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PERMAFROST CARBON DEGRADATION AT THE LAND-OCEAN-INTERFACE

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The Arctic is highly vulnerable to environmental change and is currently undergoing one of the most rapid transitions experienced on Earth. Arctic permafrost coasts, which account for 34% of the coasts of the Earth, are naturally exposed to these changes. As natural pathways for sediment, organic carbon, and nutrients from land to the ocean, they play a key role in driving shifts in the Arctic ecosystem. Changing environmental conditions could lead to greater erosion of theses coasts in the Canadian Arctic due to warmer climate, longer open water seasons, and stronger storms. Greater erosion would result in potential greater release of organic carbon and nutrients, yet, the impact of this process on the climate and the coastal ecosystem is virtually unknown. In this study, we show results from field investigations and laboratory experiments investigating the release of organic carbon and nutrients in the southern Canadian Beaufort Sea and show the large potential of this process on the Earth climate system.

The study area is the Yukon Coastal Plain, which is located in the western Canadian Arctic and is characterized by the occurrence of ice-rich permafrost. Ground ice occurrence at the coast leads to the formation of retrogressive thaw slumps, which release large quantities of sediment to the ocean. Their contribution has traditionally not been considered in coastal biogeochemical budgets. The organic matter (organic carbon and nitrogen) released from these slumps is either directly transported to the ocean by thaw streams, or deposited on the slump floor before it enters the coastal zone. The degradation processes affecting the organic matter on their way to the ocean are not known but could directly impact its quantity and bioavailability.

Several sampling transects were surveyed through a coastal retrogressive slump perpendicular to the coastline to investigate these degradation processes. Samples were taken from the active layer of the tundra above the slump, from permafrost sediments in the slump headwall, from slump deposits, and from the thaw stream to account for all morphological elements. The concentration and ratios of organic carbon (POC, δ13C, DOC, δ13DOC) and nitrogen (TON, DON) were analyzed to account for all components of the organic matter. These values were connected to archive and recent remote sensing imagery to track degradation of carbon due to slumping.

We show that slumping does affect carbon quantity and lability in soils. Given the widespread nature of these features and their increasing occurrence, their role in modifying organic matter quantity and quality should be taken into account in coastal biogeochemical budgets.