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*Supplement of*

# Sedimentary organic carbon dynamics in a glaciated Arctic fjord: tracing contributions of terrestrial and marine sources in the context of Atlantification over recent centuries

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Table S1. OC end-member values used to estimate the relative proportion of OC based on the MC analyses. SD denotes 'standard deviation'.

| OC source | Parameters | n | ±SD | References |
|---|---|---|---|---|
| | **$\Delta^{14}C_{org}$ (‰)** | | | |
| Petrogenic | −1000 | 1 | 0 | Coal samples in Kongsfjorden (Kim et al., 2011) |
| Soil-derived | −344.4 | 10 | 358.9 | Three soil samples in Kongsfjorden (Kim et al., 2023), four soil samples around Kross/Kongsfjorden (Kim et al., 2011), and three soil samples from the Ny-Ålesund area (Kusch et al., 2021) |
| Plant-derived | 9.1 | 48 | 6.4 | Average value of atmospheric $^{14}CO_2$ from the Alert station (Canadian high Arctic) during the period of 2015-2019 (Levin et al., 2022) |
| Marine | 5.2 | 21 | 6.3 | 21 $\Delta^{14}C_{org}$ value of POC data reported in the northwestern part of the Svalbard (Sanz-Martin et al., 2019) |
| | **$\delta^{13}C_{org}$ (‰ VPDB)** | | | |
| Petrogenic | −25.74 | 18 | 1.89 | 14 bedrock samples from the western part of the Svalbard, and four coal samples from the Ny-Ålesund area (Kim et al., 2023; Kim et al., 2011) |
| Soil-derived | −25.48 | 46 | 2.25 | 28 soil samples from the areas around Longyearbyen and Ny-Ålesund (Kim et al., 2023), 18 soil samples from Kross/Kongsfjorden (Kim et al., 2011; Kusch et al., 2021) |
| Plant-derived | −31.38 | 12 | 1.63 | 12 plant samples collected around Longyearbyen (Kim et al., 2023) |
| Marine | −19.9 | 20 | 0.2 | 15 POC data in Isfjorden, Kongsfjorden and Hornsund (Holding et al., 2017), five POC data in Kongsfjorden (Kuliński et al., 2014) |
| | **(Ad/Al)v ratio** | | | |
| Petrogenic | 0.49 | 17 | 0.16 | 14 bedrock samples from the western part of the Svalbard, and three coal samples from the Ny-Ålesund area (Kim et al., 2023) |
| Soil-derived | 1.37 | 28 | 1.47 | 28 soil samples from the areas around Longyearbyen and Ny-Ålesund (Kim et al., 2023). |
| Plant-derived | 0.33 | 12 | 0.09 | 12 plant samples collected around Longyearbyen (Kim et al., 2023) |
| Marine | 0 | | 0 | Assigning a (Ad/Al)v value of 0±0 to marine OC due to lignin phenols being exclusively produced by land vascular plants |
| | **Lignin phenols (mg/gOC)** | | | |
| Petrogenic | 0.01 | 17 | 0.00 | 14 bedrock samples from the western part of the Svalbard, and three coal samples from the Ny-Ålesund area (Kim et al., 2023) |
| Soil-derived | 4.44 | 28 | 4.72 | 28 soil samples from the areas around Longyearbyen and Ny-Ålesund (Kim et al., 2023). |
| Plant-derived | 26.07 | 12 | 20.47 | 12 plant samples collected around Longyearbyen (Kim et al., 2023) |
| Marine | 0 | | 0 | Assigning a lignin phenol value of 0±0 to marine OC due to lignin phenols being exclusively produced by land vascular plants |

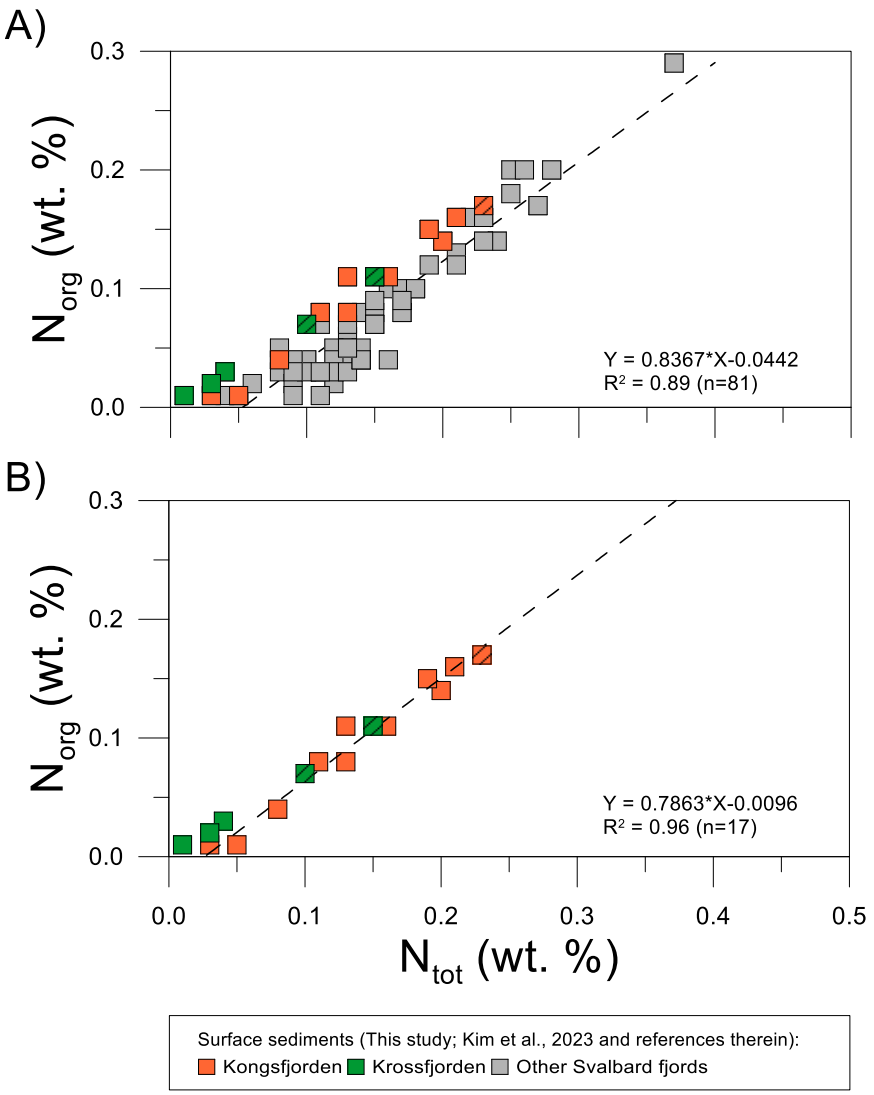


Fig. S1. Scatter plots of $N_{tot}$ content (wt. %) versus $N_{org}$ content (wt. %) in surface sediments from (A) various Svalbard fjords, including Kongsfjorden and Krossfjorden, and (B) only Kongsfjorden and Krossfjorden. Note that the surface sediment samples newly analyzed in this study are indicated by hashed square symbols.

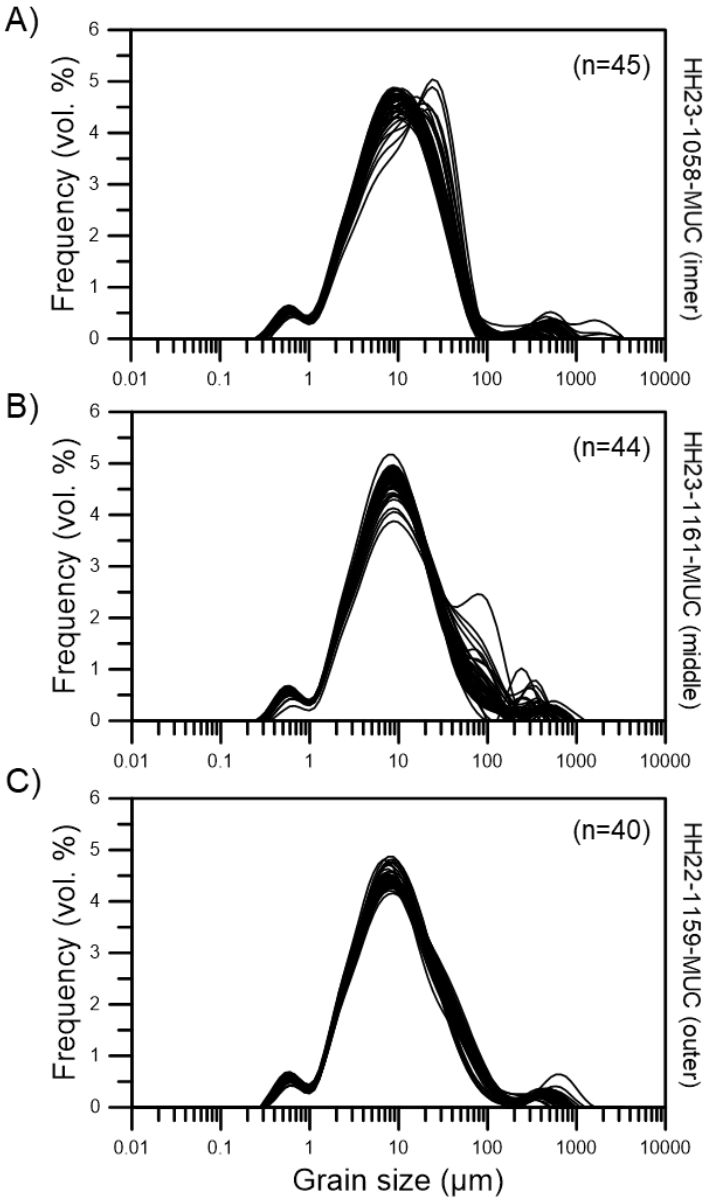


Fig. S2. Grain-size distribution curves for the multicores investigated in this study.

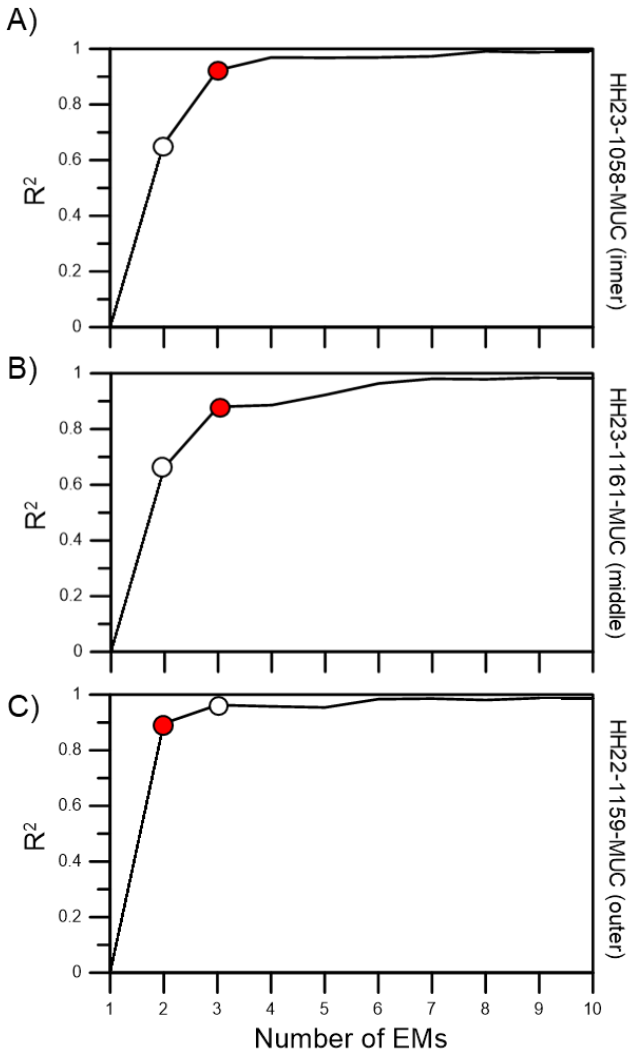


Fig. S3. Scatter plots of end-member (EM) counts (Q) versus the coefficient of determination ($R^2$) for multicores (A) HH23-1058MUC, (B) HH22-1161MUC, and (C) HH22-1159MUC. Filled red circles indicate the determined numbers of grain-size EMs and white circles indicate alternative numbers of grain-size EMs.

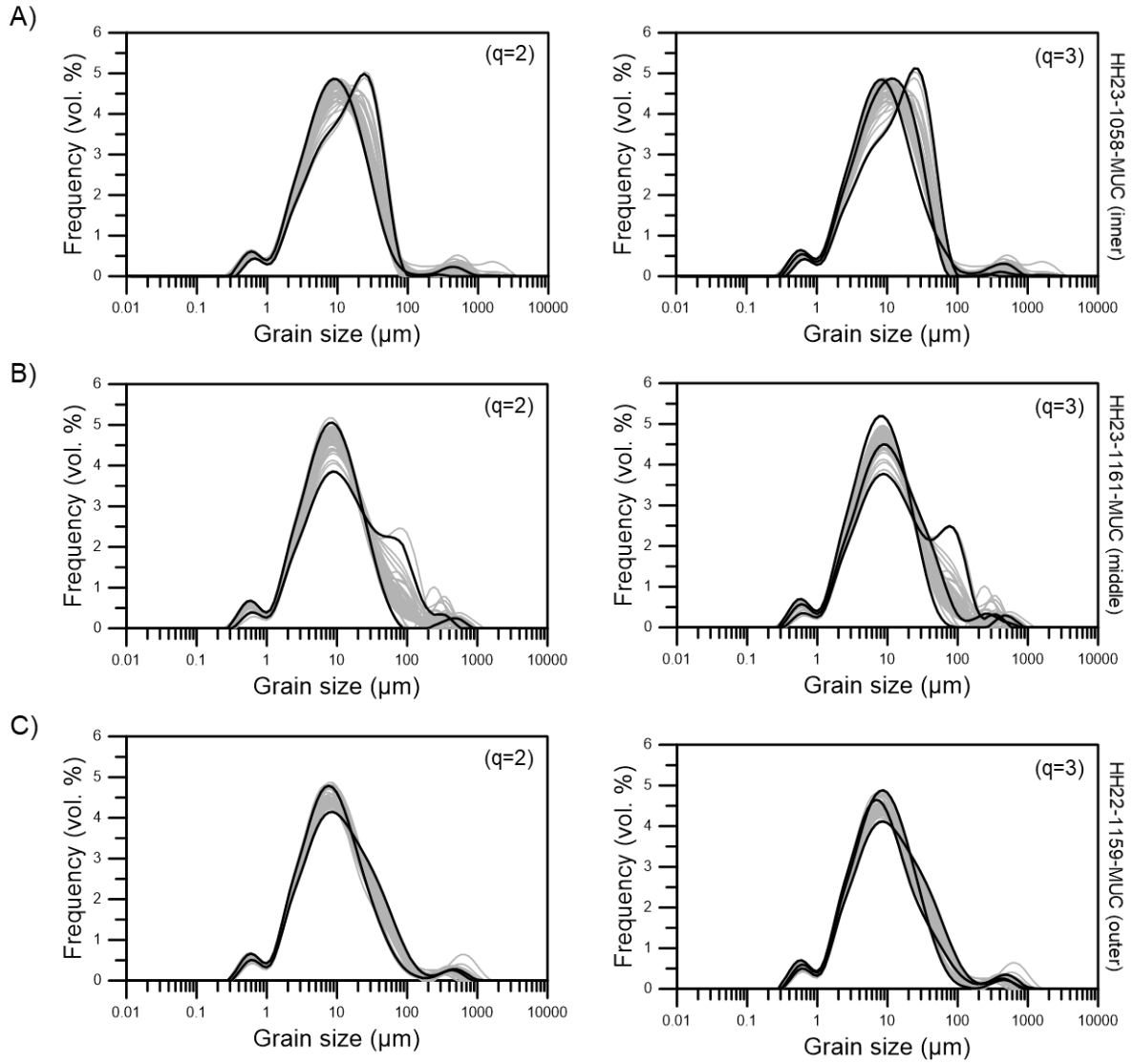


Fig. S4. Potential grain-size end-member distribution curves (black lines) for multicores (A) HH23-1058MUC, (B) HH22-1161MUC, and (C) HH22-1159MUC. Note that the grey lines represent the grain-size distribution curves for each sampling depth of the multicores investigated in this study.

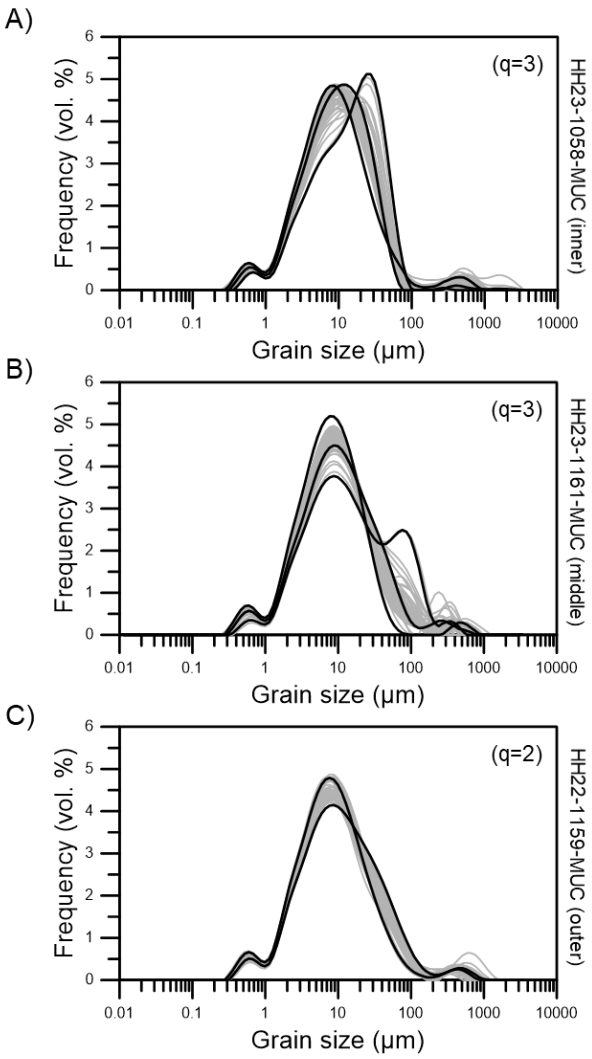


Fig. S5. Grain-size end-member distribution curves (black lines) for the multicores (A) HH23-1058MUC, (B) HH22-1161MUC, and (C) HH22-1159MUC.

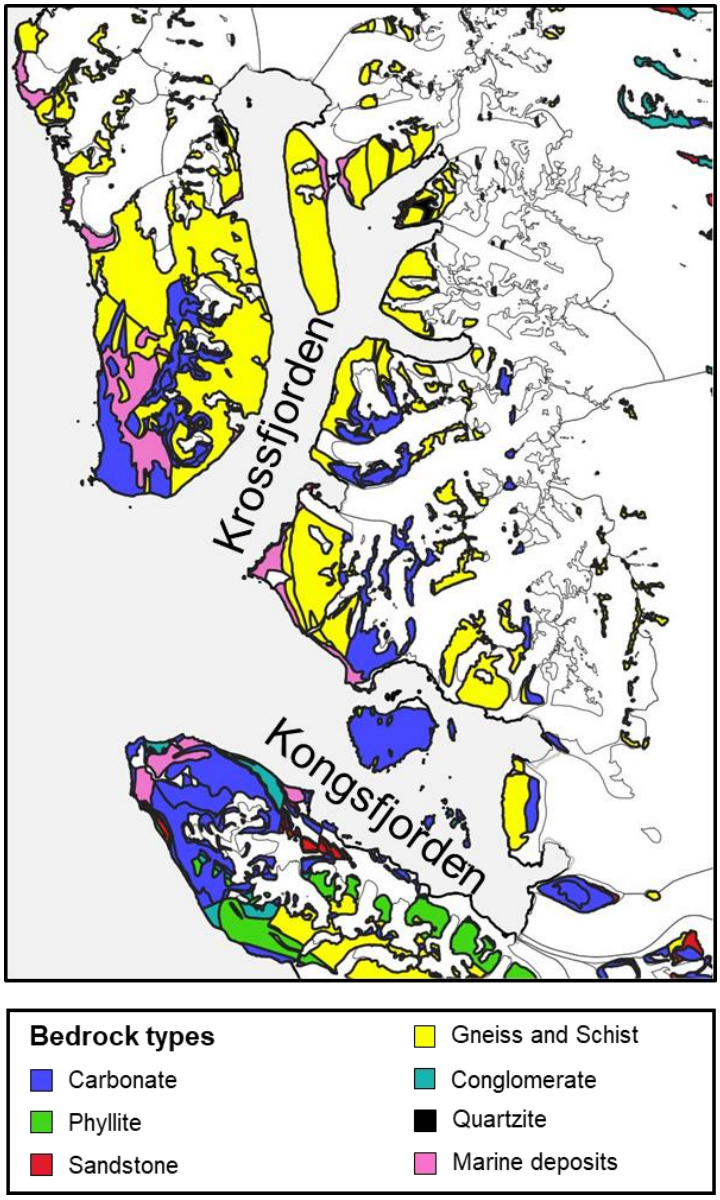


Fig. S6. Distribution of bedrocks and sedimentary/metamorphic rocks in Kongsfjorden and Krossfjorden. The maps were generated using QGIS v3.14 (https://qgis.org/en/site/forusers/visualchangelog314/), based on IBCAOv4 (https://www.ngdc.noaa.gov/mgg/bathymetry/arctic/) and data from Dallmann and Elvevold (2015).

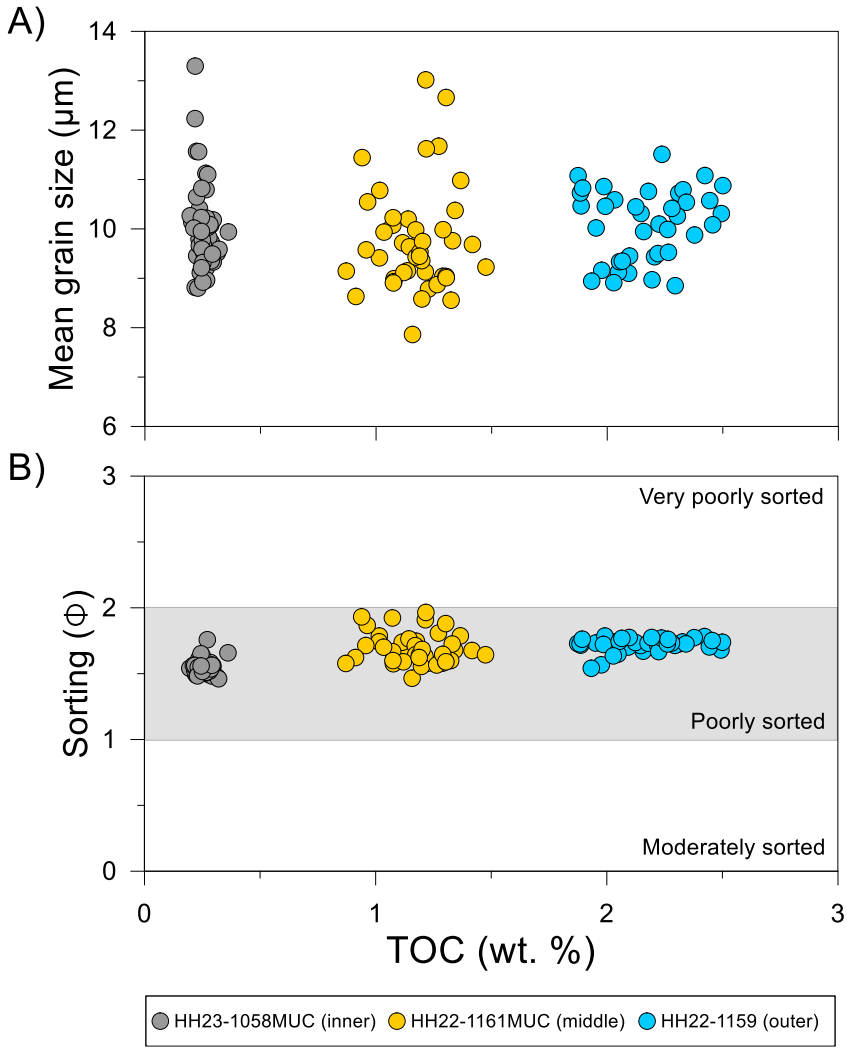


Fig. S7. Scatter plots of the (A) mean grain size (µm) and (B) sorting (Φ) versus TOC content (wt. %) for the multicores investigated in this study.

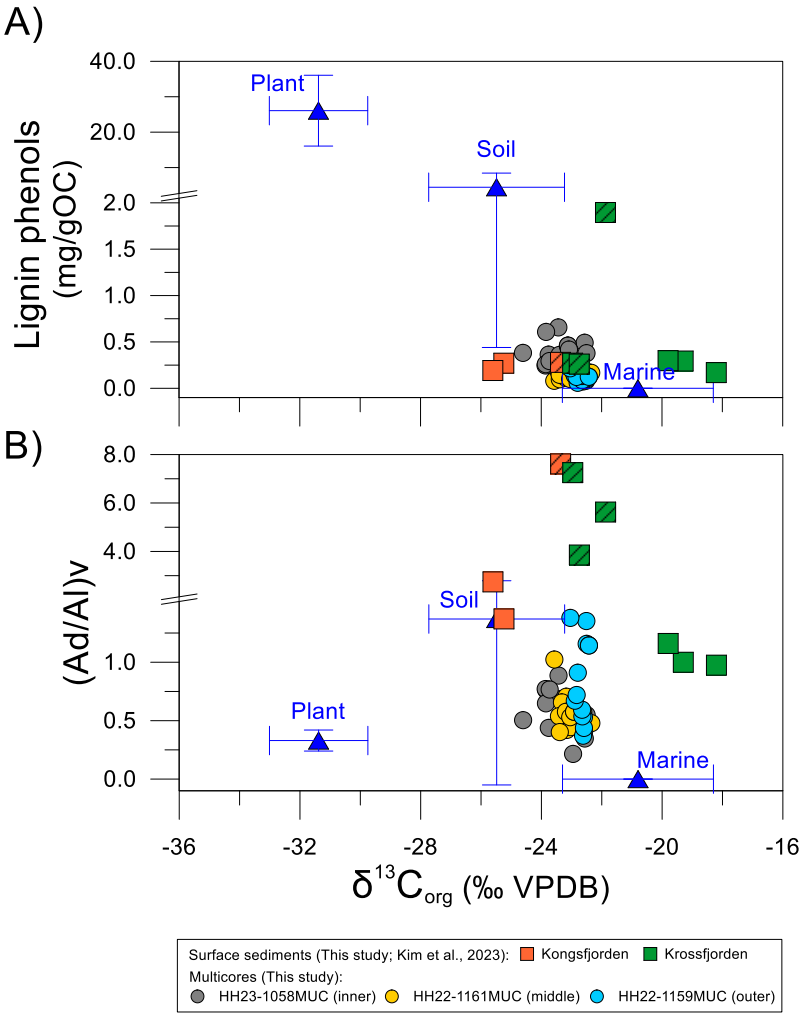


Fig. S8. Scatter plots of $\delta^{13}C_{org}$ (‰ VPDB) versus (A) lignin phenols (mg/gOC) and (B) (Ad/Al)v ratio in surface sediments and multicores collected from Kongsfjorden and Krossfjorden. The mean and range of OC source values, such as plants, soils, and marine, are indicated by filled triangles and bars in blue. Note that the surface sediment samples newly analyzed in this study are indicated by hashed square symbols.

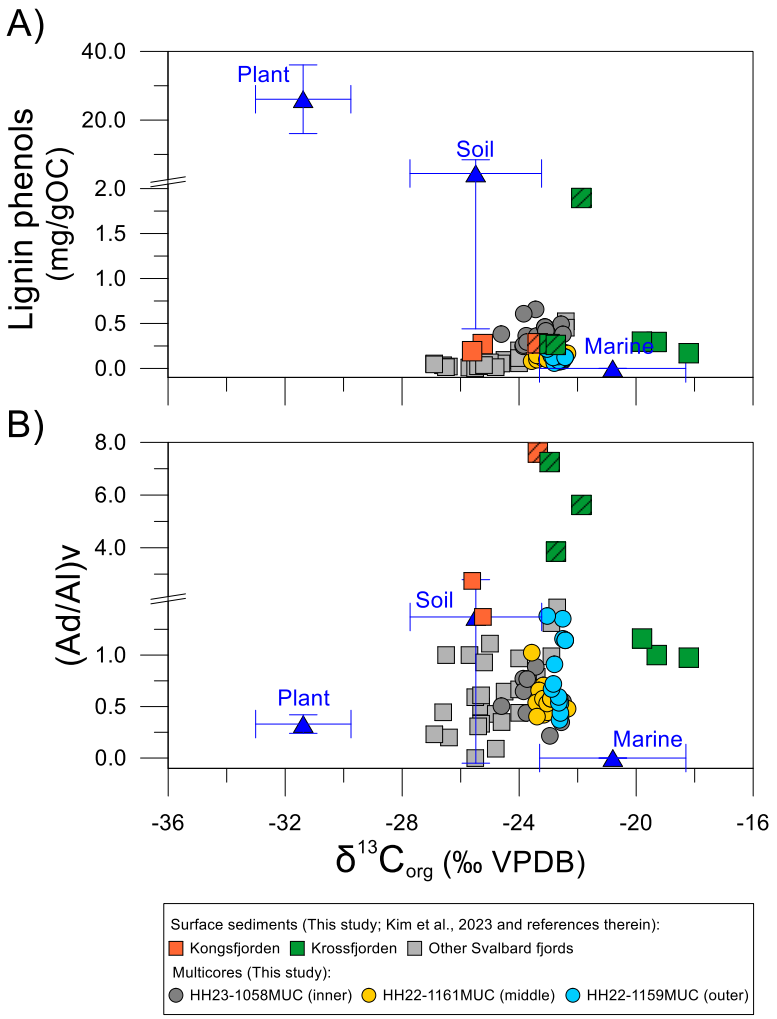


Fig. S9. Scatter plots of $\delta^{13}C_{org}$ (‰ VPDB) versus (A) lignin phenols (mg/gOC) and (B) (Ad/Al)v ratio in surface sediments and multicores collected from Kongsfjorden and Krossfjorden, including data from other Svalbard fjords. The mean and range of OC source values, such as plants, soils, and marine, are indicated by filled triangles and bars in blue. Note that the surface sediment samples newly analyzed in this study are indicated by hashed square symbols.

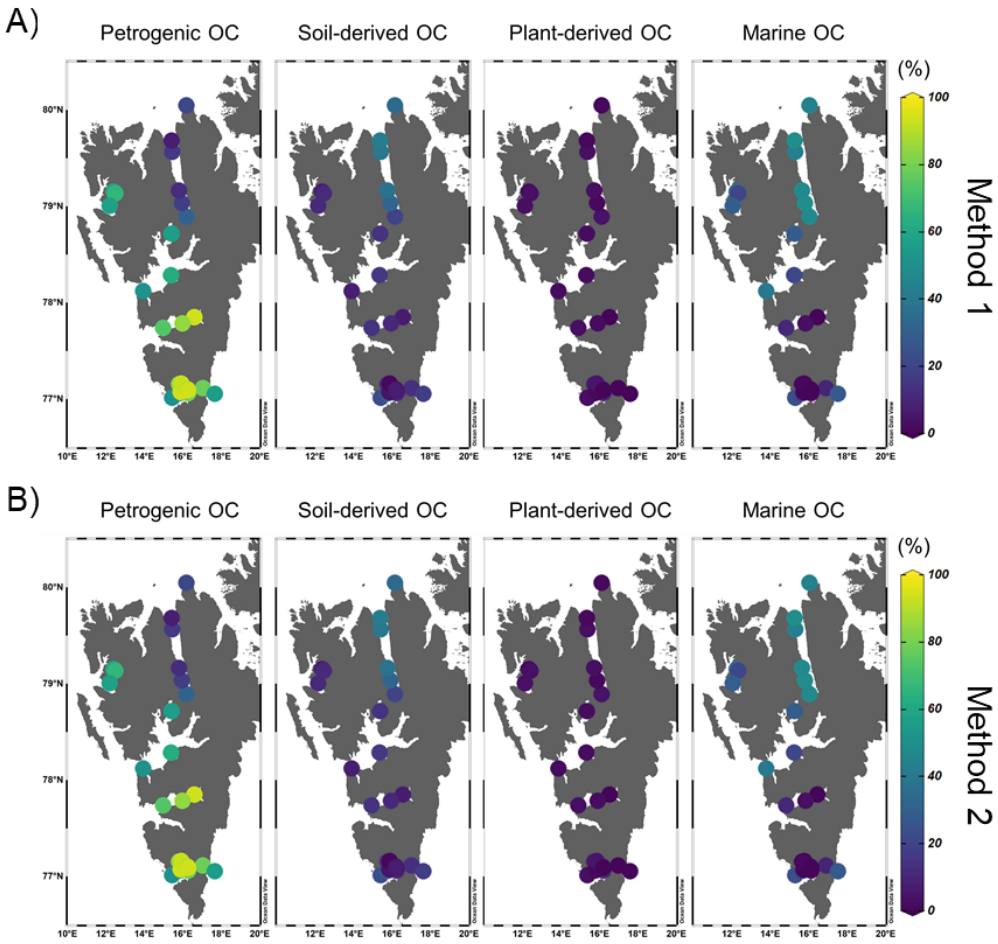


Fig. S10. Spatial distribution of the relative contributions of petrogenic, soil-derived, plant-derived, and marine OC (%) calculated using (A) Method 1, based on $\Delta^{14}C_{org}$, $\delta^{13}C_{org}$, and the (Ad/Al)v ratio, and (B) Method 2, based on $\Delta^{14}C_{org}$, $\delta^{13}C_{org}$, and lignin phenol concentrations, for surface sediment samples in Svalbard fjords.

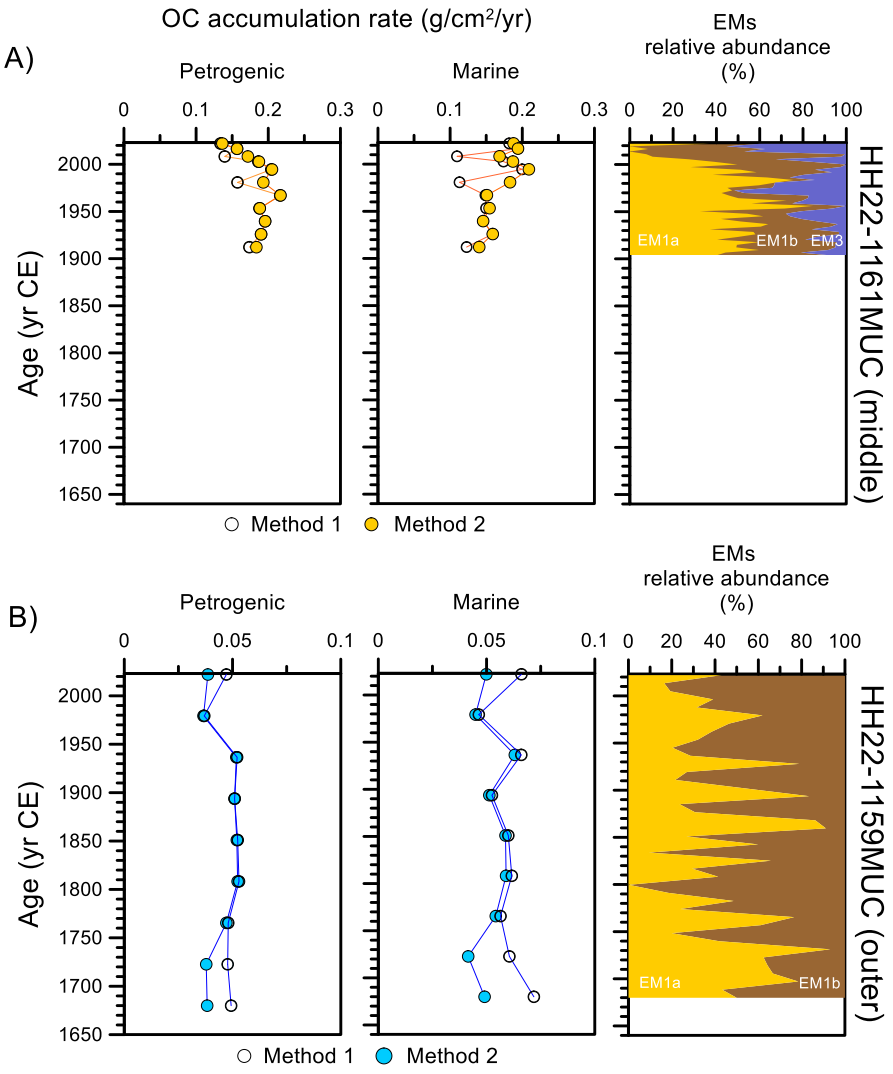


Fig. S11. Age profiles of the accumulation rates of petrogenic and marine OC derived from Method 1 and Method 2, and the relative abundances of EMs for multicores (A) HH22-1161MUC and (B) HH22-1159MUC.

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