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Ice algae-produced carbon in the central Arctic Ocean summer: Insights from lipid and stable isotope analyses in sea ice and the underlying water column

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Under the background of global change, sea ice algae is a very special and important primary producers in polar ecosystems, sea ice algae associate organic carbon makes an significant contribution to the "biological pump" of the Arctic Ocean, which in turn affects the food source of benthic organisms and the structure of the entire marine ecosystem. However, there is currently a lack of quantitative research on the changes of ice algae-produced organic carbon fluxes and their contribution to the "biological pump" in typical areas of Arctic Ocean, especially in the central Arctic Ocean. In this study, we investigated the spatial and temporal distribution of sea ice-derived particulate organic carbon (iPOC) and its contribution to the regional carbon cycle by analyzing highly branched isoprenoids (HBIs) and carbon ($\delta^{13}C$) isotope ratios in sea ice cores and the underlying water column (suspended and sinking particulate organic matter) in the central Arctic Ocean during summer 2023. Our results showed that ice-algae contributed most of the organic carbon in the marginal zone of sea ice in the central Arctic Ocean (low-latitude region), and the average proportion of iPOC to total POC was more than 80%. With increasing latitude, especially in the high-latitude region that close to the North Pole, ice-algae productivity decreased significantly, but the proportion of sea-ice-derived organic carbon contributing to the water column remained high (more than 50%). Quantitative analyses of IP_{25} and various other HBIs revealed that the intensity of ice algal production was higher in low-latitude regions, whereas high-latitude regions relied more on external inputs of organic matter. This study further reveals the critical role of sea ice on the ecosystems of the central Arctic Ocean, especially in the carbon transport function of the ice-algae biological pump. With climate change-induced sea ice retreat, the pattern of organic carbon production in the central Arctic Ocean is likely to change significantly, thus affecting the carbon cycle and ecosystem functioning in the region.