EGU24-149, updated on 06 Aug 2024
https://doi.org/10.5194/egusphere-egu24-149
EGU General Assembly 2024

Quantifying permafrost organic carbon remineralization after redeposition on the ocean floor, using $\delta^{13}C$ and $F^{14}C$.

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Arctic permafrost is a critical global tipping element in a warming climate. Annually, the erosion of coastal permafrost discharges an estimated 5 to 14 Tg of organic carbon (OC) into the Arctic Ocean. Although this previously stored OC has the potential to be reintroduced into the atmosphere, thus accelerating human-induced climate change, little is known about the benthic remineralization processes of permafrost OC after erosion and redeposition on the ocean floor. Our research quantified fluxes of dissolved inorganic carbon (DIC) and analyzed its isotopic composition of nearshore sediments in the Canadian Beaufort Sea, specifically off Herschel Island. Our findings showed a DIC release of 0.217 mmo/m²/d, with an average signature of $\delta^{13}C$ = -22.44 ± 72 ‰ and $F^{14}C$ = 0.548 ± 0.007. Utilizing a model that combines two carbon isotopes, we estimate that approximately 38 ± 10% of the released DIC is a result of subsurface degradation of redeposited permafrost OC, with an additional 15 ± 12% originating from redeposited active layer OC. Additionally, isotopic endmember analysis was utilized on bacterial membrane lipids from live sedimentary bacteria to determine the relative utilization of OC sources in bacterial communities within shallow subsurface sediment (<25 cm). Our results indicate that, on average, these communities obtain 73 ± 10% of their OC from recent marine primary production, 11 ± 6% from permafrost OC, and 16 ± 11% from active layer OC. This study is the first direct quantitative assessment of the release of permafrost OC into the active carbon cycle after it has been redeposited on the ocean floor, as far as we know. The data suggest that the redeposited permafrost OC is easily accessible and utilized by subsurface bacteria. Considering the immense size and vulnerability of the eroding coastal permafrost OC pool, 27 to 53% of it contributing to benthic DIC fluxes could have a prolonged effect on the world's climate, worsening the climate emergency.