: 100; Citations: 30; CiteScore Percentile: 99
Corresponding author: **Pieńkowski A.J.**

My contribution to this work consisted of conceptualising and leading the research. This included the compilation of pre-bomb radiocarbon-dated materials from Arctic Canada, specifically molluscs and marine mammals (bowhead whales, beluga whales, walrus). Further, it encompassed input into the calculation of regional marine reservoir offsets and their statistical data treatment. I led discussion on result interpretation and implications for palaeoceanographic studies of the late Quaternary of the polar regions. I wrote the manuscript which was then available for input from my co-authors.

- [A5] [Pieńkowski, A.J., Kennaway, S., Lang, S.I. 2020. Aquatic palynomorphs from modern marine sediments in a reconnaissance transect across the Northwest Passage – Baffin Bay region. *Marine Micropaleontology*, Elsevier, vol. 156, article number 101825; DOI: <https://doi.org/10.1016/j.marmicro.2020.101825>](#)

IF: 1.6 (Q1); MEiN₂₀₂₄: 70; Citations: 13; CiteScore Percentile: 66
Corresponding author: **Pieńkowski A.J.**

My contribution to this study consisted of conceptualising the research and leading it. I was also responsible for collecting all materials (surface sediments) used in this study. I coordinated laboratory analyses for palynology (non-pollen palynomorphs), biogeochemistry (total organic carbon, biogenic silica), and sedimentology (grain size). Further, my input encompassed applying my taxonomical expertise to characterise organic-walled microfossils (palynomorphs), and selection of appropriate multivariate statistics. I wrote the manuscript which was then revised according to the comments of the co-authors. This research was carried out as part of my Marie Curie Integration Grant (QUEEN - The Quaternary Environmental Evolution of the Northwest-Passage) [P2], which I held as Principal Investigator at Bangor University in the UK.

[A6] Heikkilä, M., S. Ribeiro, Weckström, K., Pieńkowski, A.J., 2022. Predicting the future of coastal marine ecosystems in the rapidly changing Arctic: The potential of palaeoenvironmental records. *Anthropocene*, Elsevier, vol. 37, article number 100319; DOI: <https://doi.org/10.1016/j.ancene.2021.100319>

IF₂₀₂₃ : 4.1 (Q1); MEiN₂₀₂₄: 100; Citations: 19; CiteScore Percentile: 89

*My contribution to this study consisted of co-conceptualising and co-leading the article. This review paper was solicited by invitation by the journal *Anthropocene* as a result of the Past Global Changes (PAGES) Working Group 'ACME' (Arctic Cryosphere Change and Coastal Marine Ecosystems) [P3] which I co-founded and on whose Steering Committee I sit. I was responsible for the information on palaeoclimate proxies, and jointly wrote the article with my co-authors. I was also the main responsible for generating the two main figures – conceptual illustrations that are the mainstay of the article.*

c. Description of scientific/artistic aim(s) of the listed above paper(s) and achieved results including their potential applications:

Justification for undertaking the topic and the scientific objective

Understanding the past and present dynamics of the polar regions is critical for projecting future climate change. My work addresses this challenge by reconstructing Holocene environmental and ecosystem responses in the Arctic and Antarctic, while also improving the fidelity of palaeoclimate proxies and geochronological frameworks. At its core, my research seeks to answer two fundamental questions:

(1) How do high-latitude marine environments respond to climatic transitions?

and

(2) How can we best refine the methodological tools that underpin such reconstructions?

My research has consistently focused on understanding how polar regions - both the Arctic and Antarctic - respond to climate warming, past and present. A central aim has been to

improve the accuracy of climate proxies and geochronological tools, thereby enabling more faithful palaeoenvironmental reconstructions within a robust temporal framework.

The high latitudes are integral components of the Earth's climate system. Their unique physical properties regulate global temperature through the cryospheric albedo effect (Serreze & Barry, 2011), influence planetary energy balance, and drive oceanic thermohaline circulation - the 'global conveyor belt' that redistributes heat, carbon, and nutrients worldwide (Rahmstorf, 2002). Polar regions also function as significant carbon reservoirs, storing greenhouse gases in permafrost and marine sediments (Schuur et al., 2015), and they host ecosystems with globally significant biodiversity (Post et al., 2013).

The Arctic and Antarctic are highly sensitive to climate change. Amplified warming at high latitudes results from feedbacks such as the ice-albedo effect, where ice loss exposes darker surfaces that absorb more solar energy, accelerating warming (Pithan & Mauritsen, 2014). Indeed, the Arctic is now warming up to four times faster than the global average (Rantanen et al., 2022), leading to rapid declines in sea ice (Stroeve & Notz, 2018), thawing permafrost (Thuretsky et al., 2020), and ecological regime shifts (Meredith et al., 2019). These transformations have far-reaching implications for climate feedbacks and global weather patterns (IPCC, 2021).

However, our understanding of high-latitude change is limited by the brevity of direct observational records. Satellite monitoring of Arctic sea ice, for instance, only extends back to 1979. Such short records cannot capture the full range of natural variability, which is essential for predicting future changes. Geological archives such as marine sediments provide this much-needed long-term perspective, documenting past climate fluctuations and ecosystem responses that serve as analogues for ongoing and future change (Kaufman et al., 2020).

The reliability of such reconstructions, however, hinges on two factors: (1) the fidelity of environmental proxies that record past climate and ecosystem states, and (2) robust chronological frameworks that allow for regional and inter-hemispheric comparisons. My research addresses both of these needs. By combining micropalaeontological, biogeochemical, and sedimentological indicators in a multiproxy approach, I have reconstructed deglacial dynamics, palaeoproductivity, biodiversity shifts, and sea-ice histories. Complementarily, I have advanced the calibration of proxies and refined radiocarbon-based age-depth models to strengthen chronological accuracy.

The overarching scientific objective of my work is thus twofold: to deepen our understanding of how polar marine environments respond to climatic transitions, and to enhance the methodological foundations of palaeoclimate research, thereby providing more reliable baselines for interpreting current and future changes.

Detailed issues of the individual works that make up the scientific achievement

The publication cycle of six peer-reviewed articles within my broader achievements (written and submitted after my PhD) focuses on past to present polar marine environments, as well as on improving the accuracy of palaeoclimate proxies and geochronological frameworks. The overall goal uniting these six works is to understand how high-latitude marine environments and their ecosystems respond to changing conditions, in particular climate warming. Following

is a brief description of the research objectives, methods and main results of this cycle of works.

[A1] Pieńkowski, A.J., England, J.H., Furze, M.F.A., Blasco, S., Mudie, P.J., MacLean, B., 2013. 11,000 years of environmental change in the Northwest Passage: a multiproxy record from central Parry Channel. *Marine Geology*, Elsevier, vol. 341, 2013, p. 68–85; DOI: <https://doi.org/10.1016/j.margeo.2013.04.008>

This work aimed to reconstruct marine environmental change over the Holocene in central Parry Channel, the main East-West axis of the Northwest Passage in the Canadian High Arctic, a region for which continuous palaeoenvironmental data have remained sparse. We set out to characterise the post-Last Glacial Maximum (LGM) deglacial chronology, changes in oceanographic conditions, water mass circulation, biological productivity, and sea-ice regime, by employing a multiproxy approach to a sediment core. A further goal was to identify phases such as warming, cooling or shifts in oceanographic influence (for example inflow of Atlantic-derived water) and to relate these to climatic intervals such as the Holocene Thermal Maximum or Neoglacial cooling.

To this end, a >4 m long marine sediment core (core 9722-004) from central Parry Channel was studied. A robust chronostratigraphy based on 17 radiocarbon dates was constructed, enabling a calibrated age model in calibrated kilo-years before present (cal ka BP). We combined lithological examination (sediment composition, structure), geochemical proxies, and several kinds of microfossil analyses: dinoflagellate cysts, non-pollen palynomorphs, benthic and planktonic foraminifera. Biogenic proxies were used to infer productivity, sea-ice cover, water-mass influences, and degree of ice-proximity or ice-distal conditions. The core was subdivided into environmental zones based on changes in these proxies, to resolve temporal phases of environmental change. The sediment record is interpreted in relation to contemporary bathymetry (notably sills) that influence water depth and potential oceanographic circulation patterns, and in relation to known glacial retreat histories in the area derived from terrestrial studies.

The results show that the basal part of the core contains a diamict (Zone I), indicating grounded glacial ice in the channel. Above this, Zone II (subdivided into IIa, IIb, IIc) records the transition from ice-proximal to increasingly distal glacial marine conditions. In particular, around 10.8 cal ka BP there is evidence that glacial ice had decoupled (i.e., retreated or lost its grounded contact), and that ice-proximal conditions gave way to extensive sea-ice influence and then to more distal conditions relative to the ice margin. By ~10.3-10.0 cal ka BP (Zone III), there is a marked increase in microfossil abundance and diversity across all studied microfossil groups; particularly, planktic foraminifera (especially *Neogloboquadrina pachyderma*) appear for the first time in this core. As today the study area is too shallow for planktic foraminifera, their appearance is taken as an indicator that Atlantic-derived Arctic Intermediate Water must have been able to penetrate in the subsurface (below ~250 m) into the channel, likely facilitated by higher water depths during deglaciation due to glacio-isostatic effects. Between about 10.0 and 7.0 cal ka BP (Zone IV), studied proxies suggest elevated biological productivity, reduced seasonal sea ice, and more benign summer conditions; this is interpreted as corresponding to the Holocene Thermal Maximum in that region. After ca. 7.0 to 5.7 cal ka BP (Zone V), conditions shift: the Atlantic-derived intermediate water becomes excluded, water depths decreasing towards modern values due to glacio-isostatic rebound, and a return to more Arctic-dominated circulation and more seasonal sea-ice cover is apparent. From ~5.7 cal ka BP onward (Zones VI–VII), the record shows a stabilising toward high-Arctic conditions similar to those seen more recently, with only relatively minor fluctuations; the study does not detect a clear Little Ice Age signal in the record.

The implications of these findings are several. First, we demonstrate that central Parry Channel responded dynamically and sensitively to deglaciation, including changes in water depth (via glacio-isostatic rebound) which in turn influenced oceanic water mass penetration, biological productivity, and sea-ice cover. The fact that planktic foraminifera appear in the early Holocene suggests that water column structure and circulation were very different then compared to present. The timing of transitions (e.g. ~10.8 cal ka BP for glacial decoupling, ~10.3-10.0 cal ka BP for onset of biological activity, ~7 cal ka BP onwards for transition to more 'modern' Arctic regimes) gives constraints on the chronology of environmental shifts in this part of the Northwest Passage. These data help to fill a geographic gap in Arctic palaeoclimate records, important for modelling and understanding regional climate sensitivity. Moreover, by recognising a phase of enhanced warmth and productivity during the Holocene Thermal Maximum followed by gradual transition to more sea-ice dominated and cold conditions, the work contributes to understanding how natural variability operated before anthropogenic warming, which is relevant for contextualising present and future change in the Arctic. The study also emphasises the role that bathymetry and sills play in modulating water mass exchange, a factor that may be increasingly important under changing sea levels and ice configurations. Finally, the absence of strong signatures of shorter-term cool periods (e.g. Little Ice Age) in this record suggests either that the proxies used here are not sensitive to those intervals, or that the region was buffered from those changes, which is itself informative about spatial heterogeneity of climate signals in the Arctic.

In summary, this study represents a detailed, well-dated, multiproxy environmental history spanning from just after regional LGM deglaciation (~11 cal ka BP) through to late Holocene high Arctic conditions. Our results delineate clear phases of changing glacial, oceanographic, sea ice and biological conditions, highlight key intervals such as the early Holocene warm period, and provide essential constraints for understanding Arctic climate dynamics, both for past natural change and for projecting responses under future warming.

[A2] Pieńkowski, A.J., Husum, K., Belt, S.T., Ninneman, U., Köseoğlu, D., Divine, D., Smik, L., Knies, J., Hogan, K., Noormets, R. 2021. Seasonal sea ice persists through the Holocene Thermal Maximum at 80°N. *Communications Earth & Environment*, Nature Publishing Group, vol. 2, article number 124; DOI: <https://doi.org/10.1038/s43247-021-00191-x>

This study provides critical insights into Arctic sea-ice dynamics during the Holocene Thermal Maximum (HTM), a period spanning roughly 11,000 to 6,000 years ago when Northern Hemisphere temperatures were significantly warmer than today. The HTM has been widely regarded as a period of substantial sea-ice retreat in the Arctic, particularly in high-latitude regions such as the northern Barents Sea. Understanding the behaviour of sea ice during this period is crucial for reconstructing past climate conditions, interpreting oceanographic and ecological changes, and improving predictions of future Arctic climate responses to ongoing warming. Previous reconstructions had suggested that the northernmost regions of the Barents Sea experienced near-complete loss of sea ice during the HTM, based primarily on non-sea-ice-affiliated palaeoclimate indicators and assumptions about the response of polar environments to warmer temperatures. We challenge these assumptions by analysing sea-ice and open-water biomarkers preserved in marine sediments, providing evidence that seasonal sea ice persisted in the northern Barents Sea throughout the HTM despite elevated water and air temperatures.

To achieve this, we studied two sediment (gravity) cores from strategic locations in the northern Barents Sea, an area sensitive to changes in sea-ice cover and oceanographic processes. The sediment cores were selected to provide continuous records spanning the Holocene, allowing the identification of temporal trends in sea-ice presence and productivity. The cores were subjected to detailed geochemical and HBI (highly-branched isoprenoid) biomarker analyses, focusing on compounds specifically produced by sea-ice-associated organisms. Among the key biomarkers analysed were IP₂₅

(‘Ice Proxy with 25 carbon atoms’), a mono-unsaturated highly branched isoprenoid lipid produced exclusively by certain diatoms living within sea ice, and HBI III, a biomarker associated with open-water algae and indicative of primary productivity associated with the Marginal Ice Zone (MIZ). The presence and abundance of these biomarkers in sediment layers provide powerful evidence of past sea-ice conditions, allowing the semi-quantitative reconstruction of the persistence and seasonality of sea ice through the HTM with a higher degree of confidence than previously possible.

The analyses revealed that both IP₂₅ and HBI III were consistently present in core layers corresponding to the HTM, indicating that seasonal sea ice continued to form in the northern Barents Sea despite warmer climatic conditions. The presence of IP₂₅ specifically confirms that sea-ice diatoms were thriving, suggesting the maintenance of at least seasonal ice cover sufficient to support these microbial communities. HBI III complements this evidence, indicating continued productivity along the MIZ ecosystem. These findings collectively demonstrate that the northern Barents Sea did not experience completely sea-ice-free conditions during the HTM, but rather retained a seasonal sea-ice regime. This result contrasts sharply with earlier assumptions that elevated Holocene temperatures would have caused extensive sea-ice loss at these latitudes, revealing that even during periods of significant warming, Arctic sea ice can persist seasonally.

The study also highlights the spatial and ecological significance of this persistent seasonal sea ice. By demonstrating that sea ice remained a recurring feature during the HTM, we provide evidence that the high-latitude Arctic maintained a stabilising influence on oceanographic conditions, including water column stratification, albedo feedback, and local nutrient cycling. The persistence of seasonal sea ice would have influenced primary productivity patterns and marine food web dynamics, particularly for organisms adapted to ice-associated habitats. Furthermore, the findings imply that the northern Barents Sea acted as a refugium for sea-ice-dependent organisms, allowing them to survive and maintain ecological continuity even during warmer intervals of the Holocene. These ecological and oceanographic implications extend beyond the local scale, influencing broader atmospheric and climate feedbacks, including the regulation of heat exchange between the ocean and atmosphere, the modulation of high-latitude albedo, and potential impacts on large-scale ocean circulation patterns.

Methodologically, the study underscores the value of HBI biomarker proxies in palaeoenvironmental reconstructions. Traditional proxies, such as foraminiferal assemblages often lack the specificity needed to detect seasonal ice persistence. In contrast, biomarkers like IP₂₅ and HBI III provide evidence of the presence and productivity of sea-ice-associated biota, allowing for a more quantitative and precise reconstruction of past sea-ice dynamics. We demonstrate that the combination of these biomarkers, along with stratigraphic and chronological controls from sediment cores, offers a powerful tool for examining Holocene Arctic sea-ice variability. This approach also facilitates comparisons across multiple regions and time periods, helping to elucidate the spatial heterogeneity of sea-ice cover and the factors governing its persistence under changing climatic conditions.

The persistence of seasonal sea ice through the HTM has broader implications for understanding Arctic climate resilience and variability. It suggests that high-latitude regions of the Arctic Ocean, particularly areas influenced by Atlantic-derived currents and local oceanographic conditions, may be more resistant to complete ice loss than previously assumed. This has important consequences for modelling future sea-ice scenarios, as it indicates that even under sustained warming, the Arctic may retain seasonal ice cover in certain regions, potentially buffering ecosystems and influencing regional climate feedbacks. Additionally, these findings challenge simplified assumptions that Arctic sea ice responds linearly to temperature increases, highlighting the complex interactions between ocean circulation, atmospheric forcing, and local ecological processes that govern ice persistence.

In conclusion, we provide compelling evidence that seasonal sea ice persisted in the northern Barents Sea at 80°N throughout the Holocene Thermal Maximum, despite higher-than-present temperatures.

By analysing sedimentary biomarkers such as IP₂₅, we demonstrate that sea-ice-associated diatoms and algae continued to thrive, supporting a seasonally recurrent sea-ice regime. These findings challenge earlier assumptions of near-complete ice loss in high-Arctic regions during the HTM and have significant implications for understanding Arctic climate dynamics, ecological continuity, and oceanographic processes during periods of past warming. Moreover, the study highlights the effectiveness of HBI-biomarker-based palaeoenvironmental reconstruction for resolving questions of sea-ice persistence and provides a framework for future research on Arctic climate variability. By demonstrating the resilience of seasonal sea ice under warmer Holocene conditions, this research contributes to a more nuanced understanding of past Arctic climate behaviour and informs projections of the future Arctic under ongoing global warming, with relevance for both climate science and the conservation of sea-ice-dependent ecosystems.

[A3] Pieńkowski, A.J., Szczuciński, W., Breszka, A., Chyleński, M., Juras, A., Romel, P., Rozwalak, P., Trzebny, A., Dabert, M., Belt, S.T., Jagodziński, R., Smik, L., Włodarski, W. 2024. Sedimentary ancient DNA and HBI biomarkers as sea-ice indicators: A complementary approach in Antarctic fjord environments. *Limnology & Oceanography Letters*, Wiley Blackwell, article number 10395; DOI: <https://doi.org/10.1002/lol2.10395>

This study addresses the challenge that high-resolution, long-term records of sea-ice conditions prior to modern observational datasets are scarce, yet essential for understanding recent rapid sea-ice declines in the Antarctic by putting them in a longer-term context. The study has two main objectives. First, to test the value of combining sedimentary ancient DNA (sedaDNA) targeting the obligate sea-ice dinoflagellate *Polarella glacialis* with standard highly branched isoprenoid (HBI) biomarkers, plus other proxies, to reconstruct past sea-ice variability in Antarctic fjord environments on sub-decadal to decadal timescales. And second, to extend such reconstructions back to the early 20th century, thereby covering the pre-observational period and evaluating whether these proxies reflect known warming, sea-ice retreat and productivity changes.

To achieve this, we studied a sediment archive (multi core) from a fjord on the Antarctic Peninsula (Sheldon Cove) that extends back to ca. 1900 CE (Common Era). These sediments were investigated for several proxies: sedimentary ancient DNA (sedaDNA) of *P. glacialis*, a sea-ice-affiliated dinoflagellate; several HBI biomarkers (notably IPSO₂₅, a sea-ice associated biomarker; and open-water HBIs such as HBI III); total organic carbon (TOC); and other indicators. The sampling strategy allowed sub-decadal to decadal temporal resolution. We also compared the proxy signals with known observational data (satellite and/or *in situ* records) for sea-ice, open-water, productivity changes in recent decades, to test whether the investigated proxies track those changes. The analytical methods included molecular biology techniques for extracting sedaDNA and quantifying the *P. glacialis* DNA, chemical analyses for HBI biomarkers, and geochemical work for the productivity indicators such as total organic carbon (TOC) and biogenic silica.

The main results show that pre-1940 CE, the sea-ice biomarker IPSO₂₅ is continuously present in the sediments, yet *P. glacialis* sedaDNA is absent (or nearly so), while open-water HBIs and TOC are at low levels. This combination suggests more extensive seasonal sea ice, colder conditions, and lower productivity before 1940. After ~1940 CE, *P. glacialis* sedaDNA increases, as do signals from open-water HBIs, concomitant with IPSO₂₅, indicating a shift: younger sea ice, a retreat of the sea-ice edge, less persistent or thinner sea ice, and increased productivity. In the last two decades of the record, decreases in *P. glacialis* sedaDNA coincident with increases in open-water HBIs and higher TOC are consistent with observed warming, reductions in sea ice, and greater productivity. Importantly, the multiproxy reconstructions developed in this study agree fairly well with observational (satellite/*in situ*) data over recent decades, lending confidence to the proxy approach.

Some finer-scale observations include that while IPSO₂₅ persists throughout, the changing contribution of *P. glacialis* sedaDNA to overall sedaDNA versus the HBI biomarkers reveals shifts not only in the presence/absence of sea ice but also in sea-ice type (for example “young ice” vs. more persistent seasonal ice) and possibly the sea-ice edge positions. The presence of *P. glacialis* sedaDNA in the more recent part of the core but its absence earlier suggests that either the organism was less abundant, less preserved, or perhaps the environmental conditions (light, nutrients, ice thickness or duration) were less favourable for it prior to ~1940 CE. Also, TOC trends complement the biological/chemical proxy data, showing increases in organic carbon associated with greater open water and productivity, consistent with warmer conditions.

Through the combination of sedaDNA, HBI biomarkers, and TOC, we argue that one can resolve more nuanced changes in sea-ice history than by using biomarkers alone. HBIs such as IPSO₂₅ inform about sea-ice presence (especially seasonal sea ice), but adding *P. glacialis* sedaDNA provides added sensitivity to changes in type, thickness, or duration of ice, or shifts in the sea-ice edge. The implication is that palaeo reconstructions can better detect transitions in sea ice dynamics - not only gross presence versus absence - but shifts in seasonal dynamics and productivity.

In terms of broader implications, this study suggests that proxy combinations (molecular + biogeochemical) are a powerful tool for reconstructing sea-ice histories, particularly in Antarctic fjord settings where local variability may be high and biomarker signals alone may be ambiguous. For climate change science, the study provides a longer baseline for sea-ice retreat on the Antarctic Peninsula, reinforcing that the observed reductions in recent decades are part of a larger change away from a colder, more persistent seasonal ice regime. It offers a template for applying similar methods in other locations, which may enable refining models of sea-ice change, improving projections, and informing interpretations of how sea ice influences marine productivity, carbon cycling, and ecosystems. It also points to the importance of including molecular fossil proxies (like sedaDNA) in palaeoenvironmental studies, especially where traditional proxies have limitations (e.g. preservation, specificity, sensitivity).

In sum, we provide evidence that combining sedaDNA of *Polarella glacialis* with HBI biomarkers yields a more detailed picture of sea-ice dynamics in Antarctic fjords over the last ~125 years. Distinct changes after ~1940 align with observed warming, open-water increase, shortening or thinning of sea-ice cover, and increased productivity. The study encourages use of such multiproxy approaches to improve our understanding of past sea-ice behaviour, which is essential for forecasting future changes under continuing warming and for putting recent changes in long-term context.

[A4] Pieńkowski, A.J., Coulthard, R.D., Furze, M.F.A. 2023. Revised marine reservoir offset (ΔR) values for molluscs and marine mammals from Arctic North America. *Boreas*, Wiley-Blackwell, vol. 52, p. 145-167; DOI: <https://doi.org/10.1111/bor.12606>

This study set out to address the long-standing problem of how to correctly account for marine reservoir effects in radiocarbon dating of samples from Arctic North America. Radiocarbon dating of marine organisms requires not only calibration against global reference curves but also the application of regional reservoir corrections, known as ΔR values. These offsets arise because surface waters contain varying proportions of ‘old’ carbon, leading to systematic discrepancies between radiocarbon ages of marine organisms and those of contemporaneous terrestrial material. Without appropriate correction, marine radiocarbon ages can appear hundreds to thousands of years older than their true calendar age, which has significant implications for reconstructing past climate and sea-ice history, as well as for dating archaeological material associated with subsistence on marine resources. Previous estimates of ΔR in the Arctic had been based on earlier calibration curves such as Marine04 or Marine13, or on relatively limited collections of pre-nuclear-bomb specimens, and often relied on values applied broadly across very large areas. The objective of this study was therefore to produce

revised and spatially explicit ΔR values for molluscs and marine mammals in Arctic North America that are consistent with the most recent global calibration curve, Marine20, and that reflect the diversity of oceanographic settings across the region.

Radiocarbon measurements were compiled from a wide range of pre-1956 live-collected mollusc shells and marine mammal tissues. The restriction to pre-bomb material is crucial, as nuclear weapons testing after the mid-20th century introduced large amounts of artificial radiocarbon into the atmosphere and oceans, complicating subsequent calibration. Data were compiled from published sources in turn based on museum collections, with careful vetting to ensure that they were indeed live-collected at the time of death and not subfossil specimens of uncertain age. In the case of molluscs, specimens were selected from species whose feeding habits minimise the risk of incorporating anomalously old carbon from sediments or detritus (avoiding the so-called 'Portlandia Effect'; England et al., 2013). For marine mammals, tissues such as bone collagen or baleen from species with reasonably well understood ecologies were chosen, though mobility and varied diets of marine mammals introduce additional uncertainty compared with molluscs.

For each sample, the measured radiocarbon age was compared to the expected age on the Marine20 calibration curve at the calendar year of collection. The difference between the observed and expected ages constitutes the ΔR value, and we calculated this together with its associated error term. Because oceanographic and sea-ice conditions differ markedly across Arctic North America, the study area was divided into geographic regions defined by prevailing currents, water masses and coastal configuration. Individual ΔR values from molluscs were aggregated within these zones to produce mean regional offsets. Marine mammals were treated separately, both because of their broader mobility and because their ecology can span more than one water mass. Statistical procedures were applied to identify and exclude outliers and to quantify uncertainties. The resulting dataset thus represents one of the most comprehensive compilations of pre-bomb ΔR values for the Arctic to date, firmly grounded in the new Marine20 framework.

The results show that marine reservoir offsets are far from uniform across Arctic North America. Molluscs reveal clear regional patterns: in some areas influenced by well-ventilated Atlantic-derived waters the offsets are relatively small, while in more isolated or sea-ice-covered regions, such as those strongly affected by restricted circulation, ΔR values are larger. In practical terms, this means that marine shells of the same calendar age collected in different parts of the Arctic could differ in radiocarbon age by more than a century if these offsets are not considered. For marine mammals the picture is more complex, with generally larger uncertainties. Bowhead whales, belugas and walrus all display ΔR values that are broadly consistent with the molluscan evidence from their feeding grounds, but variation among individuals and across regions is considerable. The mobility of marine mammals, their use of different habitats and their reliance on different components of the marine food web all contribute to this variability. Nevertheless, the new values provide a much-needed benchmark for correcting marine mammal radiocarbon ages in the region.

The comparison with earlier studies underscores the importance of these revisions. In several cases, previously published ΔR values differ substantially from the Marine20-based results, meaning that dates calibrated using older corrections could be offset by as much as 100-200 years. Such discrepancies have significant implications for reconstructions of the timing of sea-ice expansion or retreat, for the dating of archaeological sites reliant on marine resources, and for assessments of the historical ranges of marine mammals. For example, an apparent lead or lag between terrestrial and marine records of climate change may vanish, or even reverse, once the appropriate regional ΔR is applied. Similarly, interpretations of human adaptation to changing sea-ice conditions could shift if the radiocarbon ages of marine resources are re-calibrated using the updated corrections. We therefore caution against using uniform or outdated ΔR values across the Arctic, and instead advocate application of the revised, regionally specific offsets presented in this study.

The implications of this study extend beyond the Arctic, highlighting more generally the necessity of updating reservoir corrections in line with advances in global calibration curves. Marine20 differs significantly from earlier curves in its representation of global marine ^{14}C distribution, so recalculating regional offsets is essential. By providing a robust set of revised ΔR values for Arctic North America, we offer a vital tool for palaeoclimatologists, archaeologists and oceanographers working in the region. The study also illustrates the value of museum collections of live-collected specimens, which remain an under-exploited resource for refining chronologies. Finally, the study emphasises that marine mammal ΔR values carry greater uncertainty than those of molluscs, requiring careful consideration of species ecology and life history when applying corrections to archaeological or palaeoenvironmental material.

In conclusion, the study represents a major advance in our ability to accurately calibrate marine radiocarbon ages in Arctic North America. By systematically recalculating ΔR values using pre-bomb molluscs and marine mammals and anchoring them to the Marine20 calibration curve, we demonstrate both the spatial variability of the marine reservoir effect and the risks of relying on outdated or overly generalised corrections. The findings improve chronological precision in a region where accurate dating is critical for understanding past climate dynamics, sea-ice variability and human–environment interactions. The revised ΔR values provide a new baseline that facilitates more robust reconstructions of Arctic history and ensures that marine and terrestrial chronologies can be meaningfully compared.

[A5] [Pieńkowski, A.J., Kennaway, S., Lang, S.I. 2020. Aquatic palynomorphs from modern marine sediments in a reconnaissance transect across the Northwest Passage – Baffin Bay region. *Marine Micropaleontology*, Elsevier, vol. 156, article number 101825; DOI: <https://doi.org/10.1016/j.marmicro.2020.101825>](#)

This study presents a detailed examination of organic-walled microfossils (palynomorphs) extracted from modern marine sediments collected along a reconnaissance transect that spans the Northwest Passage to Baffin Bay. The primary objective of the research was to provide a comprehensive baseline characterisation of the occurrence, diversity, and abundance of aquatic palynomorphs in Arctic marine sediments, a topic that has received limited attention despite the growing importance of the Arctic in global climate research. By analysing the spatial distribution of these microfossils and identifying underlying correlations with measured environmental variables, the study aims to improve the understanding of contemporary Arctic marine ecosystems and establish the foundation for using palynomorphs as proxies in palaeoenvironmental reconstruction.

To achieve these objectives, a systematic sampling strategy was employed, collecting surface sediment samples (top 1 cm) from 18 boxcores distributed across a broad latitudinal and longitudinal gradient encompassing both the Canadian Arctic Archipelago and adjacent Baffin Bay. The sediment samples were processed following standard palynological techniques, including chemical treatment to remove carbonates and silicates, sieving to isolate the relevant size fractions, and mounting for microscopic examination. The analytical focus was placed on non-pollen, non-dinocyst palynomorphs, including: acritarchs, foraminiferal test linings, and the remains of zooplankton such as egg capsules, mouthparts, and other skeletal fragments. Quantitative analysis involved counting and identifying palynomorphs to the lowest possible taxonomic level, allowing for the construction of abundance matrices and diversity indices for each site. The concentration of palynomorphs in the sediments ranged widely, from approximately 400 to 21,900 individuals per gram, with an overall average of 5,730 individuals per gram, indicating that Arctic sediments can preserve a rich and detailed record of aquatic microfossils.

The results revealed substantial spatial variation in palynomorph assemblages along the transect. Areas characterised by perennial sea-ice cover, such as certain channels within the central Northwest Passage, exhibited lower palynomorph abundance and reduced taxonomic diversity. This pattern is consistent with ecological theory, as persistent ice cover limits light penetration and primary

production, thereby reducing the available energy for higher trophic levels, including the microzooplankton that produce the palynomorphs observed. In contrast, regions with seasonal sea ice or predominantly open water conditions displayed markedly higher palynomorph diversity and abundance, reflecting the increased primary productivity and ecological complexity associated with more favourable environmental conditions. Among the palynomorph taxa identified, some were observed to display clear preferences for specific environmental parameters, such as temperature, salinity, and proximity to riverine inputs, highlighting their potential utility as indicators of particular oceanographic conditions. These findings support the concept that aquatic palynomorphs are not only components of the sedimentary record but also sensitive ecological markers that respond to both physical and biological environmental factors.

The implications of this research are broad and significant for both contemporary marine ecology and palaeoenvironmental studies. Firstly, by establishing a robust baseline of palynomorph abundance and diversity across the Northwest Passage and Baffin Bay, the study provides a critical reference point against which future environmental changes, including those driven by climate warming and declining sea ice cover, can be assessed. Secondly, the observed relationships between palynomorph assemblages and environmental variables offer a valuable framework for the use of these microfossils as proxies in reconstructing past Arctic marine conditions. This is particularly important given the limited availability of other high-resolution indicators in the region, as well as the sensitivity of the Arctic to climate fluctuations. By demonstrating that specific palynomorph taxa correlate with environmental gradients, the study reinforces the potential for using modern assemblage data to infer historical conditions in sediment cores, thereby extending the temporal perspective of Arctic climate research. Additionally, the study emphasises the importance of including non-pollen palynomorphs in marine palynological investigations, advocating for a more inclusive approach to studying sedimentary microfossils that can capture both ecological and environmental variability.

In conclusion, this research significantly advances knowledge of aquatic palynomorphs in Arctic marine sediments. The sampling in a transect, quantitative analyses, and interpretation of environmental relationships demonstrate that these microfossils are valuable indicators of both contemporary ecological conditions and past environmental variability. The study provides a critical baseline for understanding how Arctic marine ecosystems respond to environmental gradients and offers a methodological and conceptual framework for future studies seeking to use palynomorphs in climate reconstruction. By highlighting the sensitivity of aquatic palynomorph assemblages to sea ice cover, temperature, and salinity, the research also contributes to broader discussions regarding the vulnerability of polar ecosystems to climate change, emphasising the need for continued monitoring and palaeoecological investigation in this rapidly changing region. Overall, this study underscores the scientific value of Arctic marine palynology and its relevance to understanding both modern and historical environmental processes in one of the most climatically sensitive regions on Earth.

[A6] Heikkilä, M., S. Ribeiro, Weckström, K., Pieńkowski, A.J., 2022. Predicting the future of coastal marine ecosystems in the rapidly changing Arctic: The potential of palaeoenvironmental records. *Anthropocene*, Elsevier, vol. 37, article number 100319; DOI: <https://doi.org/10.1016/j.ancene.2021.100319>

This invited review article examined the potential of palaeoenvironmental records to predict the future trajectories of coastal marine ecosystems in the Arctic, a region that is experiencing unprecedented environmental transformations due to global climate warming. Arctic coastal areas are particularly vulnerable because they are influenced by multiple stressors, including rising air and sea temperatures, changes in sea-ice cover, ocean acidification, and shifts in freshwater input from melting glaciers and permafrost. These factors interact in complex ways to affect biological communities, biogeochemical cycles, and overall ecosystem functioning. Understanding how these ecosystems have responded to past environmental changes is therefore crucial for anticipating future dynamics, informing

management strategies, and guiding conservation efforts. This study focuses on how palaeoenvironmental records can provide long-term data that contextualises contemporary observations and improves the accuracy of predictions for future ecosystem responses.

We approach the problem through a comprehensive review of palaeoecological methods and their applications in Arctic coastal marine research. We highlight the use of sediment cores as primary archives, which preserve biological, chemical, and physical signals accumulated over centuries to millennia. Within these cores, a range of proxies - including microfossils such as diatoms, dinoflagellate cysts, and foraminifera; geochemical indicators like stable isotopes and trace metals; and palynomorphs such as pollen and acritarchs - can provide detailed information about past environmental conditions. By analysing changes in species composition, abundance, and isotopic signatures, researchers can reconstruct variables such as sea surface temperature, salinity, nutrient availability, sea ice, and primary productivity. Importantly, these records allow for the identification of periods of natural variability as well as responses to anthropogenic pressures, enabling a more nuanced understanding of ecosystem resilience and vulnerability.

This work emphasises the value of multi-proxy approaches, which combine multiple lines of evidence to provide more robust reconstructions. For example, integrating diatom assemblages with isotopic measurements can yield both ecological and biogeochemical perspectives, while including sedimentological data allows for the identification of shifts in sediment transport and deposition patterns. Such integrated approaches improve confidence in reconstructions by reducing uncertainties associated with relying on a single proxy and by capturing the complex interplay between physical, chemical, and biological factors in Arctic coastal systems. We also highlight the importance of high-resolution temporal data, noting that fine-scale records are necessary to detect abrupt changes, seasonal variability, and responses to short-term climatic events. High-resolution records can thus inform models that aim to project near-term ecosystem dynamics, which are critical for adaptation planning.

Our review underscores methodological challenges that must be addressed to fully exploit palaeoenvironmental records. These include the need for rigorous calibration of proxies against modern environmental measurements, the careful selection of representative sites, and accounting for post-depositional processes that may alter the original signal. We also stress the importance of establishing regional baselines, as Arctic coastal ecosystems are highly heterogeneous and local factors such as bathymetry, hydrodynamics, and freshwater input can strongly influence ecological responses. Without understanding these spatial variations, it is difficult to generalise findings or apply them to predictive models with confidence.

Beyond the technical aspects, this study highlights the conceptual contributions of palaeoenvironmental research to understanding Arctic ecosystem change. Long-term records enable the separation of natural variability from anthropogenic influence, providing context for evaluating the magnitude and rate of contemporary change. For example, by comparing past periods of warming or cooling with present trends, researchers can assess whether current ecosystem responses are within the range of natural variability or represent unprecedented conditions. This perspective is crucial for identifying tipping points, potential regime shifts, and the capacity for recovery, all of which inform risk assessment and management decisions.

We also emphasise the broader significance of integrating palaeoenvironmental data into interdisciplinary research. Coastal Arctic ecosystems are shaped by the interplay of physical, chemical, and biological processes, and addressing environmental challenges requires combining palaeoecological data with oceanographic, climatological, and ecological studies. Such integration can improve predictive models by incorporating long-term trends, extreme events, and historical baselines, leading to more accurate forecasts of ecosystem responses to ongoing warming, sea-ice loss, and

human pressures. In addition, palaeoenvironmental records can guide conservation strategies by identifying habitats or species that are particularly sensitive to change, thereby prioritising protection efforts.

This paper concludes that palaeoenvironmental records are invaluable for understanding the dynamics of Arctic coastal marine ecosystems and for predicting their future trajectories under rapidly changing environmental conditions. By providing long-term perspectives on ecosystem variability and resilience, these records complement contemporary observations and enhance the capacity of scientists and policymakers to anticipate ecological responses to climate change. The study calls for continued research to expand the spatial and temporal coverage of palaeoecological data, improve proxy calibration, and strengthen integration with other disciplines. Such efforts will not only enhance scientific understanding but also support informed management and policy decisions aimed at safeguarding Arctic coastal marine ecosystems in an era of unprecedented environmental change.

In summary, this study demonstrates that palaeoenvironmental records are critical tools for assessing past ecosystem responses, contextualising contemporary changes, and informing predictions about the future of Arctic coastal marine systems. By leveraging the insights from sediment cores, microfossils, geochemical proxies, and integrated multi-proxy approaches, researchers can develop a more comprehensive understanding of the complex factors driving ecological change. This knowledge provides a foundation for evidence-based management and conservation strategies, highlighting the enduring value of palaeoecological research in addressing the urgent environmental challenges facing the Arctic.

d. Summary of research results presented in the publication cycle within the broader achievements

The results of the presented publication cycle [A1-A6] provide a coherent and integrative understanding of the functioning of polar marine environments under conditions of climatic variability, and allow the identification of key mechanisms controlling their dynamics. The studies, based on a multiproxy approach and encompassing both Arctic and Antarctic regions, integrate palaeoenvironmental, geochemical, and biological data to reconstruct environmental changes across both Holocene and modern timescales.

One of the principal outcomes of this body of work is the demonstration that the response of high-latitude marine systems to climate change is complex and non-linear. The results show that these systems do not respond uniformly to warming, but instead exhibit substantial regional variability and sensitivity to local oceanographic controls, including bathymetry, water mass circulation, and the influence of distinct water masses. In particular, the findings highlight the importance of glacio-isostatic processes and changes in basin configuration in shaping environmental conditions and controlling water mass exchange.

A second key finding is the identification of sea ice as a central regulator of polar marine environments. The results demonstrate that even during periods of elevated temperatures, such as the Holocene Thermal Maximum, sea ice can persist in a seasonal form, exerting a strong influence on water column structure, biological productivity, and ecosystem functioning. At the same time, the studies document substantial variability in sea-ice regimes across different timescales, from millennial to decadal, emphasizing the tight coupling between sea ice, oceanographic processes, and climate forcing.

An important contribution of this publication cycle is also the development and application of integrated methodological approaches in palaeoenvironmental research. In particular, the combination of micropalaeontological indicators, organic geochemical biomarkers, and sedimentary ancient DNA (sedaDNA) has been shown to provide a more comprehensive and sensitive reconstruction of past environmental conditions. This multiproxy framework allows not only the detection of sea-ice presence, but also the reconstruction of its seasonality, type, and associated changes in biological productivity.

Another significant outcome is the improvement of chronological frameworks through the refinement of regional marine reservoir corrections (ΔR) for Arctic environments. The results demonstrate substantial spatial variability in the reservoir effect, with direct implications for the accuracy of radiocarbon dating and the synchronization of marine and terrestrial records.

Taken together, the results indicate that polar marine environments operate as tightly coupled systems in which climatic, oceanographic, and ecological processes interact across multiple spatial and temporal scales. The multiproxy approach applied in this work enables the resolution of this complexity and provides new insights into the mechanisms driving environmental variability in both past and present polar systems.

e. Significance of the presented results

The results of this publication cycle make a substantial contribution to the advancement of palaeoceanographic and palaeoclimatic research in polar regions, both in terms of conceptual understanding and methodological development. Their importance lies in providing new constraints on the response of high-latitude marine systems to climate variability, as well as in improving the robustness of palaeoenvironmental reconstructions that underpin our understanding of ongoing and future climate change. The significance of these findings is reflected in their citation in numerous international peer-reviewed Q1 journals, including *Nature Communications*, *Nature Geoscience*, and *Communications Earth & Environment*, among others. Their broader relevance is further underscored by their use in studies spanning diverse geographical regions and temporal scales.

From a conceptual perspective, the findings contribute to a refinement of existing models describing the response of polar environments to climatic warming [A1–A3]. In particular, the demonstration that seasonal sea ice can persist during periods of elevated temperatures [A2] indicates that the relationship between temperature and sea-ice extent is not linear. This challenges simplified assumptions of widespread ice-free conditions under warmer climates and highlights the importance of regional oceanographic controls in modulating sea-ice dynamics. As a result, the presented studies provides a more nuanced framework for interpreting past climate variability and offers important constraints for the calibration and evaluation of climate models.

The results also advance understanding of the role of sea ice as a key component of the climate system and a regulator of marine ecosystem functioning. By demonstrating its persistence and variability across different timescales [A2–A3], the studies highlight its influence on water column structure, primary productivity, carbon cycling, and trophic interactions. These insights are particularly relevant in the context of rapid contemporary changes in polar regions, where shifts in sea-ice regimes have far-reaching ecological and climatic consequences.

A major contribution of this body of work lies in the development [A5] and application [A1–A3; A5] of integrated multiproxy methodologies. The combination of micropalaeontological, geochemical, and molecular indicators, including sedimentary ancient DNA [A3], represents a significant methodological advance that enhances both the resolution and interpretative power of palaeoenvironmental reconstructions. This approach enables the detection of subtle environmental changes and provides a transferable framework applicable to other regions and environmental settings.

In a broader context, the results contribute to placing contemporary environmental changes in polar regions within a longer-term perspective [A1–A3], while also highlighting the importance of palaeorecords in informing future climate assessments [A6]. By extending observational records beyond the instrumental period, they provide essential baseline data for distinguishing natural variability from anthropogenic change. This is fundamental for improving predictions of future climate trajectories and for assessing the resilience and vulnerability of polar systems.

Furthermore, the refinement of regional marine reservoir corrections (ΔR) [A4] constitutes an important contribution to chronological accuracy in marine studies. By demonstrating the spatial variability of the reservoir effect and providing updated correction values, this work improves the precision of radiocarbon-based chronologies and facilitates more reliable comparisons between marine and terrestrial records. This has direct implications for a wide range of disciplines, including palaeoclimatology, archaeology, and Quaternary geology.

The significance of the presented results lies in their contribution to a more comprehensive understanding of polar marine systems, the advancement of analytical approaches in palaeoenvironmental research, and the provision of critical knowledge supporting the interpretation and projection of climate change. The interdisciplinary nature of this work ensures its relevance across multiple fields, including palaeoceanography, palaeoclimatology, oceanography, and environmental science, as reflected in its broad citation.

Publications [A1] and [A2] have been cited 40 and 26 times, respectively, in studies across multiple regions of the Arctic Ocean. Publication [A2] in particular has had a strong impact since its publication in 2021 and has been cited in leading journals such as *Nature Geoscience* and *Nature Communications*. Publication [A3], published in 2024, has already been cited six times in studies extending beyond the Antarctic region, including in Q1 journals such as *Nature Communications*. Publication [A4], cited 30 times to date, has contributed significantly to improving chronological frameworks in Arctic research across palaeoceanographic, environmental, and archaeological contexts. Publication [A5], cited 13 times, has provided a methodological foundation for Quaternary studies in geographically diverse regions, including the Chukchi, Caspian, and Red Seas, southern South America, and Antarctica, as well as in research on earlier climatic events such as the Palaeocene–Eocene Thermal Maximum (PETM). The invited review paper [A6], cited 19 times to date, has contributed to discussions extending beyond the immediate academic community, including those relevant to science-based climate policy and stakeholders such as the Intergovernmental Panel on Climate Change (IPCC).

f. Discussion of additional and complementary scientific achievements beyond the publication cycle

In parallel with the publication cycle, my habilitation achievements also include a substantial body of independent scientific work that extends beyond the thematic scope of the cycle and demonstrates continuity, breadth, and development of my research profile.

Contributing to my achievements, my body of published works has consistently grown during my career. Thus far, I have published a total of 30 articles in international peer-reviewed journals, most of these after my PhD (**Table 1**). In addition to the publications described above in the cycle of publications [A1-A6], my wider body of research reflects a sustained commitment to understanding environmental and cryospheric change across both polar regions. While the Arctic has been the primary focus of my work, I have also made direct contributions to Antarctic science, ensuring that my research is situated within a circumpolar and comparative framework. These studies, often interdisciplinary and collaborative in scope, have advanced methodological foundations for palaeoenvironmental reconstruction while deepening empirical insights into Quaternary climate variability, marine ecosystems, and ice-ocean interactions.

Table 1. Research output in terms of peer-reviewed international journal papers before and after award of my PhD.

	Pre-PhD (until 2011)	Post-PhD (since 2011)	Total
Number of peer-reviewed publications	5	25	30
Number of first authored publications	2	10	12

A key area of my achievements has been the refinement of marine radiocarbon chronologies. Reliable dating is essential for constraining the timing of environmental change, yet the use of marine samples is complicated by spatial and temporal variability in reservoir effects. In Pieńkowski et al. (2022) [D1], I led a revision of ΔR values for the Barents Sea and its archipelagos, producing a set of corrections that now underpin robust and regionally specific ^{14}C chronologies. This work has become an important reference for studies of Arctic deglaciation and Holocene palaeoceanography. My earlier collaboration with Furze and Coulthard (Furze et al. 2014) [D2] on cetacean-based ΔR values for Arctic North America likewise demonstrated the necessity of context-specific corrections when working with marine-mammal-derived chronologies. Together, these contributions have helped set new standards for chronological accuracy in Arctic palaeoenvironmental research.

Another major strand of my work has focused on ice-sheet and ice-stream dynamics. My contributions to Lakeman et al. (2018) [D3] revealed the abrupt collapse of a marine-based ice stream in the western Canadian Arctic during the Younger Dryas, highlighting the sensitivity of marine-terminating margins to rapid climatic forcing. In Svalbard, I co-authored the Farnsworth et al. (2021) study [D4], which used the Vedde Ash as a tephrochronological marker to constrain the timing of Younger Dryas glacier re-advance and subsequent rapid glacio-isostatic rebound. Earlier work with MacLean et al. (2017) [D5] reconstructed Late Wisconsinan ice-stream configurations in the Canadian Arctic Archipelago from seafloor geomorphology, refining our understanding of ice-sheet drainage pathways. Collectively, these studies

underscore the complex and non-linear behaviour of Arctic ice sheets and their importance as analogues for contemporary change.

I have also made sustained contributions to the development and application of micropalaeontological proxies. My work on the isotopic signatures and distribution of *Neogloboquadrina pachyderma* morphotypes (El Bani Altuna et al. 2018) [D6] clarified the environmental controls governing this key Arctic taxon, while Pieńkowski et al. (2016) [D7] compared biogeochemical and micropalaeontological sea-ice proxies, evaluating their respective strengths and limitations. Building on this foundation, Cage et al. (2021) [D8] provided a comparative analysis of six common Arctic–North Atlantic benthic foraminiferal taxa, establishing species-specific ecological baselines essential for interpreting fossil assemblages. Most recently, Bird et al. (2025) [D9] revealed that the microbiome of *N. pachyderma* includes hydrocarbon-degrading bacteria and a diatom chloroplast store, offering novel insights into the biology of this pivotal palaeoceanographic indicator. These studies illustrate my commitment to advancing the ecological and biological underpinnings of micropalaeontological proxies to strengthen their interpretative value.

Beyond organism-focused research, I have contributed to large-scale data synthesis and database-building. The CASCADE project (Martens et al., 2021) [D10] created the first circum-Arctic database of sedimentary carbon, harmonising disparate datasets into a resource of enduring value for the research community. My involvement in this effort reflects a long-standing commitment to collaborative, integrative science and to enabling future advances through shared data frameworks.

Although much of my work centres on the Arctic, I have also contributed substantially to the reconstruction of cryospheric change in both polar regions. In the Antarctic, Pieńkowski et al. (2013) [D11] investigated organic-walled microfossil assemblages in the north-west Weddell Sea following the collapse of the Larsen-A and Prince Gustav Channel ice shelves. This study provided some of the earliest post-collapse ecological observations, documenting dinoflagellate cysts and other palynomorphs in newly ice-free marine environments. By analysing assemblages from surface sediments, we were able to characterise ecosystem reorganisation and provide a baseline for subsequent monitoring of Antarctic ice-shelf loss. This research complements my Arctic focus and represents a direct contribution to understanding environmental change across both poles.

At lower latitudes, I have collaborated on reconstructions of glaciomarine environments at the margins of former ice sheets. Scourse et al. (2019) [D12] constrained the advance and retreat of the Irish Sea Ice Stream into the Celtic Sea during the Last Glacial Maximum, providing insights into the dynamics of a major marine-terminating outlet of the British-Irish Ice Sheet. Furze et al. (2014) [D13] reconstructed the transition from deglacial to postglacial environments in the Celtic Sea, distinguishing between lacustrine and marine phases and demonstrating the complexity of marginal sequences. These projects extend my expertise into mid-latitude systems, while maintaining a consistent methodological focus on stratigraphy, micropalaeontology, and chronological control.

My broader interests also extend into non-marine polar systems. Roberts et al. (2017) [D14] investigated the chemistry and ecology of High Arctic lakes under the influence of climate and permafrost dynamics, showing how terrestrial cryospheric changes propagate into aquatic

ecosystems. This complements my marine research and highlights the systemic interconnectedness of Arctic environments.

Taken together, these achievements illustrate a consistent commitment to three overarching objectives: reconstructing cryospheric and marine environmental change, refining chronological frameworks, and strengthening the ecological and taxonomic basis of palaeoenvironmental proxies. By contributing to research in both the Arctic and the Antarctic, and by situating these efforts within a broader Quaternary and global framework, my work highlights the value of comparative perspectives between polar regions. This body of research complements and extends the publications in my cycle of works [A1]-[A6], demonstrating not only a deep regional expertise but also a capacity to link Arctic and Antarctic change in ways that enrich our understanding of polar processes in the Earth system. This circumpolar scope - bringing together insights from both polar regions - constitutes a signature accomplishment of my scientific profile and a distinctive contribution to the wider field of polar research.

5. Presentation of significant scientific or artistic activity carried out at more than one university, scientific or cultural institution, especially at foreign institutions:

Another pillar of my overall achievements is the distinctly international character of my academic career, which has spanned four countries (Canada, the United Kingdom, Norway, and Poland) and has encompassed research, teaching, and leadership roles across a wide range of institutions. This mobility has not only broadened my expertise but also established long-term collaborations and visibility within the global polar research community.

After completing my PhD at the University of Alberta (Canada), I gained extensive teaching and research experience as Lecturer in Marine Geology and Palaeoceanography at Bangor University (UK) and later as Assistant Professor in Biogeochemistry at MacEwan University (Canada). These roles provided me with a solid foundation in both undergraduate and graduate teaching as well as the supervision of theses across several disciplines in the Earth and Environmental Sciences.

My subsequent research positions in Norway significantly expanded my international profile. As Postdoctoral Fellow at the Norwegian Polar Institute and later as Adjunct and subsequently Associate Professor at the University Centre in Svalbard (UNIS), I developed and coordinated research in micropalaeontology, sea-ice reconstructions, and polar marine ecosystems. I continue to serve at UNIS as iEarth Education Chair and Associate Professor, where I represent one of Norway's national centres for excellence in education. Since 2021, I have combined this with my position at the Institute of Geology, Adam Mickiewicz University in Poznań, where I have led research as Principal Investigator. This dual affiliation positions me at the intersection of Polish and international Arctic research and facilitates the exchange of expertise, methods, and student mobility between institutions.

My international research has consistently been project-based and collaborative in nature. I have led large-scale interdisciplinary initiatives, such as the CHARME project (Polish–Norwegian Grants, National Science Centre Poland) [P1], the Marie Curie project QUEEN [P2], the NCN Opus project APHRODITE [P4], and, in Canada, a Northwest Passage palaeoceanography initiative (funded by the Canadian Research Council NSERC) [P5]. My work has brought together geologists, biologists, and oceanographers from multiple countries.

Through these projects, I have coordinated multi-proxy research on polar Holocene palaeoceanography, advanced methodological standards in proxy calibration and chronology, and built research networks that now directly benefit Polish science.

My achievements have also been recognized through invitations to lecture and present keynote talks at international meetings and universities. For example:

- Invited keynote: *Polar fjords as sensitive archives of past and future climate warming*, 4th INQUA-MARE workshop at XIX ABEQUA Congress, Rio Grande de Do Norte, Brasil, 2024 (Sep)
- Invited keynote: *Microfossils: a window into past, present, and future polar environments*, INQUA MARE 2022, Pisa, Costa Rica, 2022 (Dec)
- Invited Plenary talk: *Arctic marine geoscience: a hidden world uncovered?*, CommOcean Conference, Bruges, Belgium (2016).
- Invited talk: *Dinoflagellate cysts as palaeo-sea-ice indicators: an example from Arctic Canada*, Plankton Resting Stages Workshop, Finland (2015).
- Invited session presentations at major congresses such as the World Climate Research Programme (Kigali 2023), and the International Symposium on Cryosphere & Biosphere (Kyoto 2018).
- Guest lectures at universities including the University of Copenhagen, GEUS (Geological Survey of Denmark and Greenland), the Arctic University of Tromsø (Norway), and the University of Galloway (Ireland).

Furthermore, my active participation in international working groups, being on the Steering Committee of initiatives such as ArcPAC (*Arctic Research Community: PAst Changes for the future*), ACME (*Arctic Cryosphere Change and Coastal Marine Ecosystems*, PAGES), and SvalHolA (*Svalbard Holocene Assembly*), reflects recognition of my expertise at the global level. These affiliations have allowed me to contribute to shaping research agendas, organizing international meetings, and strengthening interdisciplinary dialogue within the polar sciences.

In summary, my scientific activity across institutions in four countries, combined with numerous invitations to speak at international conferences and universities, demonstrates not only the visibility and recognition of my research and scientific achievements, but also its contribution to building global academic dialogue. This international background enables me to integrate Polish research more firmly into global discussions on climate change and polar science, thereby increasing the visibility and impact of both my own work and the institutions I represent.

6. Presentation of teaching and organizational achievements as well as achievements in popularization of science or art:

I have consistently combined research with a strong commitment to teaching, mentorship, and science communication. I have taught more than 30 university courses across four countries and two continents, supervised 22 theses (BSc, Masters), coordinated eleven international projects, and actively engaged in public outreach. These activities complement my research and reflect my commitment to developing both future scientists and broader public awareness of polar environmental change.

Over the past 15 years, I have taught over 30 BSc and graduate courses in Earth and Environmental Sciences, including marine geology, palaeoceanography, micropalaeontology, geochemistry, and polar environmental change. My teaching has taken place at Bangor University (UK), MacEwan University (Canada), the University Centre in Svalbard (UNIS, Norway), and Adam Mickiewicz University in Poznań (Poland); note that at the latter institution I hold a research position and therefore only contribute to courses as guest lecturer. Courses have combined lectures, laboratory classes, and fieldwork, with an emphasis on active, inquiry-based learning and the integration of students into real research environments. Selected examples of the courses I have developed, taught and organised are included in **Table 2**.

Table 2. Selected courses developed, delivered, and organised. Note that my current post at Adam Mickiewicz University is primarily a research position, with little teaching involved.

Course Code	Course Title	No. of Students	Credits/Hrs	Terms & years delivered	Involvement	Description
UNIS (2018-present)						
AG-353/853	Arctic Terrestrial & Marine Climate Histories	20	10 ECTS	Summer/ Autumn 2024	Course responsible. Developed & delivered 10 hrs lectures, 20 hrs lab (micropalaeontology, sedimentology), 20 hrs seminars, 6 day ship expedition; co-ordinated guest lecturers	Lectures, seminars, exercises, fieldwork incl. ship expedition
AG-326/826	Arctic Quaternary Environments	20	10 ECTS	Autumn 2018	Developed & delivered 6 hrs on the environmental evolution of Arctic Canada	Lectures, class discussions, in-class exercises
MacEwan University (2014-2018)						
EASC 495	The Global Cryosphere: Earth's changing ice environments	10	45 hrs	Spring 2018	Developed & delivered	Seminars
EASC 375	Paleoclimatology	10-20	45 hrs	Autumn 2015	Developed & delivered	Lectures, seminars, class discussions & presentations
EASC 373	Anthropogenic Climate Change	20-30	45 hrs	Autumn 2015 & 2016	Re-designed significantly & delivered	Lectures, class discussions, in-class exercises
EASC/CHEM 322	Introduction to Biogeochemistry	10-20	45 hrs	Autumn 2016	Developed & delivered	Lectures
EASC 271	The Oceans	40	45 hrs	Winter 2017	Developed & delivered	Lectures, class discussions, scientific posters, presentations
Bangor University (2011-2014)						
OSX-3012	Palaeoceanography	50	10 ECTS	Autumn 2012, 2013	Course organizer; delivered 15 lectures on past oceanic environments, environmental change and micropalaeontology; as well as 4 full-day laboratory practicals and 2 day field excursions	lecture and laboratory teaching

OSX-3007	Coastal Sediments Field Study (residential field course)	45	20 ECTS	Summer 2011, 2012, 2013	Delivered 1 week of daily field sampling (on marine micropalaeontology) during residential field course, followed by 4 lectures on data analysis and interpretation	Field and laboratory teaching, lectures
OSX-2011	Ice & Oceans	50	10 ECTS	Autumn 2011, 2012, 2013	Course organizer; delivered 12 lectures on cryosphere environments and 2 day field excursions	lecture and field-based teaching

I have supervised over a dozen BSc and MSc theses, as well as contributing to the co-supervision of doctoral students (**Table 3**). Several of my students have co-authored peer-reviewed publications, including in *Marine Micropalaeontology* and *Limnology & Oceanography Letters*, reflecting my dedication to mentoring and preparing students for research careers.

My organizational achievements include leadership of major interdisciplinary projects (e.g. PI of the Polish–Norwegian CHARME project [P1] and PI of a Marie Curie Integration Grant [P2] at Bangor University). As part of these projects, I trained and supervised 15 individuals in research techniques and the interpretation of results. My scientific achievements also encompass memberships on supervisory and academic committees at multiple institutions. At UNIS, I represent the iEarth consortium, a Norwegian Centre for Excellence in Education, where I have contributed to curriculum development, teaching innovation, and pedagogical training, particularly in the context of field-based education in polar environments.

I also play an active role in disseminating science beyond academia. I have given more than 20 invited public lectures and outreach presentations, contributed to media interviews on climate and polar issues (print, radio, and online), and co-edited the 2022 issue of *Past Global Changes Magazine* on ‘Sea ice in the polar regions’, which reached both scientific and general readerships. My work has been featured in press articles for the BBC and the Washington Post, in film documentaries such as ‘Breaking the Ice’ (2018), and invited presentations for TEDx (Canada, 2018) and the Science Museum London (UK, 2016). My outreach activities also include developing accessible visualizations and conceptual figures [A6] that have been widely used in teaching and public communication of Arctic climate change.

In summary, my teaching and organizational achievements demonstrate a sustained commitment to high-quality education across diverse cultural and institutional settings, effective supervision and mentorship of students at multiple levels, leadership in educational innovation, and active engagement in science communication. Together, these contributions highlight my broader role in fostering knowledge exchange between research, education, and society.

Table 3. Outline of students supervised and mentored.

PhD					
Institution	Project/Thesis Title	Student	Terms/Years	Role	Comments
UNIS, Norway	Northern Svalbard fjords during the Anthropocene	Petra Hus	2025 (Sep) - present	Principal Supervisor	Funded by UNIS
	Climate change, ice retreat and carbon cycle across the Svalbard-North Greenland transect	Cecilie Thaarup	2024 (Aug) - present	Co-supervisor	Funded by UNIS
Adam Mickiewicz University, Poland	The palaeoceanography of the Holocene Thermal Maximum in Arctic Canada	Paulina Romel	2024 (Jan) - present	Co-supervisor	Project funded by National Science Centre Poland
Bangor University, UK	Climate and climate feedbacks in the Arctic during the last deglacial transition.	Ilka Johanna Illers	Autum 2012- Spring 2014.	Principal Supervisor	NERC (UK Research Council)-funded project; PhD; halted due to medical reasons
MSc			Mdegree (3 year BSc + 1 year Masters)		
Institution	Principal Supervision	Co-supervision	Principal Supervision	Co-supervision	
UNIS, Norway		2			
MacEwan University, Canada		3			
Bangor University, UK	4		4		
BSc					
Institution	Capacity	Principal supervision	Co-supervision	Comments	
Adam Mickiewicz University, Poland	BSc thesis		1		
MacEwan University, Canada	NSERC BSc Student Research Award	1		Funded by the Natural Sciences & Engineering Research Council (NSERC)	
	BSc Student Research Award Initiative		3	Funded by MacEwan BSc Research Award	
	BSc Independent Research Project	4			

7. Other information about the professional career deemed important:

Beyond my scientific publications and core research outputs, my professional trajectory demonstrates sustained international engagement, leadership, and contributions to the academic community. I have combined research excellence with successful grant acquisition, editorial service, teaching, and outreach.

In particular, this includes:

- **International Research Experience and Leadership:** I have held academic and research positions in Poland, Norway, the UK, and Canada, reflecting both breadth and adaptability in international research environments. I currently serve as Project Principal Investigator at Adam Mickiewicz University (Poznań) and as iEarth Education Chair & Associate Professor at the University Centre in Svalbard.
- **Active Roles in Scientific Networks:** I am a steering committee member of several international working groups, including ArcPaC (*Arctic Research Community: PAst Changes for the future*), the ACME (*Arctic Cryosphere Change and Coastal Marine Ecosystems*) Working Group of PAGES, and the SvalHolA (*Svalbard Holocene Assembly*) initiative. These roles demonstrate my recognized expertise and ability to shape research agendas at the international level.
- **Grant Acquisition and Management:** I have successfully secured competitive research funding in multiple countries (Norway, Poland, UK, Canada, EU), including prestigious grants such as the Marie Curie Integration Grant [P2] and the National Science Centre-Norwegian Grants POLS project (CHARME) [P1]. My experience as PI includes leading large, interdisciplinary projects and coordinating multi-institutional teams.
- **Editorial and Peer Review Contributions:** I am a member of the Editorial Board of *Marine Micropaleontology* (Elsevier) and co-edited the 2022 special issue of *Past Global Changes Magazine* ('Sea ice in the polar regions'). In addition, I regularly serve as a reviewer for leading journals (*Quaternary Science Reviews*, *The Holocene*, *Marine Micropaleontology*, among others) and for national funding agencies (Swiss NSF, NCN Poland).
- **Teaching and Mentorship:** My teaching portfolio spans undergraduate to doctoral levels across four countries, and encompasses classroom, field, and laboratory instruction. I have supervised students at BSc, MSc, and PhD levels, integrating them into research teams and co-authored publications.
- **Public Engagement and Science Communication:** I have participated in outreach activities, media contributions, and public lectures, with a focus on raising awareness of polar climate change and its global significance.

Literature

Uncategorised Literature

- England, J. et al. 2013. The exaggerated radiocarbon age of deposit-feeding molluscs in calcareous environments. *Boreas* 42, 362–373.
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- Schuur, E.A.G. et al. 2015. Climate change and the permafrost carbon feedback. *Nature* 520, 171–179.
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- Stroeve, J. & Notz, D. 2018. Changing state of Arctic sea ice across all seasons. *Environmental Research Letters* 13, 103001.
- Thuretsky, M.R. et al. 2020. Carbon release through abrupt permafrost thaw. *Nature Geoscience* 13, 138-143.

Cycle of 6 publications

- [A1] **Pieńkowski, A.J.**, England, J.H., Furze, M.F.A., Blasco, S., Mudie, P.J., MacLean, B., 2013. 11,000 years of environmental change in the Northwest Passage: a multiproxy record from central Parry Channel. *Marine Geology*, Elsevier, vol. 341, 2013, p. 68–85; DOI: <https://doi.org/10.1016/j.margeo.2013.04.008>
- [A2] **Pieńkowski, A.J.**, Husum, K., Belt, S.T., Ninneman, U., Köseoğlu, D., Divine, D., Smik, L., Knies, J., Hogan, K., Noormets, R. 2021. Seasonal sea ice persists through the Holocene Thermal Maximum at 80°N. *Communications Earth & Environment*, Nature Publishing Group, vol. 2, article number 124; DOI: <https://doi.org/10.1038/s43247-021-00191-x>
- [A3] **Pieńkowski, A.J.**, Szczuciński, W., Breszka, A., Chyleński, M., Juras, A., Romel, P., Rozwalak, P., Trzebny, A., Dabert, M., Belt, S.T., Jagodziński, R., Smik, L., Włodarski, W. 2024. Sedimentary ancient DNA and HBI biomarkers as sea-ice indicators: A complementary approach in Antarctic fjord environments. *Limnology & Oceanography Letters*, Wiley Blackwell, article number 10395; DOI: <https://doi.org/10.1002/lol2.10395>
- [A4] **Pieńkowski, A.J.**, Coulthard, R.D., Furze, M.F.A. 2023. Revised marine reservoir offset (ΔR) values for molluscs and marine mammals from Arctic North America. *Boreas*, Wiley-Blackwell, vol. 52, p. 145-167; DOI: <https://doi.org/10.1111/bor.12606>
- [A5] **Pieńkowski, A.J.**, Kennaway, S., Lang, S.I. 2020. Aquatic palynomorphs from modern marine sediments in a reconnaissance transect across the Northwest Passage – Baffin Bay region. *Marine Micropaleontology*, Elsevier, vol. 156, article number 101825; DOI: <https://doi.org/10.1016/j.marmicro.2020.101825>
- [A6] Heikkilä, M., S. Ribeiro, Weckström, K., **Pieńkowski, A.J.**, 2022. Predicting the future of coastal marine ecosystems in the rapidly changing Arctic: The potential of palaeoenvironmental records. *Anthropocene*, Elsevier, vol. 37, article number 100319; DOI: <https://doi.org/10.1016/j.ancene.2021.100319>

Additional works [* indicates supervised students]

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- [D2] Furze, M.F.A., Pieńkowski, A.J., Coulthard, R.D. 2014. New cetacean ΔR values for Arctic North America and their implications for marine-mammal-based palaeoenvironmental reconstructions. *Quaternary Science Reviews* 91, 218-241; <https://doi.org/10.1016/j.quascirev.2013.08.021>
- [D3] Lakeman, T.R., Pieńkowski, A.J., Nixon, F.C., Furze, M.F.A., Blasco, S., Andrews, J.T., King, E.L. 2018. Collapse of a marine-based ice stream during the early Younger Dryas chronozone, western Canadian Arctic. *Geology* 46, 211–214; <https://doi.org/10.1130/G39665.1>
- [D4] Farnsworth, W.R., Ingólfsson, Ó., Mannerfelt, E.S., Kalliokoski, M.H., Guðmundsdóttir, E.R., Retelle, M., Allaart, L., Brynjólfsson, S., Furze, M.F.A., Hancock, H.J., Kjær, K.H., Pieńkowski, A.J., Schomacker, A. 2022. Vedde Ash constrains Younger Dryas glacier re-advance and rapid glacio-isostatic rebound on Svalbard. *Quaternary Science Advances* 5, 100041; <https://doi.org/10.1016/j.qsa.2021.100041>

- [D5] MacLean, B., Blasco, S., Bennett, R., Lakeman, T., Pieńkowski, A.J., Furze, M.F.A., Hughes Clarke, J., Patton, E. 2017. Seafloor features delineate Late Wisconsinan ice stream configurations in eastern Parry Channel, Canadian Arctic Archipelago. *Quaternary Science Reviews* 160, 67-84; <https://doi.org/10.1016/j.quascirev.2017.02.001>
- [D6] El Bani Altuna, N.*, Pieńkowski, A.J., Eynaud, F., Thiessen, R.* 2018. The morphotypes of *Neogloboquadrina pachyderma*: isotopic signature and distribution patterns in the Canadian Arctic Archipelago and adjacent regions. *Marine Micropaleontology* 142, 13-24; <https://doi.org/10.1016/j.marmicro.2018.05.004>
- [D7] Pieńkowski, A.J., Gill, N.*, Furze, M.F.A., Mugo, S., Marret, F., Perreux, A.* 2016. Arctic sea-ice proxies: a comparison between biogeochemical and micropalaeontological approaches from Arctic Canada. *The Holocene* 27, 665-682; <https://doi.org/10.1177/0959683616670466>
- [D8] Cage, A.G., Pieńkowski, A.J., Jennings, A., Knudsen, K.L., Seidenkrantz, M.-S. 2021. Comparative analysis of six common foraminiferal species of the genera *Cassidulina*, *Paracassidulina*, and *Islandiella* from the Arctic-North Atlantic domain. *Journal of Micropalaeontology* 40, 37–60; <https://doi.org/10.5194/jm-40-37-2021>
- [D9] Bird, C., Darling, K., Thiessen, R.*, Pieńkowski, A.J. 2025. The 16S rDNA microbiome of the Arctic foraminifera *Neogloboquadrina pachyderma* is comprised of hydrocarbon-degrading bacteria and a diatom chloroplast store. *Biogeosciences* 22, 4545–4577, <https://doi.org/10.5194/bg-22-4545-2025>
- [D10] Martens, J., Romankevich, E., Semiletov, I., Wild, B., van Dongen, B., Vonk, J., Tesi, T., Shakhova, N., Dudarev, O.V., Kosmach, D., Vetrov, A., Lobkovsky, L., Belyaev, N., Macdonald, R., Pieńkowski, A.J., Eglinton, T.I., Haghypour, N., Dahle, S., Carroll, M.L., Åström, E.K.L., Grebmeier, J.M., Cooper, L.W., Possnert, G., Gustafsson, Ö. 2021. CASCADE - The Circum-Arctic Sediment Carbon Databases. *Earth System Science Data* 13, 2561–2572; <https://doi.org/10.5194/essd-13-2561-2021>
- [D11] Pieńkowski, A.J., Marret, F., Scourse, J.D., Thomas, D.N. 2013. Organic-walled microfossil assemblages from the NW Weddell Sea, Antarctica: records from surface sediments after the collapse of the Larsen-A and Prince Gustav Channel ice-shelves. *Antarctic Science* 25, 565–574; <https://doi.org/10.1017/S0954102012001186>
- [D12] Scourse, J.D., Saher, M., Van Landeghem, K.J.J., Lockhart, E., Purcell, C., Callard, L., Roseby, Z., Allinson, B., Pieńkowski, A.J., O’Cofaigh, C., Praeg, D., Chiverrell, R., Clark, C. 2019. Advance and retreat of the marine-terminating Irish Sea Ice Stream into the Celtic Sea during the Last Glacial Maximum: timing and maximum extent. *Marine Geology* 412, 53–68; <https://doi.org/10.1016/j.margeo.2019.03.003>
- [D13] Furze, M.F.A., Scourse, J.D., Pieńkowski, A.J., Marret, F., Hobbs, W.O., Carter, R.A., Long, B. 2014. Deglacial to postglacial palaeoenvironments of the Celtic Sea: lacustrine conditions versus a continuous marine sequence. *Boreas* 43, 149–174; <https://doi.org/10.1111/bor.12028>
- [D14] Roberts, K.E., Lamoureux, S.F., Kyser, T.K., Muir, D.G.C., Lafreniere, M.J., Iqaluk, D., Pieńkowski, A.J., Normandeau, A. 2017. Climate and permafrost effects on the chemistry and ecosystems of High Arctic Lakes. *Nature Scientific Reports* 7, 13292; <https://doi.org/10.1038/s41598-017-13658-9>

Projects

- [P1] POLS Grant, Norwegian Grants & National Science Centre Poland (2021-2023). PI on ‘CHARME’ (CHanging AntArctic Marine Environments). Value: € 200,000
- [P2] Marie Curie Career Integration Grant, European Union (2012-2015). PI on ‘The Quaternary environmental evolution of the Northwest-Passage (QUEEN)’. Value: €75,000
- [P3] Working Group, PAGES (Past Global Changes) (2019-2026). Co-I on ‘ACME (Arctic Cryosphere Change and Coastal Marine Ecosystems)’ Official PAGES Working Group. No monetary value
- [P4] OPUS Grant, National Science Centre Poland (2023-2027). PI on ‘APHRODITE’ (Arctic Palaeorecords from the Htm: a ROaDmap for Imminent Transitions in marine Ecosystems). Value: € 445,000