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Collapsing permafrost coasts in the Arctic

Michael Fritz (1) and Hugues Lantuit (1,2)

(1) Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research, Periglacial Research, Potsdam, Germany (michael.fritz@awi.de), (2) University of Potsdam, Institute for Earth and Environmental Sciences, Potsdam, Germany

Arctic warming is exposing permafrost coastlines, which account for 34% of the Earth's coasts, to rapid thaw and erosion. Coastal erosion rates as high as 25 m yr-1 together with the large amount of organic matter frozen in permafrost are resulting in an annual release of 14.0 Tg (1012 gram) particulate organic carbon into the nearshore zone. The nearshore zone is the primary recipient of higher fluxes of carbon and nutrients from thawing permafrost. We highlight the crucial role the nearshore zone plays in Arctic biogeochemical cycling, as here the fate of the released material is determined to: (1) degrade into greenhouse gases, (2) fuel marine primary production, (3) be buried in nearshore sediments or (4) be transported offshore. With Arctic warming, coastal erosion fluxes have the potential to increase by an order of magnitude until 2100. Such increases would result in drastic impacts on global carbon fluxes and their climate feedbacks, on nearshore food webs and on local communities, whose survival still relies on marine biological resources. Quantifying the potential impacts of increasing erosion on coastal ecosystems is crucial for food security of northern residents living in Arctic coastal communities. We need to know how the traditional hunting and fishing grounds might be impacted by high loads of sediment and nutrients released from eroding coasts, and to what extent coastal retreat will lead to a loss of natural habitat.
Quantifying fluxes of organic carbon and nutrients is required, both in nearshore deposits and in the water column by sediment coring and systematic oceanographic monitoring. Ultimately, this will allow us to assess the transport and degradation pathways of sediment and organic matter derived from erosion. We need to follow the complete pathway, which is multi-directional including atmospheric release, lateral transport, transitional retention in the food web, and ultimate burial in seafloor sediments.

We present numbers of multi-year dissolved organic matter (DOM) fluxes from coastal erosion into the nearshore zone of the southern Canadian Beaufort Sea. We further explore removal and degradation patterns of DOM based on oceanographic monitoring of coastal waters. Ultimately, we present accumulation rates and biogeochemical properties of marine sediment sequences drilled off the Yukon coast to track the pathways of the eroded material.