SUPPLEMENT FOR AUTHOR RESPONSE TO REFEREE #1 COMMENTS

egusphere-2026-3268 — From surface flux to seafloor function: vertical carbon export and benthic communities in high-latitude coastal systems

Preprint: https://doi.org/10.5194/egusphere-2026-3268

Armitage, P., Nordström, M. C., Svensen, C., Oleszczuk, B., Legeżyńska, J., Włodarska-Kowalczuk, M. & Törnroos, A.

We thank Referee #1 for their careful and constructive reading. The comments were specific and actionable, and working through them has substantially improved both the analyses and the writing. Together with the comments from Referee #2, we have taken the feedback on board and, where we felt it appropriate, have undertaken substantial new analysis rather than revising the text alone. This applies in particular to the two major methodological concerns raised: the classification of water masses and the wet-mass-to-carbon conversion factor underlying the benthic invertebrate carbon estimates. In both cases, we have rerun the relevant analyses, tested the sensitivity of our results, and reported the outcomes in full, including where they changed our original interpretation.

This response is structured according to the comments provided, beginning with major comments and then minor comments. Referee Comments (RC1) appear in black text with our replies (Author Comments; AC) in blue. Proposed new manuscript text is given in italics. Where a comment relates to one raised by Referee #2, we cite it as RC2 followed by the comment number (e.g. RC2.1), and where the two comments are addressed by the same revision, we give the full response in both documents so that each can be read independently. Where relevant, we have extended our replies beyond the specific point raised to set out the resulting changes to the Methods, Results and Discussion. Line numbers refer to the preprint. New tables and figures created for this response are numbered R1–R8 and Fig. R1; items revised from the preprint retain their original numbers, and all will be renumbered into the supplementary material on submission of the revised manuscript. We thank the referee again for feedback that we believe has made the paper more defensible and more useful to the readership of Biogeosciences.

Major/general comments

RC1.1: The manuscript by Armitage et al., is well written and explores an interesting question in terms of how much vertical carbon export and sediment carbon stock affects benthic communities in high latitudes. A great amount of work and expertise has clearly gone into shaping this manuscript. It is an extensive piece of work trying to answer 4 different hypothesis, which makes it sometimes challenging to follow through on all the different strands the authors are aiming to tie together. There are a few aspects which might need some more attention, before the manuscript is ready for application.

AC1.1: Thank you for the positive and constructive assessment of our manuscript. We appreciate the reviewer's recognition of the work involved in bringing together the different components of the study. We also recognise that addressing four hypotheses across several aspects of carbon dynamics is complex and can make the manuscript challenging to follow in places. The comments below have helped us identify where the different strands could be brought together more clearly, and we have made several revisions to improve the manuscript's structure and clarity.

RC1.2: I am not totally convinced by the oceanographic aspect of the paper and the finding that high arctic fjords with high sills are influenced by Atlantic water, which is normally characterised by temperatures > 2 degrees and high salinity. I could not find this in the supplementary material (which shows temperatures below 2 degrees) and the authors do not provide thresholds on what they defined as Atlantic water (in Figure 1 this seems to be primarily based on salinity). Based on the figures provided, I do not think bottom waters at 0-2 degrees are an indication for fjords being influenced by warm Atlantic water. This needs to better explained or possibly dropped.

AC1.2: We thank the reviewer for raising this important point, which we agree warrants a more detailed response given the regional context of the water mass classification and its relevance to our interpretation.

We recognise that the original classification of the water masses was not sufficiently clear, particularly given that definitions of Atlantic Water can vary across Arctic regions. Compared with better-characterised regions such as the Barents Sea, the hydrography of the Northeast Greenland shelf and adjacent fjords is less well represented in the literature. We therefore agree that identifying Atlantic Water in this region requires greater transparency regarding the temperature and salinity criteria used and their regional context.

Recent work demonstrates that Atlantic-origin water reaching the Northeast Greenland shelf is modified and cooled during its transit through the Fram Strait, meaning it does not necessarily retain the temperatures characteristic of the warmer Atlantic Water core farther east (e.g., > 2 °C) (Wekerle et al., 2024). Sejr et al. (2017), Gjelstrup et al. (2022) and Rysgaard et al. (2024), working in Northeast Greenland, distinguish Polar Water ($T < 0$ °C, $S < 34.4$) from Recirculating Atlantic Water ($T > 0$ °C, $S > 34.4$). This provides a regional context for the occurrence of Atlantic origin water at temperatures of approximately 1 °C in our study, and the terminology is also consistent with previous descriptions of warm, saline Atlantic origin water in Northeast Greenland (Straneo and Heimbach, 2013, Boone et al., 2018). In response to the reviewer's comment, we have therefore revised the classification to use criteria specifically established for Northeast Greenland:

- Atlantic Water (AW): $\theta > 0$ °C and $S_p > 34.4$
- Polar Water (PW): $\theta < 0$ °C and $S_p < 34.4$
- Surface Water (SW): the relatively fresh surface layer overlying PW, identified from its position within the hydrographic profile rather than by fixed temperature and salinity thresholds.

The criteria originally given in the manuscript (L146–149) were based on a synthesis of water mass characteristics reported across Greenlandic Arctic waters, including studies from both West and Northeast Greenland. This resulted in overlapping definitions, with Polar Water defined as $\theta = -2$ to 2 °C and Atlantic Water as $\theta = -1$ to 4 °C, meaning that temperatures between −1 and 2 °C could be assigned to either water mass depending on salinity. The now-corrected version is more transparent and provides a regionally appropriate, non-overlapping framework for distinguishing water masses based on both temperature and salinity.

Applying the revised criteria to the bottom water at all nine stations gives a clearer classification. All seven stations in Kong Oscar Fjord and Ardencaple Fjord meet both the temperature and salinity criteria for Atlantic Water, with bottom water temperatures ranging from 0.91 to 1.49 °C

and salinities from 34.64 to 34.86. The closest station to either threshold is ACF2, with θ = 0.91 °C and S_p = 34.64, and therefore remains within the Atlantic Water classification. In contrast, the two Dove Bugt stations do not provide evidence for the presence of Atlantic Water at the sampled bottom depths. DB1 is classified as Polar Water (θ = −0.31 °C, S_p = 34.03), while we have described DB2 as transitional, with θ = 0.11 °C but S_p = 34.37, just below the salinity threshold. To make the revised classification transparent and auditable, we have added a supplementary table that reports θ, S_p, σθ, water mass assignment, and the distance from each classification threshold for all bottom-water samples (Table R1). The table also identifies samples close to either classification boundary, providing a clear indication of the basis for each assignment.

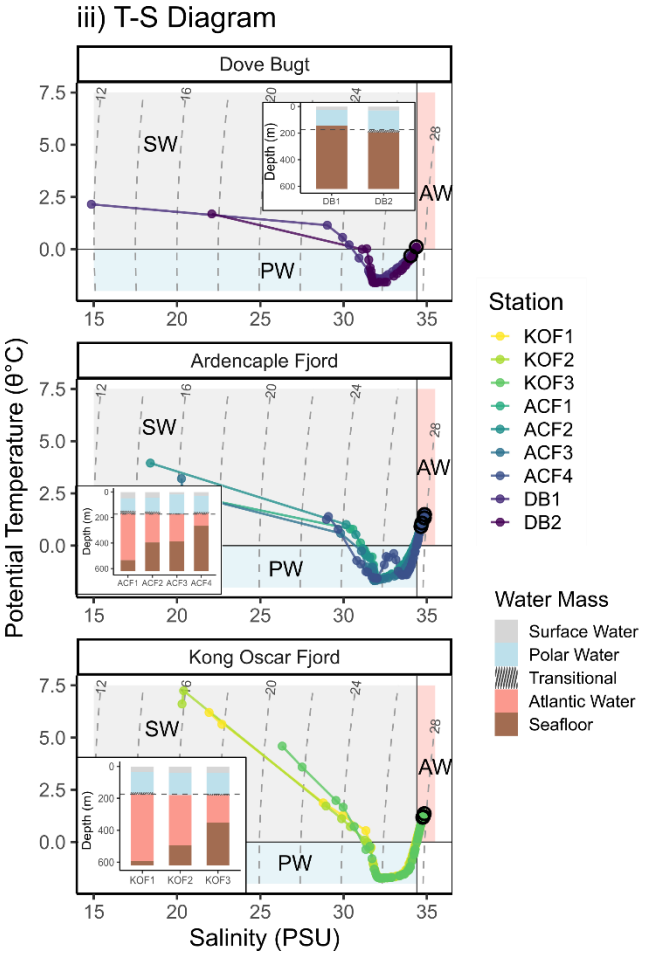
Table R1. Bottom-water properties and water-mass classification at each station. Classification follows Sejr et al. (2017) and Gjelstrup et al. (2022): Atlantic Water, θ > 0 °C and S_p > 34.4; Polar Water, θ < 0 °C and S_p < 34.4. Δθ and ΔS_p give the distance from each threshold, with the sign indicating whether a sample falls above or below the respective threshold. Samples within 0.2 °C or 0.05 S_p of a boundary are flagged as marginal. Water meeting neither definition is termed transitional.

Station	CTD Bottom-Depth (m)	θ (°C)	S_p	σθ (kg m^{-3})	Water mass	Δθ	ΔS_p	Marginal
Dove Bugt								
DB1	145.2	−0.31	34.03	27.34	Polar Water	−0.31	−0.37	—
DB2	194.2	0.11	34.37	27.59	Transitional	0.11	−0.03	**yes**
Ardencaple Fjord								
ACF1	533.5	1.08	34.7	27.8	Atlantic Water	1.08	0.3	—
ACF2	395.6	0.91	34.64	27.77	Atlantic Water	0.91	0.24	—
ACF3	385.9	1.33	34.85	27.91	Atlantic Water	1.33	0.45	—
ACF4	265.6	1.49	34.86	27.9	Atlantic Water	1.49	0.46	—
Kong Oscar Fjord								
KOF1	592.3	1.18	34.76	27.84	Atlantic Water	1.18	0.36	—
KOF2	494.1	1.22	34.79	27.86	Atlantic Water	1.22	0.39	—
KOF3	351.8	1.36	34.84	27.9	Atlantic Water	1.36	0.44	—

We have therefore corrected our original description and now describe Dove Bugt as lacking Atlantic Water, rather than as containing Atlantic Water. The revised classification is also consistent with the regional influence of bathymetry on water mass exchange, including Gjelstrup et al. (2022) who describe shallow fjords as being more Polar Water driven. The presence of Atlantic Water in our two deeper fjords, but not in the shallower Dove Bugt, is therefore consistent with the expected regional pattern. Because the revised water mass

classification and the reclassification of Dove Bugt alter some of the interpretations presented in the preprint, several related statements throughout the manuscript will also require revision. For example, the phrase “widespread AW presence” in Sect. 4.1 will be revised to refer specifically to the presence of AW at the seven stations in Kong Oscar Fjord and Ardencaple Fjord. We write some of the most important text changes below under “proposed new text”.

Importantly, the revised classification does not alter the purpose of the hydrographic analysis. The seven stations within Kong Oscar Fjord and Ardencaple Fjord share a highly consistent water mass structure, with the 0 °C isotherm occurring at approximately 170–180 m (mean = 174 m) (consistent with the referenced studies) and bottom water density ranging only from σθ = 27.8–27.9. Thus, the revised analysis supports our interpretation that differences in benthic biomass and trait composition among these stations cannot readily be attributed to differences in bottom water mass identity. Yet these changes make the hydrographic classification explicit and auditable, while retaining the underlying conclusion that Atlantic origin water reaches the deep basins of Kong Oscar Fjord and Ardencaple Fjord.



Revised Figure 1 (iii): Temperature–salinity (T–S) diagrams for each fjord system, showing potential temperature versus salinity for all CTD casts. Isopycnals of potential density (σθ) are overlaid. Water masses are classified as SW (Surface Water), PW (Polar Water), Transitional, and AW (Atlantic Water). Black circles indicate bottom-water conditions at benthic sampling depths. Smaller inserts: Stacked bars as vertical distribution of major water masses along transects in three Northeast Greenland coastal systems, with seafloor depth indicated in brown and the dashed line represents the average Atlantic Water starting depth.

Proposed new text (Replaces preprint Sect. 2.4.3, L146–149**):**

"Temperature–salinity diagrams were used to identify water masses. Definitions of Atlantic Water vary across the Arctic, and because Atlantic-origin water reaching the Northeast Greenland shelf is cooled and modified during transit through Fram Strait (Wekerle et al., 2024; Rysgaard et al., 2024*), we applied criteria established for this region rather than broader pan-Arctic definitions. Following Gjelstrup et al. (2022), Atlantic Water (AW; water of Atlantic origin) was defined as θ > 0 °C and S_p > 34.4, and Polar Water (PW) as θ < 0 °C and S_p < 34.4. Surface Water (SW) denotes the relatively fresh surface layer overlying PW, identified from its position in the hydrographic profile rather than by fixed thresholds, also following Gjelstrup et al. (2022). This characterisation is also consistent with previous descriptions of these water masses in Northeast Greenland (Straneo & Heimbach, 2013; Sejr et al., 2017; Boone et al., 2018; Rysgaard et al., 2024). Water meeting neither the AW nor the PW definition is described as transitional. Bottom-water θ, S_p, σθ, water-mass assignment, and the distance of each sample from the classification thresholds are reported for all nine stations in SM Table R1. The classification boundaries and the bottom-water observations are shown explicitly in the T–S panels of Fig. 1(iii)."*

Proposed new text (Results, Sect. 3.1**)**

"Water depth ranged from approximately 50 m at the shallowest sill to approximately 600 m in Ardencaple and Kong Oscar Fjord; Dove Bugt is considerably shallower, reaching approximately 400 m, with sampling stations at approximately 200 m. Kong Oscar Fjord and Ardencaple Fjord showed a consistent three-layer structure, with surface meltwater and Polar Water overlying Atlantic Water, and all seven stations in these systems met the AW criteria at the seafloor (θ = 0.91–1.49 °C, S_p = 34.64–34.86; Fig. 1, SM Table R1). Across these seven stations, the 0 °C isotherm occurred at 170–180 m (mean 174 m), and bottom-water density varied only between σθ = 27.8 and 27.9.

The two Dove Bugt stations differed. DB1 met the criteria for Polar Water (θ = −0.31 °C, S_p = 34.03) and DB2 was transitional, exceeding the temperature threshold (θ = 0.11 °C) but falling just below the salinity threshold (S_p = 34.37). Neither station, therefore, provides evidence for Atlantic Water at the sampled bottom depths. This distinction is consistent with the regional pattern described by Gjelstrup et al. (2022), in which shallower systems remain more strongly Polar Water-influenced, and with the shallower bathymetry of Dove Bugt relative to the two fjord systems.

All stations were comparable in sediment composition (~50 % clay, ~40 % silt, 0–10 % sand, and occasionally <5 % gravel; SM Fig. S3 & S5). We therefore conclude that the seven stations within Kong Oscar Fjord and Ardencaple Fjord experienced closely comparable seafloor physical conditions at the time of sampling, in terms of both bottom-water properties and sediment composition, while the Dove Bugt stations differed in bottom-water mass but not in sediment composition."

Proposed new text (Discussion, Sect. 4.1**)**

"Applying regionally appropriate criteria, Atlantic Water was present at the seafloor at all seven stations in Kong Oscar Fjord and Ardencaple Fjord, but at neither Dove Bugt station (Fig 1iii; SM Table R1). Its presence in the more open Kong Oscar Fjord system was expected (Gjelstrup et al., 2022), but its occurrence at the innermost stations of the connected Brede and Ardencaple Fjord

system was not, given multiple shallow sills rising in places to approximately 50 m and the absence of prior documentation of AW in this system. Its absence from Dove Bugt is consistent with the shallower bathymetry of that system and with the regional observation that shallower basins remain more strongly Polar Water-influenced (Gjelstrup et al., 2022), and could be indicative of the strong tidal energy of the Dove Bugt basin (Zoller et al., 2023). Together, these contrasts indicate that sill depth alone does not determine hydrographic connectivity in these systems (Bao and Moffat, 2024), and that basin depth relative to the regional AW layer is the more useful predictor. We emphasise that the Atlantic Water identified here is modified Atlantic-origin water on the Northeast Greenland shelf, cooled during transit through Fram Strait (Wekerle et al., 2024), rather than the warmer AW core of the West Spitsbergen Current.... (existing mechanism paragraph on episodic drawdown, calving-driven compensatory inflow and deep-water renewal follows unchanged...)"

RC1.3: When it comes to the estimation of carbon content from wet-mass, I am not convinced by the very generic conversion that has been employed here. Behrisch and Zwerschke (2026) have shown that a conversion from wet mass to dry or afdm is not always possible with specific taxa, and that all of these conversion factors are highly taxa dependent. Anemones for example may have a large amount of water stored in their wet-weight compared to bryozoans, which would result in an overestimation of their carbon content. Barnes and Sands (2017) conversion to carbon content was based on functional groups and afdw and not a blanket conversion for all taxa. This could very much bias the results when aiming to link carbon standing stock to sediment carbon and vertical carbon transport. Thus, I would urge to reconsider this aspect of the manuscript.

AC1.3: We thank the reviewer for raising these important methodological points. As Reviewer #2 also raised concerns regarding the use of a single wet mass-to-carbon conversion factor (RC2.9), we have undertaken a detailed evaluation of the choice of conversion factor, its potential uncertainty, and its consequences for our results. We provide the full response here for completeness, as the reviewer responses are provided separately. Reviewer #2 additionally requested clarification of the taxonomic resolution of the benthic identifications and completeness of trait information; these points are addressed separately in AC2.9.

As this section is a re-analysis with sensitivity testing, we have divided it into three subsections: (1) the carbon conversion factor and our reanalysis, (2) its impact on trait selection, and (3) its impact on the GLLVM analyses. Each subsection includes a separate response and, where necessary, associated new proposed text.

The carbon factor and our re-analysis

The original 4.3% conversion factor followed Rowe et al. (1994) and Wiedmann et al. (2020) to facilitate comparison with previous estimates of carbon for Arctic benthic invertebrates. We recognise that a blanket conversion does not account for taxon-dependent differences in water and organic matter content, and that this could potentially introduce bias where taxonomic composition varies among stations. We therefore addressed this concern through a taxon-specific reconstruction of the trait-carbon matrix and a sensitivity analysis.

The benthic invertebrate carbon matrix was rebuilt using taxon-specific wet mass to AFDM conversion factors, followed by a single AFDM to carbon conversion of 0.5 (Brey, 2001).

Conversion factors were assigned using a documented hierarchy: Behrisch and Zwerschke (2026), where a single family in our dataset matched their Greenland shelf dataset (mainly due to this study being an epifaunal trawl dataset against our infaunal box core dataset), Gogina et al. (2022) for the remaining taxa, and Ricciardi and Bourget (1998), where neither source provided an appropriate match. Every taxon was assigned a conversion factor, with the source and taxonomic level of each match documented in a new data table (Table R6; located at the end of the document). The combined references vary in geographic origin and taxonomic resolution, allowing us to derive a primary factor for each taxon, along with lower and upper estimates based on the published range of values. This captures uncertainty both among taxa and within taxonomic groups, as well as being highly useful for any future work using a similar dataset. We also clarified the treatment of specimens prior to weighing, including the retention of shells and tests, consistent with the convention used to derive the Gogina et al. (2022) factors.

We repeated the carbon reconstruction matrix using taxon-specific factors and both the lower and upper published conversion factors to assess the sensitivity of our estimates to the choice of conversion factors (Tables R2 & R3). The taxon-specific conversion reduced total estimated benthic carbon from 15.03 to 11.48 g C m^{-2}, while the lower and upper scenarios gave 6.23 and 18.07 g C m^{-2}, respectively. Importantly, the taxon-specific conversion also reduced the contribution of the dominant taxon from 53.4% to 28.5% of total benthic carbon. The two highest stations accounted for 64.4% of the carbon under the taxon-specific conversion, compared with 75.8% under the blanket factor. Thus, accounting for taxon-specific conversion reduces rather than amplifies the concentration of estimated carbon in the dominant taxon. Importantly for the final outputs, the relative positions of stations were largely stable across the four conversion scenarios. The same station held the lowest benthic carbon (KOF3) and the same station the highest (KOF2) in every case, and the same four lowest-carbon and two highest-carbon stations were identified throughout; station totals remained strongly rank-correlated with the blanket-factor version (Spearman ρ = 0.90–0.98; Tables R2 and R3). Only four adjacent, closely-spaced pairs exchanged position, and no station shifted by more than two rank places (Table R3).

Table R2. Effect of the wet-mass to carbon conversion on benthic invertebrate carbon estimates. Values are given for the blanket 4.3 % wet-mass factor used in the preprint, for the taxon-specific reconstruction adopted as the primary analysis, and for low and high bounding scenarios derived from the published range of factors for each taxonomic group. Spearman ρ compares station-level carbon totals against the blanket-factor version (n = 9 stations).

	Blanket factor	Taxon-specific	Low	High
Total benthic carbon (g C m^{-2})	15.03	11.48	6.23	18.07
Largest single taxon (% of total carbon)	53.4	28.5	21.9	39.8
Two highest stations (% of total carbon)	75.8	64.4	55.1	69.6
Spearman ρ vs blanket factor	—	0.98	0.98	0.90

Table R3. Station-level benthic invertebrate carbon biomass (g C m^{-2}) under four wet-mass to carbon conversion scenarios. Blanket factor applies a single 4.3 % wet-mass to carbon conversion; taxon-specific applies group-specific wet-mass to ash-free dry mass factors followed by a single AFDM-to-carbon conversion; low and high are bounding scenarios derived from the published range of factors for each group. Stations are ordered north to south.

Station	Blanket factor	Taxon-specific	Low	High
DB1	1.09	1.17	0.86	1.29
DB2	0.92	0.86	0.50	1.10
ACF1	0.27	0.35	0.23	0.69
ACF2	0.41	0.43	0.32	0.47
ACF3	5.31	2.45	0.96	4.91
ACF4	0.56	0.76	0.51	1.34
KOF1	0.28	0.32	0.24	0.33
KOF2	6.07	4.95	2.47	7.67
KOF3	0.12	0.19	0.14	0.27
Total	**15.03**	**11.48**	**6.23**	**18.07**

The sensitivity analysis nevertheless highlights an important uncertainty that we now make explicit. Even under taxon-specific conversion, *Strongylocentrotus droebachiensis* accounts for 28.5% of the reconstructed benthic carbon, and two of the nine stations contain approximately 64.4% of the total. This reflects the underlying composition of the samples rather than the blanket conversion itself. Importantly, we do not consider this dominance a limitation of the trait-based approach, as the contribution of dominant taxa to the carbon pool is itself part of the ecological signal captured by the trait-carbon matrix. Published wet-mass-to-AFDM values for echinoids also vary substantially, including 0.011 from Behrisch and Zwerschke (2026), flagged as low confidence; 0.035 from Ricciardi and Bourget (1998); and 0.077 for Echinodermata in Gogina et al. (2022). As this taxon represents the largest share of our biomass, it is consequently the largest contributor to uncertainty in the reconstructed carbon estimates. We will now report this uncertainty explicitly and frame benthic carbon biomass primarily as a comparative measure among stations rather than as an absolute estimate of standing stock (see proposed new text at the end of the section).

Additionally, while revisiting the carbon calculations, we identified two issues in the manuscript that we have corrected. First, the current description at L114–115 may be misinterpreted, as the preprint's wording could imply that the fourth-root transformation was applied before aggregation. The correct procedure was to first sum taxon-level carbon across trait modalities to obtain a station × modality matrix, after which the fourth-root transformation was applied to the modality totals prior to modelling. Second, some per-station biomass values in Sect. 3.4, and the corresponding y axis in the station level alluvial diagrams, were incorrectly labelled as g C m^{-2} as they represented sums of fourth root transformed carbon. These values and units have now been corrected throughout, where the fourth root was used for analyses and converted back to g C m^{-2} for the alluvial figures.

The taxon-specific carbon reconstruction matrix is now used as the primary analysis, while the original blanket factor is retained in the supplementary material for comparability with

Wiedmann et al. (2020). The station-level carbon estimates for the original, taxon-specific, low, and high conversion scenarios will be provided as a new table in the supplementary material (Table R3).

Proposed new text (Sect. 2.3, following construction of the trait–carbon matrix**):**

"Taxon-level carbon biomass was first summed across taxa within each trait modality to give a station × modality matrix. The fourth-root transformation was then applied to these modality totals to reduce the influence of the most carbon-rich modalities prior to modelling. Transformation was therefore applied after aggregation, not to individual taxon values. Station-level carbon biomass reported in the Results and in Fig. 4 is given on the untransformed scale (g C m^{-2})."

Proposed new text (replacing preprint Methods Sect. 2.2 L113–115**):**

"Wet mass was recorded on blotted whole specimens with calcareous shells, tests and plates retained, so that shelled taxa are represented on the same basis as the source measurements. Tubes and other externally secreted structures were also included in the wet mass of tube-dwelling taxa. Macrofaunal wet mass was converted to carbon using taxon-specific wet-mass to ash-free dry mass (AFDM) conversion factors, followed by a single AFDM-to-carbon conversion of 0.5 (Brey, 2001). Conversion factors were assigned to each taxon using a fixed source hierarchy: Behrisch and Zwerschke (2026), derived from Greenland shelf benthos, was applied first, where a taxonomic match was available; Gogina et al. (2022) was applied to the remaining taxa; and Ricciardi and Bourget (1998) was used where neither source provided an appropriate match. Matches were made at the finest taxonomic level available in the source, and every taxon in the dataset was assigned a factor. The factor applied to each taxon, the source, and the taxonomic level of the match are documented in the published dataset (Zenodo). Because published factors for a given group vary across sources, we also derived lower and upper factors for each taxon from the published range, and recalculated the full carbon matrix under both scenarios. These bounding scenarios, together with the original blanket 4.3 % wet-mass conversion used for comparability with previous Arctic estimates (Rowe et al., 1994; Wiedmann et al., 2020), are reported in SM Tables R2 and R3. The taxon-specific carbon matrix is used as the primary analysis throughout."

Proposed new text (Discussion Sect. 4.3**):**

"These estimates depend on the conversion from wet mass to carbon, and this is a substantive source of uncertainty. Applying taxon-specific conversion in place of a single blanket factor reduced total reconstructed benthic invertebrate carbon from 15.03 to 11.48 g C m^{-2}, and bounding scenarios built from the published range of factors span 6.23 to 18.07 g C m^{-2} (SM Table R2). The dominant taxon, Strongylocentrotus droebachiensis, accounts for 28.5 % of reconstructed carbon under taxon-specific conversion, and two of the nine stations together hold approximately 64 % of the total. This concentration reflects the composition of the samples rather than the conversion itself; taxon-specific conversion in fact reduced the share attributed to the dominant taxon relative to the blanket factor (from 53.4 % to 28.5 %). We do not treat this dominance as a limitation of the trait-based approach, since the contribution of dominant taxa to the carbon pool is itself part of the ecological signal the trait–carbon matrix is designed to capture, and it is consistent with the concentration of carbon in single modalities described above.

Published wet-mass-to-AFDM values for echinoids nevertheless vary by close to an order of magnitude: 0.011 in Behrisch and Zwerschke (2026), flagged there as low confidence; 0.035 in Ricciardi and Bourget (1998); and 0.077 for Echinodermata in Gogina et al. (2022). Because this taxon carries the largest share of the biomass, it is also the largest single contributor to uncertainty in the reconstructed estimates. We therefore treat benthic invertebrate carbon primarily as a comparative measure among stations rather than as an absolute standing stock. The comparison among stations is robust to this choice: station carbon totals were strongly rank-correlated across all four conversion scenarios (r^2 = 0.90–0.98), and the trait–environment relationships underpinning our conclusions were unchanged (SM Table R4)."

The impact on trait selection

We also tested whether the conversion approach affected the trait structure used in the subsequent analyses. We found the conversion approach did slightly alter the first step of truncating the biomass to 95%, but the overall analyses and results still stand; we discuss this here. Trait modalities were ranked by their contribution to total macrofaunal carbon within each trait family and retained in decreasing order until adding the next modality would cause cumulative biomass to exceed 95%. Because modalities are retained as whole categories rather than divided to reach the exact threshold, the achieved coverage depends on their relative sizes and therefore falls below the nominal 95% threshold. Under the original blanket 4.3% conversion, the retained modalities represented 94.6% of biomass for environmental position, 94.7% for feeding habit, and 94.0% for mobility. With the taxon-specific conversion, the same set of retained modalities was selected, but their cumulative contribution was slightly lower, representing 91.4% of biomass for environmental position (2 of 6 modalities), 91.6% for feeding habit (5 of 19), and 92.2% for mobility (4 of 15). Including the modality that crossed the 95% threshold would increase coverage to 96–99% but would also retain a larger, sparser set of modalities; we therefore retained the conservative criterion and assessed its consequences in Sect. 4.3. Critically, the same set of retained modalities was obtained using the taxon-specific carbon reconstruction as in the original analysis. Thus, the revised conversion altered the magnitude of carbon estimates but did not change the trait modality structure used in subsequent analyses. Given the importance of this methodological decision, we now explicitly discuss its implications in Section 4.3 as part of the proposed new text in our joint response to RC1.24 and RC2.22 (proposed new text below; combined with the next section).

The impact on GLLVM analyses

Most importantly, we tested whether the conversion approach affected the trait-environment relationships (e.g., the GLLVM approach) underpinning our main conclusions. Models were refitted using the taxon-specific carbon matrix under the same specifications as the original analysis. Models were fitted with zero to three latent variables, and with our new approach, all four converged. However, the information criteria did not agree, and disagreed at opposite ends of the candidate set: AIC and BIC both favoured three latent variables, while AICc favoured none (Table R7; at the end of the document). This is a symptom of the parameter-to-observation ratio rather than a genuine ambiguity in the data. With 99 observations and 55 to 85 estimated parameters, the AICc small-sample correction term ranges from 143 to 1125, an order of magnitude larger than any difference in AIC across the candidate set, so AICc returns the smallest model mechanically, irrespective of fit. AIC fails in the opposite direction: log-likelihood

rises monotonically with each additional latent variable (9.7, 53.7, 87.4, 125.9) and the AIC penalty is too weak to offset it. Neither criterion is therefore informative here, and selecting on either alone would not have been defensible.

Instead, we based the choice on the estimated latent variance, which does not depend on the parameter count. In every fit, a single axis accounted for the majority of the latent variance, with additional axes contributing substantially less. The data support a single interpretable latent gradient, and the higher-dimensional models differ mainly in how many weakly supported axes they include. We therefore report the single latent variable model, as this was the most parsimonious model supported by the data. We have assessed the consequences of this choice directly rather than assuming it is unimportant. Trait–environment coefficients were compared across all four latent models and are reported in a new supplementary table (Proposed new Table R8; at the end of the document). Five terms are significant under every specification, with tightly constrained estimates. For example, POC flux × burrower ranges only from 0.213 to 0.224 across the four models, and POC flux × opportunist-predator-scavenger from 0.535 to 0.560. A further eight terms are significant under two or three specifications, and three under only one. The conclusions we draw in the revised Discussion rest on the five robust terms and are therefore unaffected by the number of latent variables fitted; terms significant under some specifications are described as suggestive, and terms significant under one are not used to support claims.

Importantly, the latent gradient under the taxon-specific carbon scenario ('primary') was identical to the preprint analysis, with stations ordered KOF1 < ACF1 < ACF4 < DB2 < KOF3 < KOF2 < DB1 < ACF2 < ACF3. The five relationships supporting our main conclusions remained significant under both the original blanket conversion and the taxon-specific conversion across models (Table R4). Since LV1, rather than absolute carbon, is the axis along which the trait results are interpreted, we find no evidence that the original conversion factor drove the relative spatial patterns or the trait-environment relationships on which our main conclusions are based.

Table R4. Trait–environment coefficients that were significant under all four latent-variable specifications, compared between the blanket-factor and taxon-specific carbon conversions. Values give the range of the estimate across models fitted with zero to three latent variables. All terms retained the same sign and remained significant under both conversions. POC, particulate organic carbon flux; SOC, sediment organic carbon.

Term	Blanket factor	Taxon-specific
POC flux × SOC × filter + suspension	1.571 to 2.799	1.598 to 3.100
SOC × filter + suspension	0.688 to 1.627	0.687 to 2.033
POC flux × SOC × sessile	1.077 to 1.316	0.955 to 1.197
POC flux × opportunist + predator + scavenger	0.569 to 0.582	0.535 to 0.560
POC flux × burrower	0.213 to 0.232	0.213 to 0.224

The impact on trait structure results and Latent Variable interpretation

While the latent gradient itself was unaffected by the change in conversion factor, the trait composition underlying it was not, and we report this explicitly. Because the taxon-specific factors differ by close to an order of magnitude between taxonomic groups, the relative contribution of individual taxa to each trait modality was substantially reweighted, even though the set of retained modalities and the station ordering along LV1 were preserved. The station panels in New Fig. 4 therefore differ from those in the preprint, and several descriptive and

interpretive statements in Sects. 3.4.1–3.4.3, 4.3 and 4.4 require revision (written at the end of the section).

The most consequential change concerns functional diversity. The preprint described functional diversity as increasing toward the high-LV1 end of the gradient, and this framing recurred in Sects. 3.4.3, 4.3 and 4.4. Under the taxon-specific reconstruction, it is not supported. Testing the relationship directly, functional evenness (Pielou's J) shows no association with LV1 (Spearman $\rho = -0.15$, $p = 0.70$; leave-one-out $\rho = -0.45$ to $+0.21$), and neither do Shannon diversity or Hill numbers ($\rho = +0.10$, $p = 0.80$) or Simpson's index ($\rho = -0.10$, $p = 0.80$). The number of trait combinations expressed is likewise unrelated ($\rho = +0.47$, $p = 0.20$). The most evenly distributed functional composition in the dataset now occurs at a low-LV1 station (KOF1, evenness J' = 0.69) and the most concentrated at a high-LV1 station (ACF3, evenness J' = 0.22). We have therefore removed the statements describing functional richness, functional integration and redistribution across co-occurring feeding modes, rather than weakening them.

The revised results support a clearer, more specific claim. LV1 is a gradient in which functional strategies hold the carbon, not in how many. The strongest relationship in the dataset is the proportion of carbon held by taxa capable of mixed deposit–opportunist– predator–scavenger feeding, which increases monotonically along LV1 ($\rho = +0.91$, $p = 0.0006$). Crawling taxa show a comparable pattern ($\rho = +0.82$, $p = 0.007$). Epifaunal contribution increases toward high LV1 but only marginally ($\rho = +0.58$, $p = 0.099$), and filter/suspension feeding shows no significant relationship ($\rho = +0.43$, $p = 0.24$). This revised interpretation is more directly consistent with the GLLVM coefficients themselves, in which filter/suspension feeding and sessile mobility show the strongest and most robust responses to POC flux, SOC and their interaction, while deposit feeders and burrowers show none (Table R8). It is also more consistent with the trait–environment framework on which the study is built, since a gradient in dominant functional strategy is precisely what a trait–carbon matrix is designed to resolve. We consider the revised interpretation both better supported and more specific than the original, and we note that it required no change to the model, the latent ordering, or the trait–environment coefficients on which our main conclusions rest.

A final observation on the revised model outputs: the relationship between LV1 and epifaunal contribution is not monotonic: the intermediate-LV1 stations are the most strongly infaunal in the dataset (mean epifaunal contribution 1.2 %, against 16.9 % at low-LV1 and 66.0 % at high-LV1 stations). We now describe this explicitly rather than presenting the gradient as a smooth progression, since the intermediate group represents a distinct infaunal, deposit-associated configuration rather than an intermediate state between the two ends.

Results
Proposed new text (Sect. 3.4)

"To characterise the gradient, we tested the association between LV1 rank and both the composition and the diversity of benthic trait carbon biomass across the nine stations. Compositional measures showed clear associations: the proportion of carbon held by taxa capable of mixed deposit–opportunist–predator–scavenger feeding increased monotonically along LV1 (Spearman $\rho = 0.91$, $p < 0.001$), as did the contribution of crawling taxa ($\rho = 0.82$, $p = 0.007$), while epifaunal contribution increased less consistently ($\rho = 0.58$, $p = 0.10$). Measures of functional diversity showed none: functional evenness ($\rho = -0.15$, $p = 0.70$), Shannon diversity and Hill numbers ($\rho = 0.10$, $p = 0.80$), and the number of trait combinations expressed ($\rho = 0.47$, $p = 0.20$) were all unrelated to LV1. Benthic trait carbon itself tended to increase along

the gradient but not significantly at this number of stations (ρ = 0.57, p = 0.11). LV1 is therefore best interpreted as a gradient in the functional strategies that hold benthic carbon, rather than in the amount of carbon held or the diversity of strategies present."

Proposed new text (Sect. 3.4.1 — Low LV1: infaunal and mixed-strategy assemblages)

"The two stations with low LV1 scores held low benthic invertebrate carbon (KOF1 = 0.32, ACF1 = 0.35 g C m $^{-2}$), among the lowest recorded in the study, although the lowest total of any station occurred at KOF3 (0.19 g C m $^{-2}$), which has an intermediate LV1 score. The two low-LV1 stations differed markedly from one another in functional composition. ACF1 was composed entirely of infauna, with mixed deposit–filter/suspension feeders holding 79.9 % of its carbon and burrowers 95.5 %, and expressed the fewest trait combinations of any station among the retained modalities (n = 4). KOF1, by contrast, showed the most even functional composition in the dataset (Pielou's J' = 0.69, n = 11 combinations), with carbon distributed across opportunist–predator–scavengers (43.0 %), filter/suspension feeders (31.6 %) and deposit-based modalities, and across burrowing (24.1 %), mixed burrower–crawler (37.8 %) and sessile (33.6 %) strategies. Neither station held carbon in the mixed deposit–opportunist–predator–scavenger modality. Low standing carbon at these two stations therefore does not correspond to a single functional configuration."

Proposed new text (Sect. 3.4.2 — Intermediate LV1: infaunal, deposit-dominated assemblages)

"Stations with intermediate LV1 scores (ACF4, DB2, KOF3) held between 0.19 and 0.86 g C m $^{-2}$ of benthic invertebrate carbon, with KOF3 holding the least of any station in the study. These were the most strongly infaunal stations in the dataset, with epifauna contributing 2.5 % or less at each and filter/suspension feeding effectively absent (0.4–3.8 %). ACF4 and KOF3 again showed convergent composition despite occupying different coastal systems, both dominated by deposit feeding (95.3 % and 75.2 %) and by burrowing and mixed burrower–crawler movement (86.1 % and 89.2 % combined). DB2 differed in holding the majority of its carbon in opportunist–predator–scavengers (78.7 %), the highest proportion at any station, expressed almost entirely by burrowing infauna (93.6 %). Resource use across this group is therefore predominantly sediment-associated rather than suspension-based, and the intermediate position of these stations on LV1 does not correspond to an intermediate functional composition between the low- and high-LV1 ends."

Proposed new text (Sect. 3.4.3 — High LV1: epifaunal assemblages with mixed feeding strategies)

"Stations with high LV1 scores (KOF2, DB1, ACF2, ACF3) spanned the widest range of benthic trait carbon in the study (0.43 to 4.95 g C m $^{-2}$), including both the highest value recorded (KOF2) and one of the lowest (ACF2). The group is distinguished by composition rather than by standing carbon. Epifaunal contribution was highest here (mean 66.0 %, against 1.2 % at intermediate and 16.9 % at low-LV1 stations), as was the contribution of taxa capable of mixed deposit–opportunist–predator–scavenger feeding (mean 29.4 %, against ≤0.5 % elsewhere). KOF2 held both the highest total benthic trait carbon and the largest proportional contribution of filter/suspension feeders (68.8 %), expressed almost entirely by sessile epifauna (68.8 %). ACF3 held the highest proportional representation of mixed feeding of any station (86.3 %), expressed by crawling epifauna (88.1 %), and consequently had the most concentrated functional composition in the dataset (J' = 0.22). ACF2 was the most evenly distributed (J' = 0.70), with carbon split between filter/suspension (45.2 %) and deposit feeding (37.6 %). DB1 departed from the group pattern, being predominantly infaunal (66.7 %) and dominated by mixed deposit–filter/suspension feeders (69.1 %). High LV1 scores therefore correspond to a shift in feeding mode and environmental position, and not to a consistent increase in either standing carbon or functional evenness."

Discussion

Proposed new text (Sect. 4.3 — replaces L462–477**) – NB:** This forms the third paragraph of the revised Sect. 4.3. The two preceding paragraphs, on the responses of filter/suspension feeders and infaunal groups to the carbon predictors, are given in AC1.24 (RC1) / AC2.22 (RC2).

"Mixed feeding strategies, by contrast, provide the clearest insight into how carbon is redistributed along the latent gradient. The proportion of carbon held by taxa that are jointly deposit feeders, predators and scavengers increased along LV1 (r_s = 0.91, $p < 0.001$), the strongest association with LV1 of any compositional measure examined, although it was substantial only at KOF2 (28.1 %) and ACF3 (86.3 %), the two stations that also held the highest benthic invertebrate carbon. A recent isotope study of feeding types in epibenthos from Northeast Greenland characterised most fauna as generalists (Nordström et al. 2026), suggesting that access to multiple carbon sources may be particularly important for benthic consumers in this region. Our trait framework captures this generalism by retaining combined trait modalities where taxa express multiple feeding strategies. Two such modalities were retained under the 95 % biomass criterion, and one of them (combined deposit, opportunist, predator and scavenger feeding) proved to be the compositional measure most strongly associated with the latent gradient. Finer mixed strategies beyond these two contributed proportionally little carbon and were excluded by the retention rule. Rather than reflecting reliance on a single prey source, the prominence of this modality suggests exploitation of advected particulate matter, sedimentary detritus and benthic secondary production together, and in such carbon-rich settings trophic flexibility may allow organisms to exploit spatially and temporally variable resources across co-occurring energy pathways (McMeans et al. 2015; Mavraki et al. 2020).*

We emphasise that this represents a change in which strategies hold the carbon, not an increase in the range of strategies present. Functional evenness, Shannon diversity and the number of trait combinations expressed were all unrelated to LV1 (Spearman's $\rho = -0.15$ to $+0.47$, all $p > 0.20$), and at ACF3 the majority of benthic invertebrate carbon was held within a single mixed-feeding modality, producing the most concentrated functional composition in the study. Where mixed feeding was prominent, it was therefore concentrated in a small number of dominant taxa rather than distributed across the assemblage. Together, these contrasting responses between epifaunal and infaunal strategies indicate that benthic invertebrate carbon is governed not simply by carbon quantity, but by the interaction between carbon supply pathways and resource characteristics, with different trait strategies potentially exploiting distinct components of the carbon pool that are not equally captured by bulk POC flux or sedimentary carbon measures."

Proposed new text (Sect. 4.4 — replaces L498–502)

"We hypothesise that a comparable configuration emerged in our coastal systems, with high latent-variable scores situated on steep sills supporting epifaunal assemblages in which mixed deposit–opportunist–predator–scavenger feeding was prominent, and, at two of the four stations, the highest benthic invertebrate carbon was recorded, even in the absence of elevated POC export or SOC. The gradient captured by LV1 is compositional rather than one of diversity: functional evenness and richness were unrelated to LV1, and the two most carbon-rich stations were among the most functionally concentrated in the dataset. We therefore interpret LV1 as an axis along which particular epifaunal and mixed-feeding strategies come to hold an increasing share of the carbon, rather than as a gradient of increasing functional complexity. We note that the low- and intermediate-LV1 ends are not characterised by a single alternative strategy: deposit feeding, mixed deposit–filter feeding and burrowing showed no significant association with LV1 in either direction, and the two low-LV1 stations differed markedly from one another. As LV1 is also moderately associated with seabed slope and terrain ruggedness ($r^2 \approx 0.26$–0.33), we hypothesise this compositional shift could be consistent with an influence of near-bed hydrodynamic conditions on which species trait strategies may capture carbon, though our data cannot establish that relationship directly."

Proposed new text (Sect. 4.4 — add after the ACF1 passage (L508–512))

"The intermediate-LV1 stations are worth noting in this context. Rather than representing a transitional state between the two ends of the gradient, they were the most strongly infaunal and deposit-dominated stations in the study, with epifaunal contributions below those of the low-LV1 stations. This suggests that the latent gradient does not represent a simple continuum of increasing exposure, but instead distinguishes different configurations of resource use, from communities dominated by sediment-associated strategies to those where epifaunal strategies become more prominent. The intermediate LV1 group is therefore not simply transitional, but represents a particularly strong expression of infaunal and deposit-dominated resource use."

RC1.4: The other aspect is that vertical carbon transport is unlikely to be completely vertical in a system regulated by tides and currents. This means that surface carbon content may not be linked to sediment carbon stock, particularly in areas with high flux, which is not necessarily linked to benthic-pelagic coupling but dictated by the abiotic environment and it would be good to have this acknowledged or considered when calculating the vertical carbon flux.

AC1.4: We agree with the reviewer that particle transport in a tidally and hydrographically dynamic fjord system is unlikely to be exclusively vertical, and that lateral advection and resuspension can influence the relationship between trap-derived POC flux and sedimentary carbon stocks. We acknowledge this caveat, but retain the trap-derived flux estimates as a measure of POC flux through the water column at each station. Lateral transport and resuspension do not alter the flux measurement itself, but may influence the origin and subsequent fate of the particles captured by the traps. This is also relevant to the interpretation of sedimentary carbon stocks, which integrate deposition and subsequent redistribution and processing at the seafloor. We therefore retain this distinction in our interpretation rather than treating trap-derived POC flux as a direct measure of local sediment carbon accumulation.

We will now make this caveat explicit in the Methods (in Sect. 2.4.3, Line 153 onwards) when describing the trap-derived POC flux estimates.

Proposed new text:

"...Each cylinder was pre-filled with GF/F filtered seawater adjusted to a salinity of ~40 to reduce turbulence upon particle entry. Such traps may also be influenced by lateral advection and resuspension, particularly under tidally energetic conditions (Reigstad et al., 2008; Estapa et al., 2021; Iversen, 2023). We acknowledge this source of uncertainty but assume that these processes affect the measurements consistently across stations, allowing trap-derived POC fluxes to be used as comparable estimates of downward carbon transport."

RC1.5: One aspect that has been neglected in this paper is, that substratum availability, generally dictated by abiotic environments as well, is a great driver of benthic communities. To find large amounts of high biomass sessile suspension feeders, hard substratum tends to be required, which is found in the high energy environments. The authors touch upon this, by linking their LV gradient to bathymetry and steepness, but it would be nice to see a clearer acknowledgement of this.

AC1.5: We agree that the availability of substrata is an important driver of benthic community structure. Our data addresses this aspect directly within the habitat sampled: box coring

recovers soft sediment, and sediment composition was broadly comparable across all nine stations, with mud (clay and silt combined) comprising approximately 90% of sediment mass (SM Fig. S3 in the original preprint). Thus, variation in the sedimentary substratum within the sampled habitat is unlikely to account for the differences in trait composition observed among stations. This is why substratum was not developed further in the original text, and we will now state this explicitly rather than leaving it implicit.

Sessile suspension feeders were nevertheless present at stations, indicating that the trait responses reported here occur in soft-sediment habitats and do not depend on the presence of hard substrata in our sampled habitat. We did not survey consolidated substrata or mixed hard-soft interfaces, which cannot be sampled with a box corer; therefore, fauna attached exclusively to such surfaces are not represented in our biomass estimates. The relationship between LV1 and seabed slope and terrain ruggedness ($R^2 \approx 0.26–0.33$), therefore, remains most consistent with variation in the physical conditions associated with these geomorphological characteristics, particularly near-bed hydrodynamics, rather than variation in sediment type, which was broadly consistent among stations.

Proposed new text in sect. 2.5.1:

"Sediment composition was highly consistent across stations, with ≥90% of sediment mass comprising mud (clay and silt combined), and was therefore not included as a predictor due to its limited variation and potential to add noise to the models."

RC1.6: Although the paper is very well written, there is a tendency to overcomplicate statements, which sometimes makes it hard to follow and figure out what it is the authors are trying to say. E.g a temporal decoupling of POC, SOC and benthic carbon biomass in the abstract, or greater redistribution of carbon across co-occurring feeding modes under advective conditions in the discussion. A simplification and greater precision of language here might help the reader to better understand the point that is being made. This is particularly evident in the discussion, where the authors are making bold statements, which are not necessarily underpinned by the data that is presented.

AC1.6: We thank the reviewer for this helpful comment. We agree that some statements, particularly in the Abstract and Discussion, may be more complex than necessary. We will therefore revise the manuscript throughout to simplify the language, distinguish more clearly between observed patterns and their interpretation, and ensure that the strength of our wording reflects the evidence provided by the analyses. For example, "temporal decoupling among POC export, SOC, and benthic carbon biomass" will be revised to describe the observed lack of correspondence among these carbon pools, with temporal dynamics presented as a possible interpretation rather than as an observed mechanism. Similarly, "greater redistribution of carbon across co-occurring feeding modes under advective conditions" will be simplified to describe the observed differences in trait composition more directly. Throughout the Discussion, we will also ensure that the interpretation of these patterns is clearly supported by the results, using specific evidence from our analyses where appropriate and distinguishing between relationships that are demonstrated by the data and those that are consistent with, or provide evidence for, our ecological interpretation. We will apply this more explicit distinction, particularly to the statements highlighted in the specific comments below.

RC1.7: The figures are very nice and clear, but I am not sure it is necessary to have the same figure three times. It makes it difficult to compare the differences in traits across the latent variable scores. Maybe all the trait-biomass diagrams could be combined into one, based on their z score.

AC1.7: We thank the referee for the suggestion and have produced the trait z-score heatmap (Fig. R1, this response) to assess it directly. We find that it addresses a different question than the one the manuscript poses, and we propose retaining the alluvial presentation in a restructured form.

The heatmap displays, for each trait modality, which stations deviate from the among-station mean. This is a station-anomaly question. The manuscript asks how a given station's benthic trait carbon is partitioned among co-expressed functional roles, that is, how the same carbon is distributed across position, feeding and mobility simultaneously. Because each species contributes its carbon to one modality within each trait family, the three families describe the same carbon three times over. The alluvial diagram encodes this as a partition; the heatmap presents modalities as independent cells, so a reader summing a column would double- and triple-count.

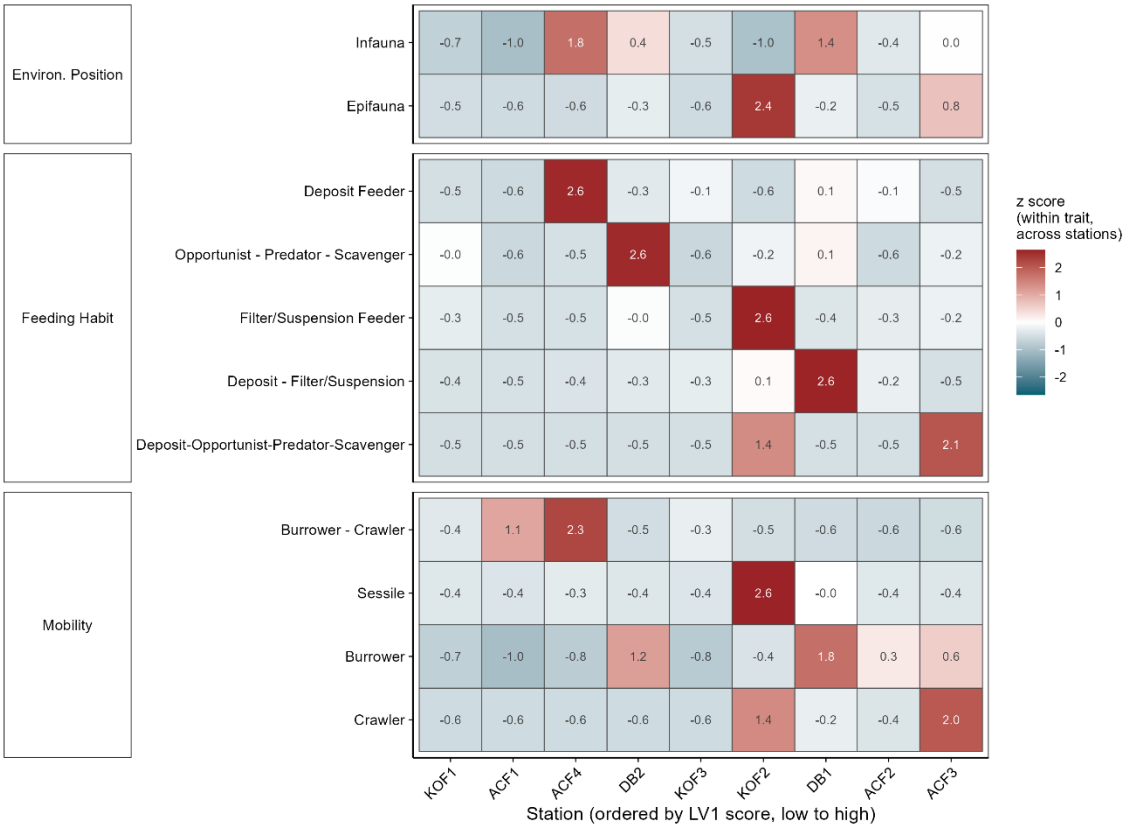


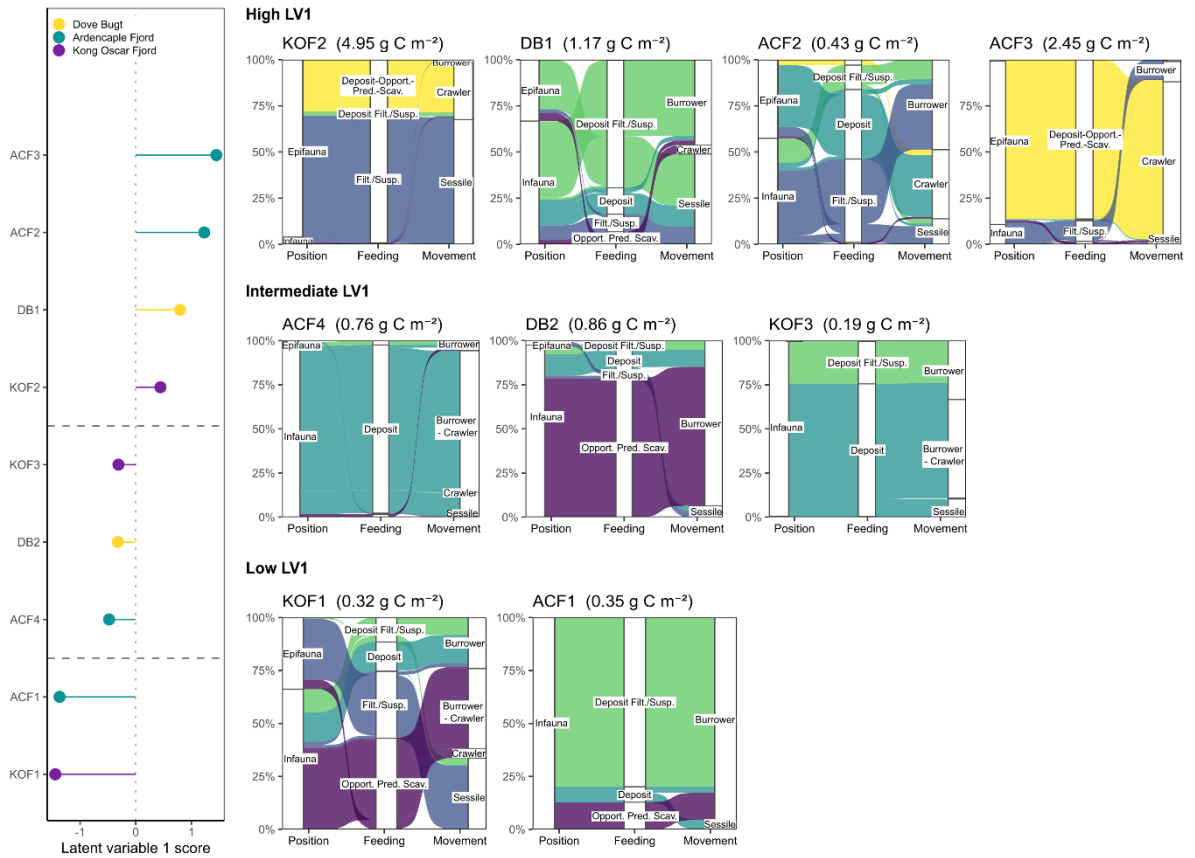
Fig. R1. Trait z-score heatmap produced in response to RC1.7, shown here for the referee's assessment. Cells give the standardised benthic carbon biomass of each trait modality (rows) at each station (columns), with carbon standardised within trait modality across the nine stations (z = 0 is the among-station mean for that modality; positive values indicate stations holding more of that modality's carbon than average). Modalities are grouped by trait family (environmental position, feeding habit, movement); stations are ordered by LV1 score.

Two further properties limit the heatmap here. Standardising within-trait across nine stations yields $z = (n-1)/\sqrt{n} = 2.67$, and several cells sit at that ceiling (2.6), where the value indicates only that a single station holds nearly all of that modality; the scale appears graded but is close to binary for rare modalities. Standardisation also removes absolute biomass, which is the response variable in the GLLVM, so the display cannot show the relationship between carbon supply and benthic carbon biomass that the paper is about.

We have, however, taken the underlying point that Figs 4–6 are difficult to read. They are now a single figure, restructured rather than merged: stations are ordered by LV1 score and grouped into low, intermediate and high blocks alongside the LV1 panel itself, so the ordination and the trait composition can be read against one another at a glance (New Fig. 4). Flows are scaled to proportion within station, so ribbon width has one meaning throughout, with total benthic carbon biomass given in each panel title. The repeated feeding-habit labels, which appeared nine times in the previous version, are replaced by a single shared legend. We are happy to include the heatmap as supplementary material if the referee considers it useful alongside this.

Relatedly, we propose promoting the fjord schematic as a graphical abstract. It was drafted to convey where each station sits within its system and why the latent gradient is interpretable in physical terms, but with the trait figure now carrying the LV1 ordering directly, the schematic no longer fits well in the Results. As a graphical abstract, the updated version provides an overview of the study context, spatial and environmental setting, and main results, allowing the reader to understand the study design and key findings at a glance.

New main text figure (edit to figs. 4-6):

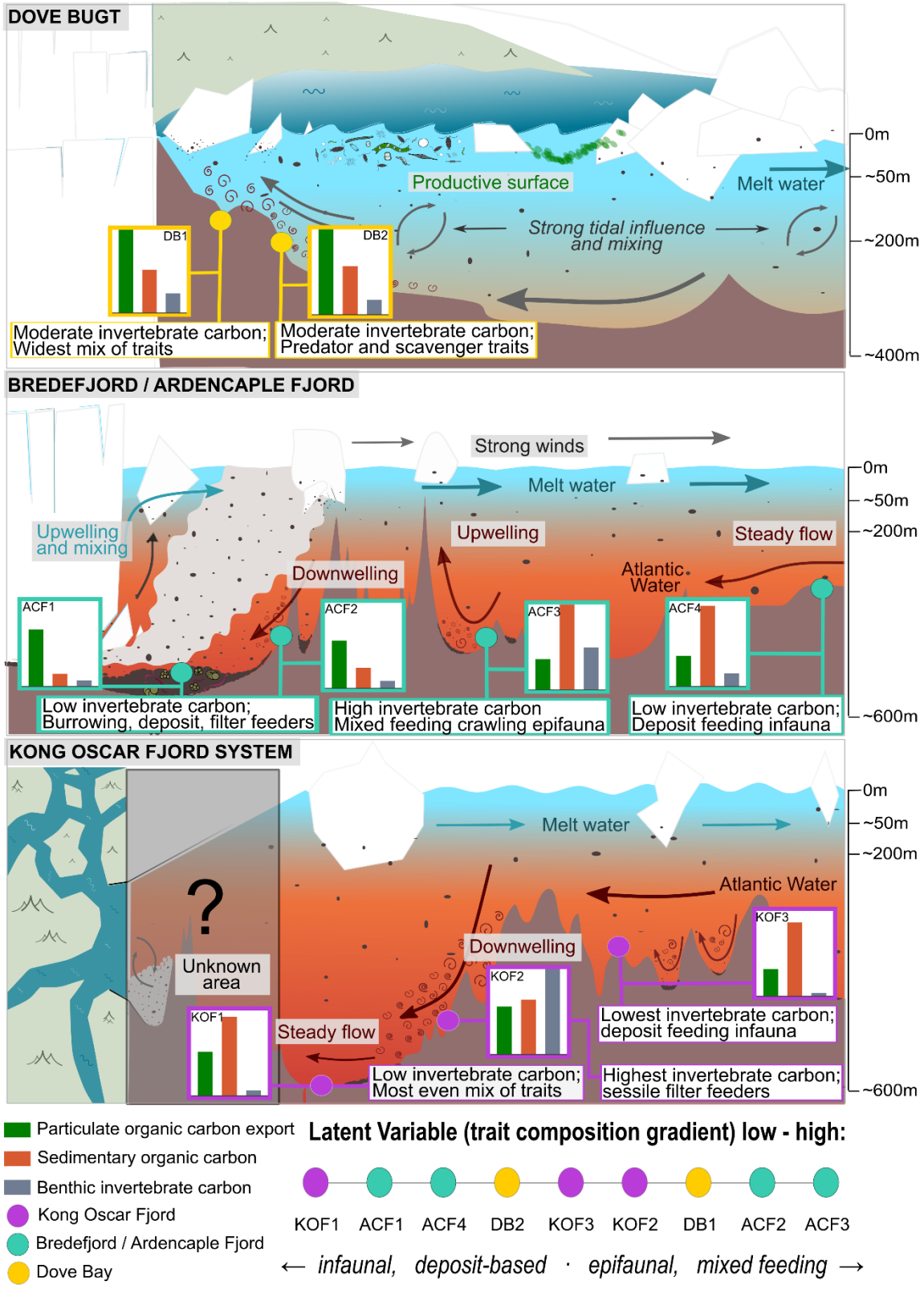


New Figure 4 *| Benthic trait carbon biomass composition across trait families at each station, ordered along the first latent variable (LV1). Left: station scores on LV1 from the GLLVM, coloured by coastal system, with dashed rules marking the divisions between low, intermediate and high LV1 groups. Right: alluvial diagrams for each station, arranged in the same three groups and in the same top-to-bottom order as the LV1 panel. Each diagram partitions that station's benthic invertebrate carbon across three trait families — environmental position, feeding habit and movement — with ribbons linking the modalities co-expressed by the same taxa, so the same carbon is followed across all three axes rather than treated as three independent quantities. Ribbon width is the share of that station's carbon, allowing composition to be compared between panels; total benthic carbon biomass at each station is given in the panel title (g C* m^{-2}*). Ribbons are coloured by feeding habit (shared legend); position and movement modalities are labelled within panels. Flows show only the trait modalities retained by the 95 % biomass truncation).*

New Graphical Abstract:

*"**Graphical abstract** | Conceptual overview of the physical and biological processes shaping benthic invertebrate carbon and taxon-level traits across fjord systems in Northeast Greenland. The highly dynamic physical environment, including freshwater input, tidal mixing, upwelling, downwelling and the presence or absence of Atlantic Water at depth, influences surface water conditions and primary production, which in turn regulate the export and redistribution of particulate organic carbon to the seafloor. Benthic invertebrate carbon biomass as traits determines how this carbon is processed and contributes to variation in ecological functioning among stations and fjord systems. The schematics illustrate contrasting environmental settings and associated patterns of benthic invertebrate carbon and trait composition across Dove Bugt, Brede Fjord / Ardencaple Fjord, and the Kong Oscar Fjord system."*

Carbon supply alone does not explain benthic carbon; local seafloor setting shapes which strategies hold it.



RC1.8: I would also recommend spelling out some of the abbreviations such as surface water or Atlantic water or as a minimum spell them out in a new paragraph/section again, so the reader is reminded what it means.

AC1.8: Thank you for this suggestion. We will expand the abbreviations AW (Atlantic Water), PW (Polar Water), SW (Surface Water), POC (particulate organic carbon), SOC (sedimentary organic carbon), and LV (latent variable) at their first use in each section to improve readability and remind the reader of their meaning.

Minor/specific comments

RC1.9: Line 49: modify in which way?

AC1.9: We thank the reviewer for pointing out that "modifying stratification" was too vague. We will clarify this statement to specify that glacier-driven circulation can alter the vertical structure of the water column by changing mixing and upwelling.

New proposed text:

"...enhancing circulation and increasing water mixing, thereby weakening stratification in the water column..."

RC1.10: Line 54: Bathymetric highs?

AC1.10: Thank you. We will replace "bathymetric highs" with "shallow sills within fjords" to more explicitly describe the bathymetric features referred to: the idea that shallow seafloor features can influence water circulation.

New proposed text:

"As many marine-terminating glaciers in Northeast Greenland are retreating toward terrestrial termination and exposing shallow sills within fjords (Hill et al. 2017; 55 Wood et al. 2021), associated changes in..."

RC1.11: Line 53-56: Check and consider Buydens 2026

AC1.11: We thank the reviewer for highlighting this recent study. Buydens et al. (2026) provide relevant evidence from Greenland fjords showing that enhanced primary production associated with subglacial upwelling does not necessarily translate into greater sedimentary carbon accumulation, highlighting the importance of physical transport and depositional processes. We will incorporate this study here and again in Sect. 4.2. (the discussion, RC1.23) of how changes in glacier type, circulation and stratification may influence carbon delivery and benthic carbon storage.

New proposed text:

"Recent evidence from Greenland fjords further indicates that enhanced primary production associated with subglacial upwelling does not necessarily result in greater sedimentary carbon accumulation, highlighting the role of physical transport and depositional processes in determining carbon delivery to the seabed (Buydens et al. 2026)."

RC1.12: Line 82- 86: sentence is being repeated

AC1.12: Correct, and we apologise for the oversight. The duplicated sentence beginning "We combine sediment trap measurements at 6 to 8 depths…" will be kept and the earlier one deleted.

RC1.13: Line 130-132: was this analysed in different sections, e.g. surface and lower depth, if so how?

AC1.13: Thank you for highlighting this clarification. The sediment subsamples represented the upper 10 cm of each box core and were homogenised prior to analysis. We will clarify this in Section 2.4.1 by adding "The subsamples were homogenised prior to analysis." We also recognise that the terminology used for the fine-sediment fraction was inconsistent between the main manuscript and the supplementary material. We will revise the terminology throughout to distinguish between clay and silt, while using "mud" only when referring to their combined fraction. For example, the sediment composition will be described as "…consisting of approximately 50% clay, 40% silt, and 0–10% sand, with gravel…"

New proposed text:

"… using 50 mL Falcon tubes inserted vertically ~10 cm into the sediment to capture both surface and subsurface layers. The subsamples were homogenised prior to analysis."

RC1.14: Line 154: When was it deeper

AC1.14: We thank the reviewer for highlighting this ambiguity. We will clarify that traps were deployed at the standard depths of approximately 20, 30, 50, 90, 120 and 200 m, with additional traps at 300 and 400 m where permitted by the local bottom depth. Thus, stations with shallower bottom depths did not include the deepest trap depths. The full deployment depths for each station are provided in the supplementary material (updated Fig. S11i and Table S11ii in RC2.12.)

New proposed text:

"Bottom moored arrays equipped with 2–4 transparent plexiglass cylinders (KC Denmark, 72 mm inner diameter; aspect ratio 6.25) were deployed at 6–8 depths, typically including 20, 30, 50, 90, 120 and 200 m, with additional traps at 300 and 400 m where permitted by local bottom depth, for ~22 hours."

RC1.15: Line 165-170: Can you explain what the coeffcient means, for people not familiar with analysis? You speak of it being stable or high or moderate. Is that the intervariability between sites or stations etc etc

AC1.15: We thank the reviewer for highlighting this point. We will clarify that the coefficient of variation (CV) describes the relative variability of each environmental variable across the nine sampling stations, rather than the variability within-station replicates. We will describe that the CV is calculated as the standard deviation divided by the mean and expressed as a percentage, allowing the relative variability of variables measured on different scales to be compared. We will therefore clarify that "stable", "moderate", and "high" refer specifically to the degree of spatial variability among stations. We will also retain the caveat that high CVs for fluorescence and turbidity largely reflect their very low mean values and therefore do not necessarily indicate ecologically meaningful spatial variation.

New proposed text:

"... we calculated the mean, standard deviation, and coefficient of variation (CV) across the nine sampling stations (SM, Fig. S5; Table S6). The CV, calculated as the standard deviation divided by the mean and expressed as a percentage, describes the relative variability among stations and was used to compare the spatial variability of environmental variables measured on different scales. We therefore describe variables as "stable", "moderately variable", or "highly variable" based on their degree of spatial variability among stations. Depth exhibited..."

RC1.16: Line 180-183: Not clear

AC1.16: We thank the reviewer for highlighting this point. We will revise this section to more clearly express the GLLVM approach by explaining that the measured predictors account for variation in trait biomass associated with the environmental variables included in the model, whereas the latent variable captures residual covariation among trait modalities that remain after accounting for these predictors. The latent variable is therefore interpreted as an unmeasured ecological gradient associated with the remaining community structure, rather than as a directly measured environmental variable.

New proposed text:

"Generalised Linear Latent Variable Models (GLLVMs) are a model-based framework for multivariate data that combines regression and ordination approaches. In this approach, the measured environmental predictors were used to explain variation in trait biomass, while the latent variable captured residual covariation patterns among trait modalities that remained after accounting for these predictors. The latent variable therefore represents an unmeasured ecological gradient associated with the remaining community structure, rather than a directly measured environmental variable. Models were fitted using a Tweedie distribution, appropriate for continuous biomass data containing zeros (SM, Fig. S8 & S9), using the R package gllvm (Niku et al., 2019)."

RC1.17: Line 242: I would not call this comparable

AC1.17: We thank the reviewer for pointing this out. We will remove this wording and describe the observed range directly. We will also remove the interpretation that carbon supply was broadly comparable among stations, as comparing the observed fluxes with reported values from other Arctic and fjord environments is better suited to the Discussion.

New proposed text:

"Across the three coastal systems, POC export reaching the seafloor showed x3.5 variation among stations (~94 to ~326 mg C m^{-2} d^{-1}), with differences among stations reflecting variation in POC export and attenuation (Fig. 2ii)."

RC1.18: Line 251-2: Is this linked to primary production

AC1.18: We thank the reviewer for raising this point. The observed spatial pattern in POC export could potentially be related to differences in primary production, but our data do not allow us to directly test this relationship. The results presented here therefore describe the observed spatial variation in POC export, while potential links with primary production and the processes controlling carbon export are considered in the Discussion.

RC1.19: Line 318: this biomass is greater than other stations, such as KOF3

AC1.19: We thank the referee for this observation, which identified an error with wider consequences than the sentence itself. The referee is correct: the preprint claim that low-LV stations held "the lowest benthic invertebrate biomass among all stations" is contradicted by our own values, since KOF1 (3.65) exceeds KOF3 (2.75). Pursuing this, we established that the per-station values quoted throughout Sect. 3.4 were sums of fourth-root-transformed carbon carrying the units g C m^{-2}. On the correct scale, KOF3 holds the least benthic invertebrate carbon of any station, and the ordering of the three lowest stations changes. We have corrected the values and units throughout Sect. 3.4 and on the alluvial axes, and have applied the same check to Sects. 3.4.2 and 3.4.3, where two comparable statements also required correction.

We have removed the superlatives and now describe the relationship between LV1 and standing carbon directly. Benthic invertebrate carbon tended to increase along LV1, but the association is not statistically significant at n = 9 (r_s = 0.57, p = 0.11), and two stations depart clearly from it: KOF3, which holds the lowest carbon of any station despite an intermediate LV1 score, and ACF2, which holds among the lowest despite a high score. Excluding these two, r_s = 0.89 (p = 0.007). We therefore present LV1 as a gradient in trait composition along which standing carbon tends to increase, rather than as a predictor of biomass, and note that the limited number of stations limits the power to resolve this relationship. This tendency and its non-significance are unchanged by either correction (r_s = 0.55–0.57 across the original transformed values, the blanket-factor values and the taxon-specific reconstruction).

Proposed new text (Sect. 3.4.1):

"The two stations with low LV1 scores held low benthic invertebrate carbon (KOF1 = 0.32, ACF1 = 0.35 g C m^{-2}), among the lowest recorded in the study, although the lowest total of any station occurred at KOF3 (0.19 g C m^{-2}), which has an intermediate LV1 score."

RC1.20: Line 321: Why would the deep stations be more prone to disturbance from deposition and sediment resuspension

AC1.20: Thank you for this comment. We can see how "based on their position in the bathymetry" could be interpreted as water depth, rather than seafloor topography. Our

interpretation does not imply that greater depth itself causes greater disturbance. Rather, ACF1 and KOF1 occupy enclosed inner fjord settings, where basin geometry and proximity to glacier-derived sediment inputs are expected to promote deposition, sediment resuspension and near-bottom plume activity. We will clarify this distinction and avoid implying that depth alone determines disturbance. The full compositional description of both low-LV1 stations is given in the revised Sect. 3.4.1 (AC1.3).

New proposed text (Sect. 4.4, replacing L508–512**):**

"Both stations occupy enclosed inner fjord settings. Given their position within the basin, proximity to glacier-derived sediment inputs and the surrounding seafloor topography, these environments are expected to experience frequent deposition, sediment resuspension and near-bottom plume activity. At ACF1 this is consistent with an assemblage composed almost entirely of burrowing infauna, whereas the more even composition at KOF1 indicates that these conditions do not produce a single characteristic assemblage."

DISCUSSION:

RC1.21: It is not always clear whether some of the statements are supported by a statistical analysis, as some of this factors such as particle size have ben measured but there is no indication about a formal analysis here

AC1.21: Thank you for this comment. We acknowledge that, in some places, it was not always clear whether statements in the Discussion referred to relationships identified in our analyses or to broader interpretations based on the literature. We will revise the Discussion to make this distinction more explicit, using phrases such as “our results” where appropriate and ensuring that interpretations are clearly separated from relationships directly supported by the analyses. For example, see the revision described in RC1.24/AC1.24, where we explicitly identify the findings as “our GLLVM results” when referring to relationships observed in our analysis.

Regarding sediment characteristics, sediment composition was measured but not included as a predictor in the statistical analysis because it was highly homogeneous across sampling stations, with more than 90% of the sediment being mud (SM Fig. S3, S7) and would add noise to the model. See the proposed new text for sect. 2.5.1 (AC1.5). The sediment composition is already described in Section 3.1. Additionally, C:N and the bathymetric terrain metrics were measured, but several were strongly correlated with the predictors we retained (SM Fig. S7), and were excluded on that basis rather than overlooked (Sec. 2.5.1). Reviewer 2 made a nice observation regarding our C:N (RC2.22), and so we have proposed new text for the discussion there.

RC1.22: Line 428-430: unclear

AC1.22: Thank you for highlighting this. We agree that the explanation of the seasonal timing of the measurements was not sufficiently clear. We will clarify that sampling occurred toward the end of the productive season and that the approximately 22-hour trap deployments provide a short-term measure of POC export, which may not capture earlier seasonal export peaks. In contrast, sedimentary carbon stocks integrate organic matter inputs over substantially longer periods. We will simplify this section to make the difference in temporal scales more explicit.

New proposed text:

"As sampling occurred toward the end of the productive season, the measured POC flux represents a short-term snapshot that may not capture earlier seasonal export peaks. In contrast, sedimentary carbon stocks integrate organic matter deposited over much longer periods, including earlier seasonal inputs."

RC1.23: Line 435-438: unclear

AC1.23: Thank you for pointing this out. We will clarify that sedimentary carbon stocks integrate carbon accumulation over longer timescales, whereas the sediment trap measurements represent approximately 22 hours of POC export. The observed lack of correspondence between these measurements therefore reflects their different temporal integration between water column export and sedimentary carbon accumulation. We will also include Buydens et al. (2026), highlighted by the reviewer in RC1.11, as supporting evidence that enhanced production or export does not necessarily translate directly into increased accumulation of sedimentary carbon in Greenland fjords.

New proposed text:

"Similar decoupling between pelagic flux and benthic carbon storage has been reported in Arctic systems (Wiedmann et al. 2020; Bodur et al. 2024), further indicating that sedimentary carbon stocks integrate organic matter accumulation over longer timescales, whereas sediment traps capture POC export over approximately 22 hours. A direct correspondence between these measurements is therefore not necessarily expected. The observed differences indicate that sedimentary carbon stocks reflect not only POC export, but also subsequent transport, deposition, degradation and retention processes at the seafloor, as also observed in Greenland fjords by Buydens et al. (2026)."

RC1.24: Line 455-457: Would this not be a seasonal pattern

AC.1.24. Thank you for this comment. Yes, the original argument was intended to address the long lifespans often attributed to Arctic benthic species, which may require them to persist through substantial seasonal variation in food availability, including periods of both high and low carbon availability. On reflection, however, we agree that this interpretation goes beyond what our study directly addresses. We have therefore revised the text to keep the discussion focused on the results presented here. While the potential role of different carbon sources remains relevant, we have reframed this section around the contrasting responses of the feeding strategies observed in our data and the potential importance of resource characteristics beyond bulk carbon quantity. Reviewer 2 also raised a related concern regarding the statement about longevity in this section, and we have addressed both comments through the same revision. For readability, we have also split the original paragraph into two.

Proposed new text - This forms the first two paragraphs of the revised Sect. 4.3; the remainder of the section is given in AC1.3 (RC1) / AC2.9 (RC2)**:**

"Filter and suspension feeding taxa showed the strongest and most consistent responses to the carbon predictors themselves. This was the only feeding trait significant across all latent-variable

specifications, for both sedimentary organic carbon and its interaction with POC flux (SM Table R8). Their response to the interaction term suggests that neither POC flux nor SOC alone is sufficient, but that the combination of pelagic carbon supply and benthic carbon availability is important. Carbon held by this modality was concentrated at KOF2, ACF2 and KOF1 (68.8, 45.2 and 31.6 % of station carbon respectively), with smaller contributions at ACF3 and DB1, and these stations span a wide range of carbon environments. This distribution does not follow the latent gradient: filter/suspension contribution showed no significant association with LV1 (Spearman's ρ = 0.43, p = 0.24), and the third-largest contribution occurred at the lowest-LV1 station.

In contrast to these epifaunal taxa, our GLLVM results showed that several prominent infaunal trait groups, including deposit feeders, burrowers and mixed deposit–filter feeders, showed little or no statistical response to bulk carbon predictors, with coefficients centred near zero. Rather than indicating insensitivity to organic matter, this suggests that these strategies may depend on resource characteristics not captured by bulk carbon metrics, such as particle size, lability and biochemical composition. For example, infaunal benthic consumers may preferentially assimilate sea ice-derived organic matter over pelagic sources even when total carbon availability is similar, reflecting differences in energetic value rather than quantity alone (Cautain et al. 2022; Clarke 1983; Niemi et al. 2024; Yunda-Guarin et al. 2020). This highlights a broader challenge for benthic trait-based research: functional categories such as deposit feeding encompass diverse resource acquisition strategies that are not captured by current broad trait classifications. Organisms classified as deposit feeders may therefore exploit different components of the sedimentary organic matter pool that are not distinguished by this category. Resolving these finer feeding specialisations, particularly among infaunal taxa, could substantially improve our understanding of how benthic communities acquire, transform and redistribute carbon."

RC1.25: Line 470 – 472: Would this not be the other way around

AC1.25: Thank you for pointing this out. We agree that the original statement was too categorical and could be interpreted as implying that trophic generalism is disadvantageous under carbon-limited conditions. As this argument is not central to our study and the relative advantages of generalist versus specialised feeding strategies depend on the environmental context, we will remove the statement rather than develop an interpretation that is not directly tested by our data.

RC1.26: Line 472-475: this contradicts your previous statements

AC1.26: Thank you for pointing this out. We agree that this apparent contradiction arose from the preceding statement, which we will remove as described in AC1.25. The remaining text will therefore be revised to maintain a consistent interpretation of the trait responses.

RC1.27: Line 485-486: exposure to what

AC1.27: Thank you. We will clarify “basin exposure” as differences in seabed topography, which are associated with differences in hydrodynamic conditions.

New proposed text:

"In this spatial context, LV scores clustered along gradients in seabed topography, suggesting that the LV captures an emergent hydrodynamic regime."

RC1.28: Line 487-488: like what substratum type, depth, currents

AC1.28: Thank you. We understand that the reviewer is asking for clarification of what we mean by "static hydrographic or sedimentary metrics". We will clarify that the static hydrographic properties refer to the oceanographic conditions and water masses described in this study, while the sedimentary properties refer to sediment composition and organic matter measured in the study.

New proposed text:

"This regime likely reflects the cumulative effects of horizontal advection, sill-driven transport, tidal mixing, and resuspension processes that redistribute carbon across fjord basins but are not directly captured by the static hydrographic properties (e.g., the water masses) or sedimentary properties (e.g., sediment composition and organic matter) measured here."

RC1.29: Line 492-3: Well yes because there is more hard substratum, no?

AC1.29: Thank you for raising this point. We agree that the studies cited here include systems where complex topography is associated with hard substrata. However, our intended comparison concerns the hydrodynamic mechanism rather than substratum availability. Topographic complexity and steep slopes can enhance horizontal flow and particle transport, thereby creating benthic biomass hotspots by increasing the delivery of suspended material. In our study, the sampled stations were soft sediment environments, so the elevated biomass associated with high LV scores cannot be attributed to increased availability of hard substrata. We will clarify this distinction in the Discussion and emphasise that our results suggest a similar topographically mediated hydrodynamic mechanism operating in soft-sediment habitats.

New proposed text:

"These hydrodynamically exposed environments often favour epifaunal filter feeders such as sponges, corals, and other suspension feeders, which benefit from increased encounter rates with suspended particles and reduced sediment clogging (Lundsten et al. 2009; Rowden et al. 2010). In our study, a similar hydrodynamic mechanism may operate over soft sediment, where steep sills and topographic complexity can enhance horizontal particle transport and delivery to the seabed."

RC1.30: Line 504: unclear what you mean with hydrographic scale

AC1.30: Thank you for highlighting this. We acknowledge that "hydrographic scale" was unclear and will clarify that we are referring to hydrodynamic processes operating at finer spatial scales, such as individual habitat patches, rather than at the basin scale.

New proposed text:

"Parallel to this, Barnes & Sands (2017) also show how benthic communities increase in biomass and in the number of functional groups in response to enhanced carbon accumulation at finer spatial scales, such as individual habitat patches characterised by boulder fields and mixed hard–soft interfaces, highlighting the importance of considering local hydrodynamic context when interpreting benthic–pelagic coupling and carbon pathways in glacial coastal systems."

RC1.31: Line 512-514: This is very hard to interpret

AC1.31: Thank you for highlighting this. We will simplify it to more directly link the ACF1 example to the local hydrodynamic and depositional conditions inferred from its setting, while retaining the broader implication for habitat heterogeneity.

Proposed new text:

"Recognising local and fine-scale hydrodynamic processes as important drivers of benthic structure may therefore provide a more mechanistic framework for predicting ecosystem responses to both climatic and anthropogenic change in Arctic coastal systems."

RC1.32: Line 516-518: I am not sure I agree here and whether this is clearly supported in your data

AC1.32: Thank you for this comment. We agree that the original wording presented hydrodynamic redistribution too firmly as an established component of the hierarchy. In our analysis, this interpretation arises from the spatial pattern of the latent variable and its association with seabed topography, rather than from direct measurements of hydrodynamic processes. We will therefore revise the statement to distinguish the carbon patterns directly supported by our data from those attributed to the hydrodynamic mechanism proposed to explain the remaining spatial variation.

New proposed text:

"The findings of this cross-disciplinary study support a conceptual framework in which benthic communities in Northeast Greenland coastal systems are influenced by regional carbon production and export, local seafloor sediment carbon availability, and potentially by hydrodynamic redistribution associated with seabed topography."

RC1.33: Line 525: what processes

AC1.33: Thank you. We will clarify that "processes" refers to the specific physical transport and redistribution mechanisms discussed throughout the manuscript, including sill overflow and hydraulic control, along fjord advection, tidal mixing, and resuspension and downslope transport of previously deposited material.

New proposed text:

"Sill overflow and hydraulic control, along fjord advection, tidal mixing, and resuspension and downslope transport of previously deposited material can redistribute organic matter across

heterogeneous basins in ways that amplify, dilute, or decouple vertical POC flux from benthic carbon supply (Barnes and Sands 2017; Yin et al. 2024).”

RC1.34: Line 525-530: But this is not what you did, no?

AC1.34: We thank the reviewer for pointing this out. This paragraph is intended to identify a direction for future research rather than describe an analysis undertaken in this study. We will clarify this by explicitly framing the incorporation of horizontal transport processes into carbon budgets as a future research need. This follows from our interpretation that lateral transport may contribute to the spatial decoupling between measured POC flux and benthic carbon supply, but was not directly quantified in the present study.

New proposed text:

“These lateral pathways are rarely measured directly and remain largely absent from carbon budgets. In the context of accelerating Arctic change, where meltwater discharge, glacier retreat and shifts in water mass inflow are reshaping fjord circulation, future carbon budgets should incorporate these horizontal processes to better understand how carbon is transferred, transformed and retained in benthic communities in soft sediments.”

RC1.35: Line 535-537: I am not sure you can say that you have shown that

AC1.35: Thank you for this comment. We agree that the original wording overstated the extent to which our analyses demonstrated hydrodynamic processes. We will therefore remove the reference to hydrodynamic processes from this concluding statement and focus on the relationships directly supported by our data.

New proposed text:

“This study demonstrates that, despite broadly homogeneous bottom water conditions, benthic communities exhibited pronounced spatial heterogeneity associated with differences in vertical carbon export and sedimentary carbon stocks.”

RC1.36: Line 539-541: But you did not measure that

AC1.36: Thank you for pointing this out. We agree that how the preprint reads might overstate that carbon quality, trophic mediation, and access pathways were directly measured in this study. Our intention was to interpret the contrasting responses among trait strategies in light of these potential mechanisms. We will revise the wording to distinguish the relationships directly supported by our analyses from the mechanisms that may underlie them.

New proposed text:

“Only a subset of trait strategies showed relationships with vertical POC flux or sedimentary organic carbon, indicating that standing biomass was not explained by bulk carbon quantity alone. Differences among trait strategies may instead reflect variation in resource quality, trophic mediation, or access pathways that were not directly measured here.”

New References:

Behrisch, J. and Zwerschke, N.: Conversion factors for Greenland shelf benthos: Weight-to-weight and body-size-to-weight relationships, Earth Syst. Sci. Data, 18, 5009–5026, https://doi.org/10.5194/essd-18-5009-2026, 2026.

Boone, W., Vergeynst, L., and Sejr, M. K.: Coastal freshening prevents fjord bottom water renewal in Northeast Greenland – a mooring study from 2003–2015, Geophys. Res. Lett., 45, 2733–2741, https://doi.org/10.1002/2017GL076591, 2018.

Brey, T.: Population dynamics in benthic invertebrates. A virtual handbook, Version 01.2, Alfred Wegener Institute for Polar and Marine Research, Germany, available at: http://www.thomas-brey.de/science/virtualhandbook (last access: 13 August 2026), 2001.

Buydens, M., De Borger, E., Meire, L., Bodé, S., Schirone, A., Soetaert, K., Vanreusel, A., and Braeckman, U.: Carbon burial in two Greenland fjords shows no direct link to glacier type, Biogeosciences, 23, 1159–1174, https://doi.org/10.5194/bg-23-1159-2026, 2026.

Gogina, M., Zettler, A., and Zettler, M. L.: Weight-to-weight conversion factors for benthic macrofauna: recent measurements from the Baltic and the North seas, Earth Syst. Sci. Data, 14, 1–16, https://doi.org/10.5194/essd-14-1-2022, 2022.

Lam, P. J., S. C. Doney, and J. K. B. Bishop. 2011. The dynamic ocean biological pump: Insights from a global compilation of particulate organic carbon, CaCO3, and opal concentration profiles from the mesopelagic. Global Biogeochem. Cycles 25: GB3009. doi:10.1029/2010GB003868

Martin, J. H., G. A. Knauer, D. M. Karl, and W. W. Broenkow. 1987. VERTEX: carbon cycling in the northeast Pacific. Deep-Sea Res. Part A 34: 267–285. doi:10.1016/0198-0149(87)90086-0

Marsay, C. M., R. J. Sanders, S. A. Henson, K. Pabortsava, E. P. Achterberg, and R. S. Lampitt. 2015. Attenuation of sinking particulate organic carbon flux through the mesopelagic ocean. Proc. Natl. Acad. Sci. U.S.A. 112: 1089–1094. doi:10.1073/pnas.1415311112

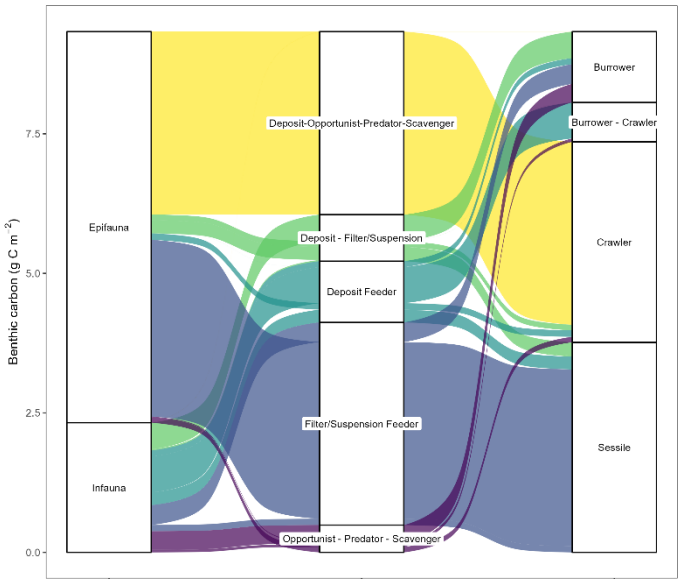
Nordström, M. C., Bondgaard, M., Sejr, M. K., and Blicher, M. E.: Epibenthic food web structure across the Northeast Greenland seascape, Mar. Environ. Res., 221, 108295, https://doi.org/10.1016/j.marenvres.2026.108295, 2026.
Ricciardi, A. and Bourget, E.: Weight-to-weight conversion factors for marine benthic macroinvertebrates, Mar. Ecol. Prog. Ser., 163, 245–251, doi.org, 1998.

Rysgaard, S., Mortensen, J., and Haxen, M.: Summer Hydrography Conditions at Proglacial Fjord Entrances Along East Greenland, J. Geophys. Res.-Oceans, 129, e2023JC020665, https://doi.org/10.1029/2023JC020665, 2024.

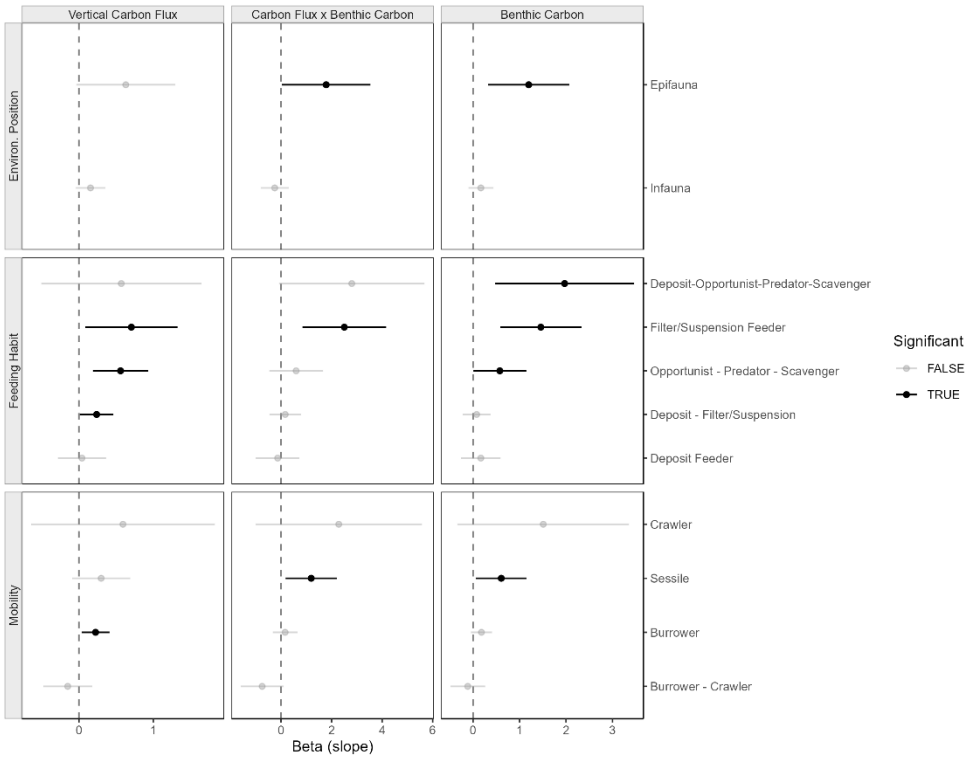
New/replaced Tables and Figures Regarding the Updated Carbon Factor

Updated Figure 3 | Trait-based composition of benthic carbon biomass and trait-specific responses to carbon variables. (i) The distribution of benthic carbon biomass (g C m^{-2}) across major trait groups. Colours represent the proportional contribution of each trait combination to the total benthic invertebrate carbon pool. **(ii)** Trait-specific coefficients from the GLLVM models for three carbon predictors: vertical POC flux (export) (mg C m^{-2} d^{-1}) at the deepest sediment trap depth, the interaction between vertical POC flux and SOC, and surface SOC. Points represent estimated coefficients (β), with horizontal lines indicating 95% confidence intervals. Black points denote statistically significant effects at $P < 0.05$ ("true"), whereas grey points indicate non-significant effects at $P \geq 0.05$ ("false"). Panels are grouped by trait categories of environmental position, feeding habit and mobility.

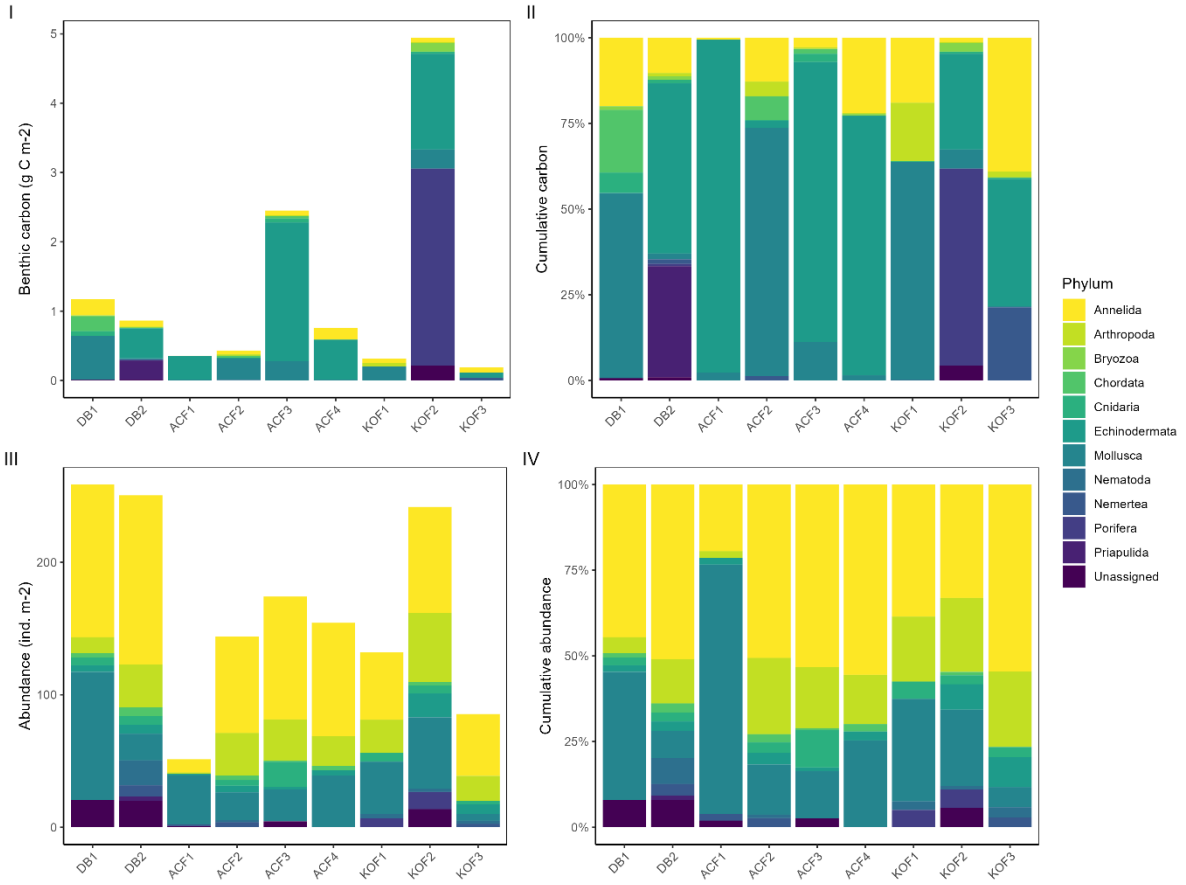
(i)



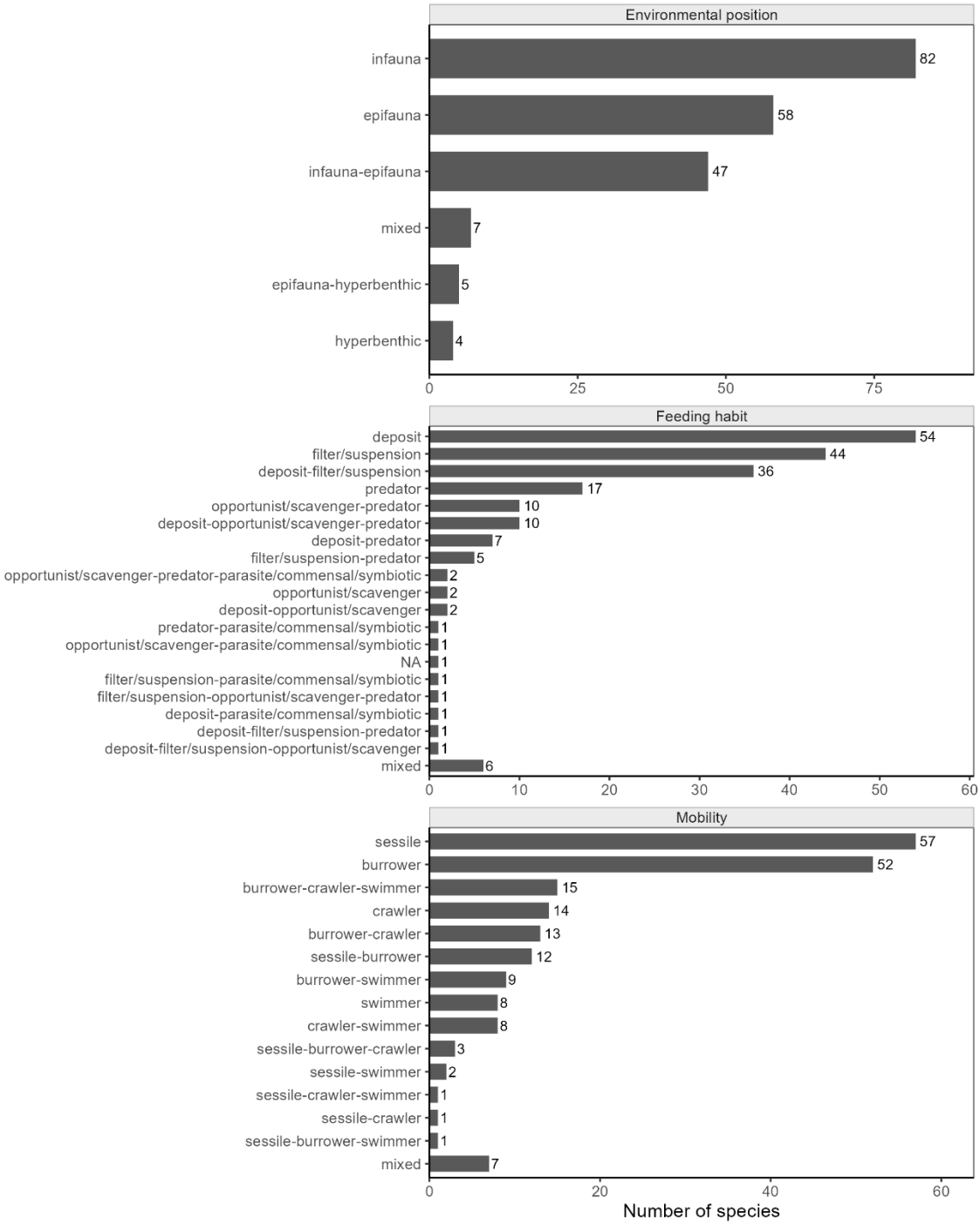
(ii)



Updated Figure S1. Taxonomic composition of benthic communities across sampling stations in Northeast Greenland coastal systems. Panels (I) and (II) show absolute and cumulative benthic carbon biomass (g C), respectively, while panels (III) and (IV) show absolute and cumulative abundance (ind. m^{-2}). Absolute values are shown as stacked bars partitioned by phylum, and cumulative panels display proportional contributions of each phylum to total community biomass or abundance. Colours indicate major benthic phyla. Stations are ordered by coastal system and inner–outer position within each system; Dove Bugt (DB), Ardencaple Fjord (ACF), and Kong Oscar Fjord (KOF).



Updated Figure S2. Distribution of categorical trait assignments across all taxa in the full benthic community prior to truncation at 95 per cent cumulative biomass. Shown are counts of species for three traits: environmental position, feeding habit, and mobility. Bars represent the number of species assigned to each trait category. Categories comprise multiple terms from fuzzy-coded trait assignments that were subsequently translated into composite text labels, such that species with any affinity to multiple modalities (*e.g.*, deposit feeder and predator) are represented as combined categories (*e.g.*, deposit-predator). NA denotes species for which trait information was unavailable.



Updated Figure S9: Diagnostic residual plots for the selected Generalised Latent Variable Model (GLLVM) with one latent variable. Panels show Dunn–Smyth residuals plotted against (i) linear predictors, (ii) theoretical quantiles (normal Q–Q plot), (iii) site index (rows), and (iv) trait biomass matrix index (columns), as well as (v) scale–location residual patterns. The final panel (vi) shows the single latent variable (LV1) ordered by sampling station (rather than LV1 score as shown in main text). Residuals show no major violations of model assumptions, with approximately constant variance, no strong trends against predictors or station/trait biomass, and acceptable normality of transformed residuals, indicating adequate model fit.

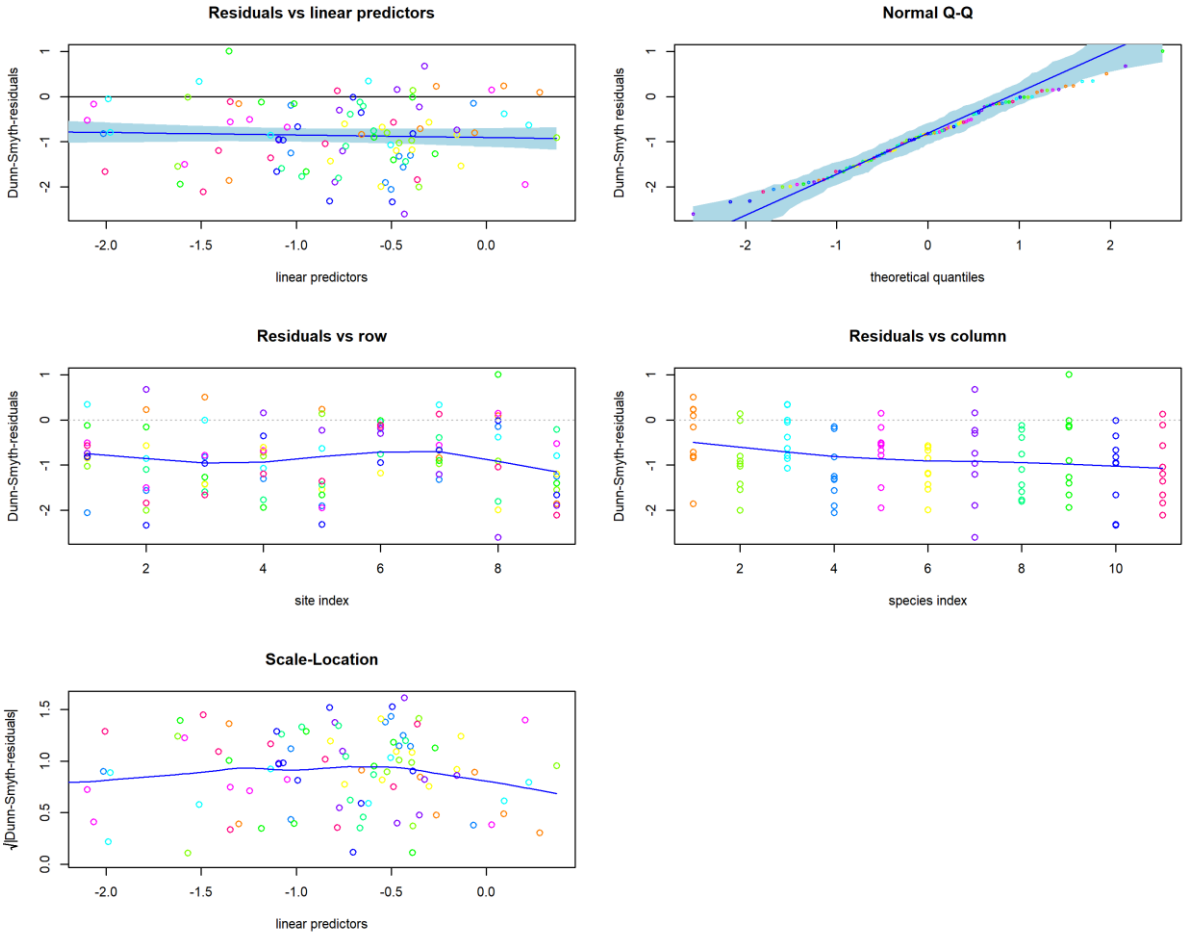


Table R6. Wet-mass to ash-free dry mass conversion factors applied to benthic taxa. Factors were assigned at the level of taxonomic group; all taxa within a group received the same factor. The primary factor was used in the reported analysis, with low and high values defining the bounding scenarios reported in Table X. Sources: B&Z, Behrisch and Zwerschke (2026); Gogina, Gogina et al. (2022); R&B, Ricciardi and Bourget (1998). Where sources disagreed, preference was given to B&Z as the most regionally appropriate, then to Gogina et al., whose measurements were made under the same convention as ours with shells and tests retained. The full per-taxon assignment is given in the archived dataset.

Group	*n* taxa	Primary	Low	High	Basis
Polychaeta	63	0.148	0.119	0.160	Gogina North Sea 0.148 (Baltic 0.119); R&B all polychaetes 0.160
Amphipoda	26	0.128	0.121	0.160	Gogina 0.121–0.128; R&B 0.160
Bivalvia	21	0.084	0.058	0.084	Gogina North Sea 0.084 (shells retained); R&B 0.058
Bryozoa	18	0.073	0.037	0.073	Gogina 0.073; B&Z Horneridae 0.045, Phidoloporidae 0.037
Isopoda	9	0.119	0.112	0.221	Gogina Baltic 0.119
Porifera	6	0.113	0.057	0.145	B&Z Polymastiidae 0.113 (high confidence, *n* = 44); Theneidae 0.071; Gogina 0.057
Gastropoda	5	0.096	0.075	0.106	Gogina 0.096–0.106; R&B prosobranch 0.075
Ophiuroidea	5	0.074	0.062	0.101	R&B 0.074; B&Z Ophiacanthidae 0.062, Ophiopholidae 0.101
Sipuncula	5	0.148	0.020	0.148	Gogina 0.148; R&B 0.112; B&Z Golfingiidae 0.020 (low confidence)
Anthozoa	4	0.130	0.089	0.151	Gogina 0.130–0.141; B&Z Hormathiidae 0.089, Liponematidae 0.151
Cumacea	4	0.120	0.076	0.130	Gogina 0.120–0.130; R&B 0.076
Asteroidea	3	0.112	0.071	0.222	R&B 0.112; B&Z Benthopectinidae 0.097, Echinasteridae 0.222
Tanaidacea	3	0.151	0.120	0.183	Gogina
Ascidiacea	2	0.045	0.012	0.048	Gogina 0.045; B&Z Didemnidae 0.048
Crinoidea	2	0.063	0.031	0.095	B&Z Antedonidae 0.063 (high confidence; direct match for *Poliometra*)
Hydrozoa	2	0.301	0.099	0.301	B&Z Sertulariidae 0.301 (high confidence; direct match for *Thuiaria*); Gogina 0.099
Caudofoveata	1	0.189	0.133	0.245	Gogina

Group	*n* taxa	Primary	Low	High	Basis
Echinoidea	1	0.035	0.011	0.077	R&B 0.035; B&Z Strongylocentrotidae 0.011 (low confidence); Gogina Echinodermata 0.077
Hirudinea	1	0.178	0.089	0.267	Gogina
Holothuroidea	1	0.109	0.020	0.109	R&B 0.109; B&Z Laetmogonidae 0.020, Molpadiidae 0.026
Nemertea	1	0.158	0.142	0.200	Gogina 0.142–0.158; R&B 0.200
Oligochaeta	1	0.129	0.129	0.256	Gogina Baltic 0.129
Polyplacophora	1	0.105	0.105	0.272	Gogina 0.105; R&B 0.272 (*n* = 1)
Priapulida	1	0.106	0.065	0.106	Gogina 0.106 (*n* = 269); R&B 0.065
Pycnogonida	1	0.107	0.092	0.260	Gogina 0.107; B&Z Nymphonidae 0.260
Nematoda	1	0.148	0.119	0.160	No published value; polychaete proxy
Ostracoda	1	0.128	0.121	0.160	No published value; amphipod proxy
Scaphopoda	1	0.096	0.075	0.106	No published value; gastropod proxy

Table R7. Information Criterions (AIC, BIC and AICc) values for Generalised Latent Variable Models (GLLVMs) fitted with zero to three latent variables.

Latent Variables	Converg-ence	df	logL	AIC	BIC	AICc	dAIC	dBIC	dAICc
0	TRUE	55	9.71	90.59	233.32	233.84	172.48	94.62	0
1	TRUE	66	53.68	24.64	195.92	301.02	106.53	57.22	67.17
2	TRUE	76	87.35	-22.71	174.52	509.29	59.18	35.82	275.45
3	TRUE	85	125.94	-81.89	138.70	1042.71	0	0	808.88

Table R8. Robustness of trait–environment coefficients across latent-variable specifications. Generalised linear latent variable models were fitted with zero to three latent variables (lv0–lv3); each row gives one covariate × trait modality term. A term was considered significant where its 95 % confidence interval excluded zero. Estimates are on the standardised predictor scale, so one unit corresponds to one standard deviation of the covariate. Terms are grouped by robustness and ordered within each group by the magnitude of the median estimate. POC flux, particulate organic carbon flux to the seafloor; SOC, sediment organic carbon; POC flux × SOC, their interaction. Conclusions in the main text are drawn only from terms in the robust category.

Covariate	Trait family	Modality	Significant under	n	Median	Range	Direction
Robust — significant under all specifications							
POC flux × SOC	Feeding habit	filter + suspension	lv0–lv3	4 of 4	2.563	1.598 to 3.100	+
SOC	Feeding habit	filter + suspension	lv0–lv3	4 of 4	1.601	0.687 to 2.033	+
POC flux × SOC	Mobility	sessile	lv0–lv3	4 of 4	1.081	0.955 to 1.197	+
POC flux	Feeding habit	opportunist + predator + scavenger	lv0–lv3	4 of 4	0.542	0.535 to 0.560	+
POC flux	Mobility	burrower	lv0–lv3	4 of 4	0.218	0.213 to 0.224	+
Mostly robust — significant under two or three specifications							
SOC	Feeding habit	deposit + opportunist + predator + scavenger	lv1, lv2, lv3	3 of 4	2.260	0.581 to 3.460	+
SOC	Environmental position	epifauna	lv1, lv2, lv3	3 of 4	1.221	0.522 to 1.392	+
SOC	Mobility	sessile	lv1, lv2, lv3	3 of 4	0.558	0.426 to 0.609	+
SOC	Mobility	crawler	lv2, lv3	2 of 4	2.256	0.382 to 3.537	+
POC flux × SOC	Environmental position	epifauna	lv1, lv3	2 of 4	1.696	0.851 to 1.838	+
POC flux	Feeding habit	filter + suspension	lv1, lv2	2 of 4	0.757	0.383 to 0.911	+
SOC	Feeding habit	opportunist + predator + scavenger	lv0, lv1	2 of 4	0.520	0.497 to 0.576	+
POC flux	Feeding habit	deposit + filter + suspension	lv0, lv1	2 of 4	0.223	0.204 to 0.239	+
Model-dependent —							

Covariate	Trait family	Modality	Significant under	n	Median	Range	Direction
significant under one specification							
POC flux × SOC	Mobility	crawler	lv3	1 of 4	2.989	0.634 to 3.975	+
POC flux × SOC	Feeding habit	deposit + opportunist + predator + scavenger	lv3	1 of 4	2.845	0.766 to 4.163	+
POC flux × SOC	Mobility	burrower + crawler	lv3	1 of 4	−0.667	−0.744 to −0.553	−
Not significant under any specification							
POC flux	Mobility	crawler	—	0 of 4	0.794	0.059 to 1.137	+
POC flux	Feeding habit	deposit + opportunist + predator + scavenger	—	0 of 4	0.636	−0.053 to 0.989	varies
POC flux	Environmental position	epifauna	—	0 of 4	0.625	0.334 to 0.664	+
POC flux × SOC	Feeding habit	opportunist + predator + scavenger	—	0 of 4	0.519	0.502 to 0.600	+
POC flux × SOC	Environmental position	infauna	—	0 of 4	−0.283	−0.334 to −0.247	−
POC flux	Mobility	sessile	—	0 of 4	0.260	0.233 to 0.299	+
SOC	Feeding habit	deposit	—	0 of 4	0.174	0.158 to 0.228	+
POC flux × SOC	Feeding habit	deposit + filter + suspension	—	0 of 4	0.164	0.156 to 0.183	+
SOC	Environmental position	infauna	—	0 of 4	0.163	0.158 to 0.168	+
SOC	Mobility	burrower	—	0 of 4	0.158	0.145 to 0.181	+
POC flux	Environmental position	infauna	—	0 of 4	0.155	0.151 to 0.156	+
POC flux	Mobility	burrower + crawler	—	0 of 4	−0.135	−0.195 to −0.112	−
POC flux × SOC	Feeding habit	deposit	—	0 of 4	−0.132	−0.155 to −0.121	−
POC flux × SOC	Mobility	burrower	—	0 of 4	0.096	0.039 to 0.164	+
SOC	Mobility	burrower + crawler	—	0 of 4	−0.080	−0.192 to −0.044	−
SOC	Feeding habit	deposit + filter + suspension	—	0 of 4	0.067	0.057 to 0.077	+
POC flux	Feeding habit	deposit	—	0 of 4	0.040	0.036 to 0.082	+