Tracing terrestrial organic matter in two contrasting Arctic systems: a case study in the Mackenzie Trough in the Canadian Beaufort Sea and in Wijdefjorden in the Svalbard Archipelago

Dahae Kim[1,2], Jung-Hyun Kim[1*], Sujin Kang[2], Kwangkyu Park[1], Dong-Hun Lee[2], Young Keun Jin[1], Seung-Il Nam[1], Kyung-Hoon Shin[2]

[1]*KOPRI Korea Polar Research Institute, 26 Songdomirae-ro, Yeonsu-gu, Incheon 21990, Republic of Korea*

[2]*Hanyang University, 55 Hanyangdaehak-ro, Sangrok-gu, Ansan 15588, Republic of Korea*

The Arctic is warming twice as fast as other parts of the Earth by thawing permafrost and thus mobilizing the organic carbon (OC) stored in permafrost. With ongoing climate changes, inputs of terrestrial OC into the Arctic Ocean have been expected to increase through several pathways including river discharges, coastal erosions, and glacial discharges. In order to understand the Arctic carbon cycle, knowledge of OC dynamics with various regional characteristics is essential.

The Mackenzie River, which flows into the Beaufort Sea, is the fourth-largest Arctic river in terms of freshwater discharge, but the first in terms of sediment discharge. Wijdefjorden is the longest fjord in Svalbard archipelago, located in the northern portion of the island of Spitsbergen, which supplies glacigenic terrestrial material through glacial discharges. In this study, two contrasting Arctic environments were investigated using surface sediments collected along Mackenzie Trough and Wijdefjorden during the expeditions of the R/V ARAON (ARA04C, ARA05C, and ARA08C in 2013, 2014, and 2017) and R/V Helmer Hanssen (HH17 in 2017), respectively. We analyzed the samples for bulk (e.g. Corg/Norg ratio, $\delta^{13}C_{org}$, and $\delta^{15}N_{org}$) and molecular (concentrations and $\delta^{13}C$ of *n*-alkanes) parameters to assess sources of organic matter. In addition, we analyzed the radiocarbon content ($\Delta^{14}C$) to evaluate the contribution of fossil and non-fossil to the overall OC pool of OC. Our results will provide information on the contribution of organic carbon to the thawing of terrestrial permafrost in the two contrasting Arctic environmental systems.

*Corresponding author: J. H. Kim (jhkim123@kopri.re.kr)

Author information

Name	Affiliation	Email
Dahae Kim	KOPRI Korea Polar Research Institute, 26 Songdomirae-ro, Yeonsu-gu, Incheon 21990, Republic of Korea	dhkim@kopri.re.kr
Jung-Hyun Kim	KOPRI Korea Polar Research Institute, 26 Songdomirae-ro, Yeonsu-gu, Incheon 21990, Republic of Korea	jhkim123@kopri.re.kr
Sujin Kang	Hanyang University, 55 Hanyangdaehak-ro, Sangrok-gu, Ansan 15588, Republic of Korea	su1423@hanyang.ac.kr
Kwangkyu Park	KOPRI Korea Polar Research Institute, 26 Songdomirae-ro, Yeonsu-gu, Incheon 21990, Republic of Korea	kp@kopri.re.kr
Dong-Hun Lee	Hanyang University, 55 Hanyangdaehak-ro, Sangrok-gu, Ansan 15588, Republic of Korea	thomaslee0118@gmail.com
Young Keun Jin	KOPRI Korea Polar Research Institute, 26 Songdomirae-ro, Yeonsu-gu, Incheon 21990, Republic of Korea	ykjin@kopri.re.kr
Seung-Il Nam	KOPRI Korea Polar Research Institute, 26 Songdomirae-ro, Yeonsu-gu, Incheon 21990, Republic of Korea	sinam@kopri.re.kr
Kyung-Hoon Shin	Hanyang University, 55 Hanyangdaehak-ro, Sangrok-gu, Ansan 15588, Republic of Korea	shinkh@hanyang.ac.kr

The 25th International Symposium on Polar Sciences

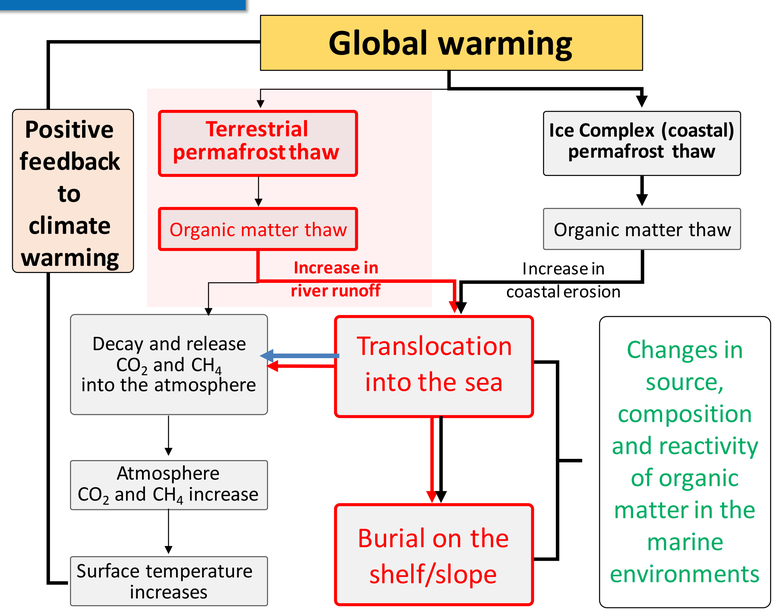
Tracing terrestrial organic matter in two contrasting Arctic systems:
A case study in the Mackenzie Trough in the Canadian Beaufort Sea and in Wijdefjorden in the Svalbard Archipelago

Dahae Kim[1,2], Jung-Hyun Kim[1*], Sujin Kang[2], Kwangkyu Park[1], Dong-Hun Lee[2], Young Keun Jin[1], Seung-Il Nam[1], Kyung-Hoon Shin[2]

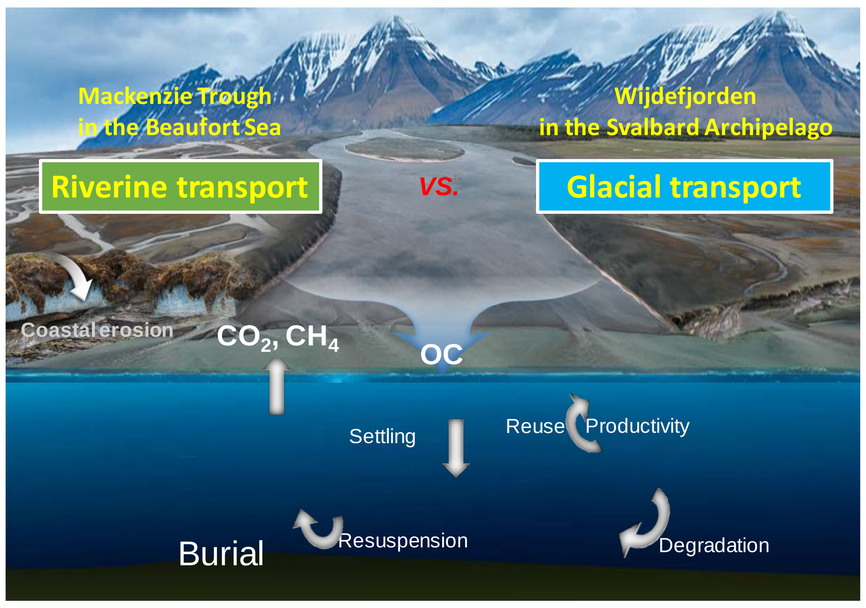
[1]Korea Polar Research Institute, 21990, Incheon, South Korea
[2]Department of Marine Sciences and Convergent Technology, Hanyang University, 15588, South Korea

Korea Polar Research Institute
HANYANG UNIVERSITY

Introduction



- The Arctic is warming twice as fast as the rest of the planet, thawing permafrost and thus mobilizing organic carbon (OC) stored in permafrost.
- With ongoing climate changes, inputs of terrestrial OC into the Arctic Ocean have been expected to increase through several pathways such as river discharges, coastal erosions, and glacial meltings.
- The potential decomposition of this OC and its subsequent release to the atmosphere as CO_2 or CH_4 constitutes a positive feedback to global warming.
- Knowledge of OC dynamics in various Arctic regions is essential to understand the Arctic carbon cycles.



- The Mackenzie River flowing into the Beaufort Sea is the fourth-largest Arctic river in terms of freshwater discharge, but the first in terms of sediment discharge.
- The Wijdeforden is the longest fjord in Svalbard Archipelago, located in the northern portion of the island of Spitsbergen, supplying terrestrial material through glacial discharges.

Study areas

Mackenzie Trough in the Beaufort Sea
Wijdefjorden in the Svalbard Archipelago

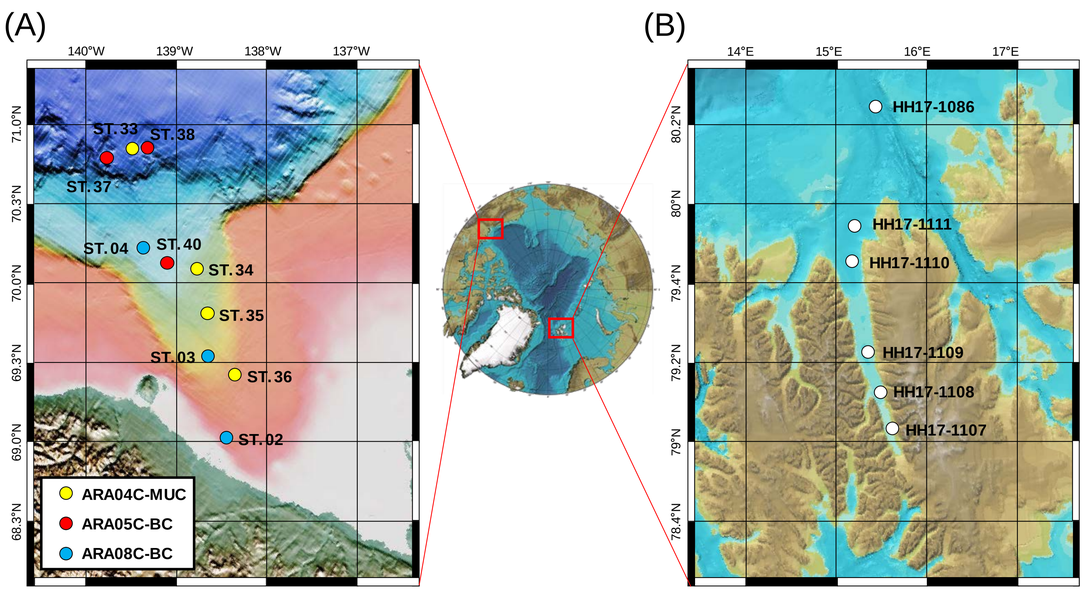


Fig. 1. Map showing the sampling sites of the study areas.
(A) Surface sediments acquired during the ARA04C, ARA05C, and ARA08C expeditions of the Korean ice-breaker R/V ARAON in the Canadian Beaufort Sea in 2013, 2014, and 2017, respectively.
(B) Surface sediments acquired during the HH17 expedition of the R/V Helmer Hansen in the Wijdefjorden in the Svalbard Archipelago.

Bulk parameters

Mackenzie Trough in the Beaufort Sea
Wijdefjorden in the Svalbard Archipelago

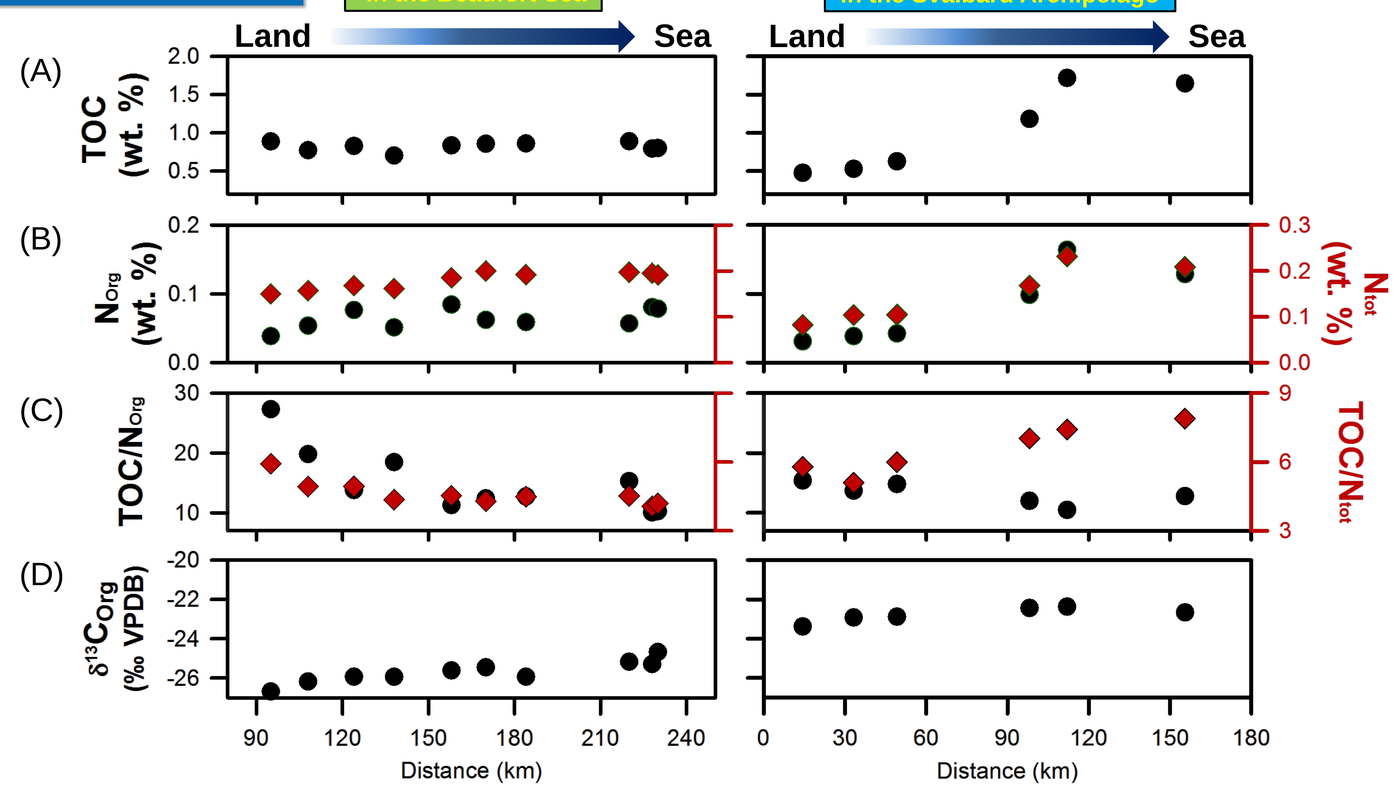


Fig. 2. The results of bulk parameters for surface sediments using EA-IRMS in two study sites: (A) total organic carbon contents (TOC, wt. %), (B) total organic nitrogen contents (N_{Org}, wt. %), (C) ratios of TOC to N_{Org}, and (D) stable carbon isotope values of TOC ($\delta^{13}C_{org}$, VPDB). The red-colored diamonds display total nitrogen contents (N_{tot}, wt. %) and ratios of TOC to N_{tot} in (B) and (C), respectively.

Molecular paramters

Mackenzie Trough in the Beaufort Sea
Wijdefjorden in the Svalbard Archipelago

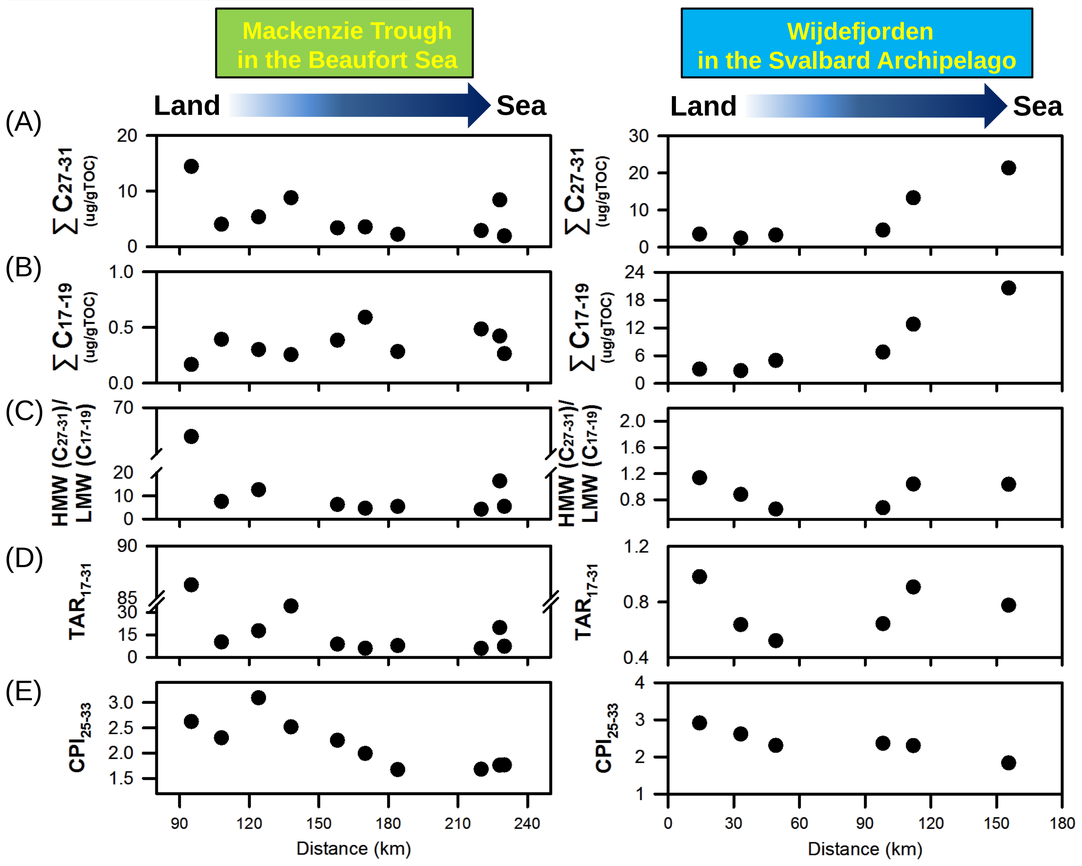


Fig. 4. Diverse *n*-alkane parameters for surface sediments: (A) the sum of *n*-alkanes with long chain and odd carbon number (C_{27} to C_{31}), (B) the sum of *n*-alkanes with short chain and odd carbon number (C_{17} and C_{19}), (C) the ratio of high molecular weight *n*-alkanes (C_{27}, C_{29}, and C_{31}) to low molecular weight *n*-alkanes (C_{17} and C_{19}), (D) terrestrial/aquatic ratio (C_{17} to C_{31}), and (E) carbon preference index (C_{25}-C_{33}). All indices were calculated based on the concentrations *n*-alkanes.

^{14}C contents of TOC

Mackenzie Trough in the Beaufort Sea
Wijdefjorden in the Svalbard Archipelago

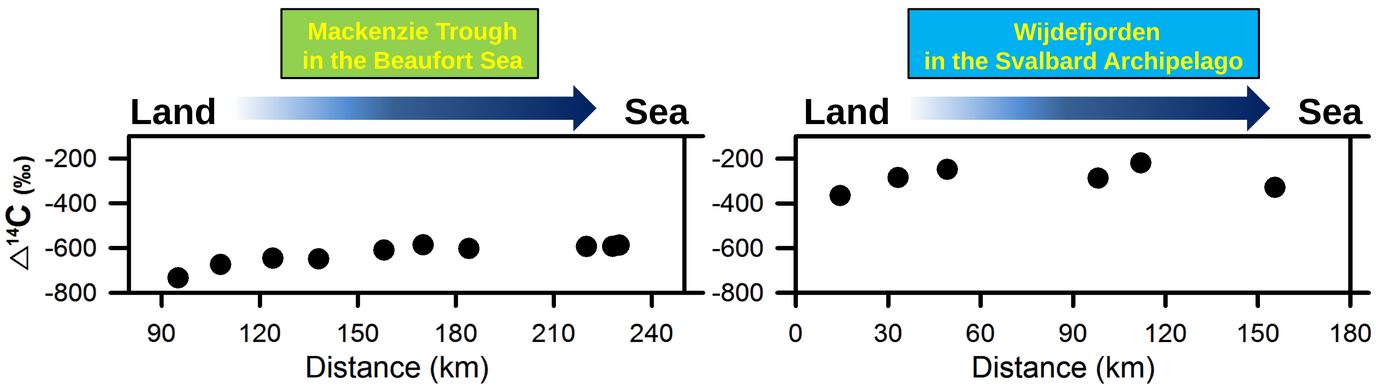


Fig. 3. Radiocarbon isotope values (^{14}C) of TOC. The samples were analyzed at the MICADAS ^{14}C dating facility of the Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research in Bremerhaven.

Summary

- At the head of both the Mackenzie Trough and the Wijdefjorden, TOC/N_{org} ratio were highest, showing a decreasing trend along the transects.
- The contents of TOC and N_{org} and $\delta^{13}C_{org}$ showed weak increasing patterns along the transect in both study areas.
- Overall the radiocarbon isotope values ($\Delta^{14}C$) of surface sediments in the Wijdefjorden were higher than those in the Mackenzie Trough.
- In the Mackenzie Trough, the sum of odd-carbon-numbered long-chain *n*-alkanes, HMW/LMW *n*-alkane, TAR, and CPI indices showed decreasing trends towards offshore.
- In the Wijdefjorden, the inner three sites and the outer three sites showed differences in both *n*-alkanes concentrations and indices.

Acknowledgement

This study was supported by the KOPRI project (PN18100; NRF-2016R1A2B3015388, PN18090; NRF-2015M1A5A1037243) funded by the National Research Foundation of Korea (NRF), and by the Ministry of Oceans and Fisheries (MOF) grants (PM18050; KIMST Grant 20160247).