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Dissolved and Particulate Organic Carbon Characteristics in Summer and Winter Waters of the Lena Delta

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ABSTRACT

Rapid Arctic warming accelerates permafrost thaw, altering water flow and organic matter transport to aquatic ecosystems. To identify sources and seasonality of OC at the mouth of the Lena River, we measured summer and winter concentrations and C isotopes ($\Delta^{14}C$ and $\delta^{13}C$) of DOC and POC along a 140-km transect of the Lena Delta. Despite low water flow during winter, DOC concentrations in the Lena Delta were higher than those measured at the end of the summer (6.31 ± 0.60 and 5.54 ± 0.17 mg L^{-1}, respectively). We found pronounced differences in the DOC isotopic composition of waters between seasons (winter: mean = −16‰ ± 16‰ ranging between −14‰ and 46‰ and summer: mean = 41‰ ± 26‰ in the range between −47‰ and 79‰). $\Delta^{14}C$ of winter DOC suggested higher relative contributions of older carbon compared to summer DOC, which is enriched in ^{14}C. POC in winter was lower (0.13 ± 0.06 and 0.40 ± 0.10 mgC L^{-1}, respectively) and enriched in $\delta^{13}C$ (−29.7 ± 2.2 and −32.4‰ ± 0.8‰, respectively) compared to summer, while no difference was found for $\Delta^{14}C$. This study with its unique dataset on the largest Arctic delta will help to assess the ongoing changes with climate warming at this frontier between the land and the ocean realm. Explicitly, the inclusion of winter sampling and isotopic analysis makes this study very valuable for assessing the biogeochemical response of the Arctic's biggest delta, as well as beyond.

1 | Introduction

The Arctic is experiencing unprecedented environmental change in response to global climate change. High-latitude landscapes are susceptible to ongoing surface permafrost thaw due to warming Arctic air and soil temperatures [1, 2]. Terrestrial landscape changes accelerate the release of organic matter (OM), containing organic carbon (OC), and nitrogen from peat, soil, and permafrost to inland aquatic systems [3–8]. Terrigenous OM and nutrients can be further transported to the Arctic coastal waters [9–11] with subsequent impacts on biogeochemical cycles, primary production, and dissolved inorganic carbon in the Arctic Ocean [12–14]. Contributions of permafrost-derived OC in aquatic and Arctic coastal waters are affected by changing river discharge regimes [15–17] and supply from rapidly eroding river banks [18–20] and coastlines [21]. Once mobilized into inland or coastal waters, permafrost and peat-derived OC from deepening active layers may be rapidly utilized by aquatic microorganisms and emitted to the atmosphere as carbon dioxide or methane [22, 23–25] enhancing riverine C emissions from river basins and nearshore waters [26]. Permafrost OC inputs to Arctic rivers and streams, particularly dissolved organic carbon (DOC) from ice- and organic-rich Yedoma permafrost, are highly labile and preferentially utilized by aquatic microorganisms, leading to patterns of decreasing permafrost contributions in OC pools with increasing water residence times [27–29].