Our reply to the anonymous reviewer

We would like to thank the reviewer for taking the time to carefully review this manuscript as well as going through our previous responses. We highly appreciate the constructive feedback and the identification of minor issues.

Marius Buydens – on behalf of all authors

We numbered the reviewer's comments and our responses below:

1. I still struggle with the source apportionment calculations using only d13C values without uncertainties. With that simplistic approach, the authors might as well just postulate that all OC is marine for all stations except NK13. If they wanted to improve their approach, they would need to include uncertainties for the endmember values and propagate these. They could also include d15N and or C:N ratios as is commonly done (e.g. using the MixSIAR models). Anyhow, for the sake of this paper, simply assuming negligible contributions of terrestrial OC is probably fair enough.

We did not apply a MixSIAR model because, although Arctic marine and terrestrial $\delta^{13}C$ end-member ranges overlap only marginally (terrestrial: -33.9‰ to -26.8‰; marine: -26.0‰ to -19.8‰), most samples fall close to the marine end-member, limiting source identifiability and the ability of a Bayesian mixing approach to resolve minor terrestrial contributions. Under such conditions, posterior estimates would be largely constrained by priors rather than the data themselves. A MixSIAR framework would be more appropriate if site-specific end-member distributions were available (e.g., plankton, terrestrial vegetation and permafrost samples from the study area including samples representing spring and summer).

An alternative approach would be Monte Carlo simulations. However, this approach implicitly assumes uniform plausibility across reported end-member ranges. In other words, it assumes that terrestrial organic matter with a $\delta^{13}C$ signature of −33.9‰ is equally likely as material with a $\delta^{13}C$ value of −26.8‰, for which no supporting data are available. We therefore adopted a more conservative approach by using an enriched marine $\delta^{13}C$ end-member value within the reported Arctic range. As correctly pointed out by the reviewer, the resulting estimates should be interpreted as indicative of dominant organic matter sources rather than precise quantitative source fractions. To clarify this point in the manuscript, we revised the Materials and Methods section to explicitly report the range of marine $\delta^{13}C$ values observed at high latitudes rather than a single representative value [lines 209–214]:

For marine organic matter, compiled high-latitude datasets indicate median $\delta^{13}C$ values of particulate organic carbon around -24‰, with most reported values falling between approximately -19.8‰ and -26‰ (Verwega et al., 2021). Due to the scarcity of $\delta^{13}C$ records specific to Greenland's marine organic matter, we used a marine $\delta^{13}C$ end-member value of -20.6‰. This value represents the reported Arctic-average $\delta^{13}C$ signature of sedimentary organic matter (Winkelmann and Knies, 2005) and has previously been applied as a marine end-member in Arctic fjord studies (Koziorowska et al., 2015).

We hereby added the following reference: Verwega, M.-T., Somes, C. J., Schartau, M., Tuerena, R. E., Lorrain, A., Oschlies, A., and Slawig, T.: Description of a global marine particulate organic carbon-13 isotope data set, Earth System Science Data, 13, 4861–4880, https://doi.org/10.5194/essd-13-4861-2021, 2021.

In addition, to underline the uncertainty in our calculations, we added the following sentence to the aforementioned paragraph [line 214]: "Given the limited availability of site-specific end-member data for Greenland fjords, fixed Arctic-average end-member values were adopted to provide first-order estimates of

organic matter source contributions. These calculations are intended to indicate relative source dominance rather than precise quantitative fractions."

We also changed the following in the results section [line 305]:

"…displayed $\delta^{13}C$ values characteristic for marine algae…"

to:

"…displayed $\delta^{13}C$ values consistent with a predominantly marine origin…"

We also added the following sentence to the discussion [line 379]: "Despite the increase in shrub vegetation observed in Greenland during recent decades (Grimes et al., 2024), our data do not indicate a substantial contribution of terrestrial OC to the sediments of both fjords (Fig. 4; Fig. 5b)."

Added reference: Grimes, M., Carrivick, J. L., Smith, M. W., and Comber, A. J.: Land cover changes across Greenland dominated by a doubling of vegetation in three decades, Scientific Reports, 14, 3120, https://doi.org/10.1038/s41598-024-52124-1, 2024.

2. Small error in line 204: "ancient marine carbon" is probably supposed to just be "ancient carbon"?

Thank you for pointing out this error. "Marine" has been removed. [line 204]

3. And there is a repetition of the following sentences "The distinct geomorphology of Ameralik and Nuup Kangerlua, particularly their differing sill depths, shapes bottom water exchange and temperature regimes, which can influence organic matter preservation. Both fjords have no anoxic deep-watermasses, and bottom water renewal occurs every one to two years (Mortensen, 2011; Stuart-Lee et al., 2021). However, Ameralik's shallower sill depth (~110 m) compared to Nuup Kangerlua (~200 m) restricts the inflow of warmer, saltier coastal waters (Stuart-Lee et al., 2021), resulting in slightly lower bottom water temperatures (~0.5 °C in Ameralik vs. ~1.3 °C in Nuup Kangerlua during spring sampling). While such temperature differences may contribute to the higher pigment and OC preservation observed in the slightly colder bottom waters of Ameralik, their overall impact is likely modest. Arctic microbial communities are well adapted to low temperatures, and mineralization rates below 10 °C differ only minimally (Thamdrup et al., 2007; Scholze et al., 2020). Nevertheless, the relationship between temperature, water renewal, and preservation remains worth considering, as studies from Svalbard fjords have suggested higher pigment content in sediments associated with colder bottom waters (Krajewska et al., 2020)."

Once starting in line 406 and once more in line 418.

Thank you for noticing this. Indeed, this entire part got accidentally repeated. We removed the repetition. [Lines 327-438].

4. Finally, we noticed a missing reference, which we added to the list:

Erlandsson, C. P.: Vertical transport of particulate organic matter regulated by fjord topography, Journal of Geophysical Research Atmospheres, 113, https://doi.org/10.1029/2006jg000375, 2008.