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Molecular, isotopic and gas-flux investigations of thaw-eroding reliefs of the Arctic Coastal-Ice complex in three different systems of the East Siberian Arctic Shelf

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Ongoing climate warming amplified in the Arctic region is intensifying the thawing and coastal erosion of the Late-Pleistocene Ice Complex (IC), widely distributed along the extensive East Siberian Arctic Shelf (ESAS). Despite the vulnerability toward decomposition of these old and carbon-rich deposits, coastal erosion of the IC remains severely understudied. Current notion is that 100% of the coastally-eroded IC organic carbon (OC) is slumped into the Arctic Ocean.

In this study, we provide elemental (C and N), isotopic (δ13C and Δ14C) and molecular (lipid biomarkers and CO_2 flux) evidences of the significant aerial degradation that the IC undergoes upon thawing before entering the sea. Six different parameters showed consistent increasing trends of degradation with the age of the thermally-destabilizing IC: 1) decreasing soil OC content, 2) increasing δ13OC, 3) decreasing Δ14OC, 4) decreasing ratio of high-molecular-weight (HMW) n-alkanoic acids to HMW n-alkanes, 5) increasing ratio of even-HMW to odd low-molecular-weight n-alkanes, and 6) increase in CO_2 atmospheric venting based on field-chamber soil respiration measurements.

Three IC systems affected by different types of thermal destabilization and coastal abrasion revealed different extent of degradation: 1) a beach-protected IC bluff on the Buor-Khaya Cape showed less pronounced degradation indicative of dormant erosion, 2) a more exposed IC scarp on the river-bank of the eroding Olenek Channel (Lena River delta) showed a further extent of degradation, and 3) the most exposed and intensively erosion-affected site (Muostakh Island) depicted increasing downscarp trends of degradation consistent with somehow higher soil CO_2 emissions.

This study documents the susceptibility of the IC OC pool to degradation upon thawing, suggesting the revision of previous estimates of the IC OC input to the Siberian Seas through coastal erosion. According to our estimations, about 66$\pm$16% (mean$\pm$stdev) of the remobilized IC OC in the Siberian coasts can be degraded to CO_2 and potentially also other metabolic gases (e.g. CH4) before entering the Arctic. This would mean that significant amounts of relict IC OC are introduced into the current atmospheric carbon pool.